Ocean Trap and Line Fishery

Environmental Impact Statement

Public Consultation Document

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NSW Department of Primary Industries
Agriculture and Fisheries Division
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NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Details of the public consultation process and contact information are included on page 24 of Chapter A

Environmental Impact Statement on the Ocean Trap and Line Fishery in NSW

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DECLARATION

For the purpose of section 115K(4) of the *Environmental Planning and Assessment Act 1979*, the Director-General, NSW Department of Primary Industries is the person engaged as responsible for the preparation of this Environmental Impact Statement (EIS). The Director-General, NSW Department of Primary Industries is Mr Barry Buffier. A range of NSW Department of Primary Industries staff and stakeholders with expertise and qualifications in fisheries management, environmental science, fisheries science and fisheries compliance assisted in the preparation of the EIS. Where expertise was not available within NSW Department of Primary Industries, external experts were contracted.

The EIS has been prepared by NSW Department of Primary Industries on behalf of the persons whom are entitled to operate in the Ocean Trap and Line Fishery (the proponents). A list of proponents is contained in Appendix A1 of this EIS.

The address for NSW Department of Primary Industries is:

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The location of the proposed activity is described in Chapter D. A description of the proposed activity and proposed controls is also provided in Chapter D. An assessment of the environmental impact of the proposed activity as described in the draft Fishery Management Strategy (Chapter D) is presented in Chapter E. This EIS contains all available information relevant to the environmental assessment of the activity to which the statement relates. The information provided in the EIS is neither knowingly false nor misleading.

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Acknowledgments

NSW Department of Primary Industries would like to thank the many people who contributed substantial amounts of time and effort towards preparing this EIS, often within short timeframes.

The management planning and environmental assessment teams within NSW Department of Primary Industries have put in a great deal of dedicated work over the past 2 years, and numerous other departmental staff have made useful comments and suggestions on the drafts.

The members of the various advisory bodies who reviewed drafts of the fishery management strategy and EIS must be acknowledged. They have provided valuable and constructive feedback, although the views expressed within this document are not necessarily those of the advisory bodies. The Management Advisory Committee (MAC) for the Ocean Trap and Line Fishery in particular has spent several meetings and much of members' personal time reviewing and providing advice on the various drafts of the Fishery Management Strategy and the EIS. Members of the following statutory Ministerial advisory councils (membership is detailed on the following page) have also reviewed the draft EIS:

Seafood Industry Advisory Council

Advisory Council on Recreational Fishing

NSW Department of Primary Industries appreciates the timely and committed efforts of the consultants who reported on sections of the environmental assessment guidelines: Dominion Consulting Pty Ltd and Umwelt (Australia) Pty Limited.

Membership on Advisory Boards

Ocean Trap and Line Management Advisory Committee (at February 2006)

Dr Julian Amos (Chair)	Mr John Garven	Ms Megan Kessler
Mr Allen Hicks	Mr John Joblin	Ms Sonya Errington
Mr Paul Sullivan	Mr Garry Braithwaite	1 vacancy
Mr Matthew Creek	Mr Peter Goadby	

Seafood Industry Advisory Council (at February 2006)

Mr John Roach (Chair)	Mr Ron Prindable	Mr Ian Charles
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Mr Jim Drinkwater	Mr Grahame Turk	Mr George Davey
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Mr Ron Firkin	Mr Tony Troup	1 vacancy

Advisory Council on Recreational Fishing (at February 2006)

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Mr Jim Harnwell	Mr Terry Maloney	Mr Graham Moore
Mr John Clarke	Mr Otto Volz	Mr Nick James
Mr Neil Ryan	Ms Meredith Peach	
Mr Anthony Moore	Mr John Dunphy	

Abbreviations

4WD	Four wheel drive
ABS	Australian Bureau of Statistics
AFFA	Australian Fisheries Forestry and Agriculture
ARC	Australian Research Council
AS/NZS	Australian/New Zealand Standard
CAMBA	China-Australia Migratory Bird Agreement
CBA	Cost-benefit analysis
DEH	Department of Environment and Heritage (Commonwealth)
DP	Department of Planning
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecologically Sustainable Development
FM Act	*Fisheries Management Act 1994*
FMS	Fishery Management Strategy
FRDC	Fisheries Research and Development Corporation
FSC	Fisheries Scientific Committee
GIS	Geographic Information System
IFS	Indigenous Fisheries Strategy
IFWG	Indigenous Fisheries Working Group
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
KTP	Key Threatening Process
MLL	Minimum Legal Length
NM	Nautical Miles
NP	National Park
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Service
NR	Nature Reserve
OCS	Offshore Constitutional Settlement
OH&S Act	*Occupational Health and Safety Act 2000*
PDF	Adobe Acrobat © portable document format
SEINS	Self Enforcing Infringement Notice System
SRMPA	The Scientific Research and Miscellaneous Permit Administration of NSW Department of Primary Industries
TAP	Threat Abatement Plan
TSBU	Threatened Species and Biodiversity Unit (a section of NSW Department of Primary Industries)
TSC Act	*Threatened Species Conservation Act 1995*

Glossary

Active effort	Fishing Businesses or entitlements that are actively fished
Biodiversity	The variability among living organisms from all sources (including marine and other aquatic ecosystems and the ecological complexes of which they are a part). Includes: diversity within species (genetic diversity), among species (species diversity); and ecosystems (ecosystem diversity).
Critical habitat	An area or areas of habitat declared under threatened species legislation to be critical to the survival of a threatened species.
Ecological community	The species that occur together (often delimited by a geographic boundary).
Ecologically Sustainable Development	Using, conserving and enhancing the community's resources so that ecological processes on which life depends, are maintained, and the total quality of life, now and into the future, can be increased (CoA, 1992).
Ecosystem	The biotic (living) community and its abiotic (non-living) environment.
Endangered species	Species that is likely to become extinct due to threatening process(es), reduction in population size or available habitat (under the FM and TSC Acts).
Growth overfishing	This occurs when too many small fish are taken, and therefore too few grow to a size that provides the largest yield from the fishery. Growth overfishing generally results when the fishing gear retains significant numbers of fish smaller than the optimum size. [Note that where several fisheries exploit one species, different fishing gears may be used, but all may not contribute to the 'growth overfishing'.]
Latent effort	Those endorsements never used or used at very low levels
Precautionary principle	A principle of ESD, which states that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Recovery plan	Plan designed to return a threatened species, population or ecological community to a point where its survival in nature is assured (i.e. it is no longer threatened). Preparation of recovery plans for threatened species is required under the FM Act, TSC Act and EPBC Act.
Recruitment overfishing	This occurs when fishing greatly reduces the number of mature (breeding) fish in a population, causing a decline in the reproductive output and leading to a very significant reduction in the number of young fish recruiting to the fished portion of that population.
Risk	The likelihood of an undesired event (or impact) occurring as a result of some behaviour or action.
Risk management	The culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects.
Stock	A defined group of organisms on which a fishery operates. The definition of a stock may be based on genetic or geographic boundaries.
Resource assessment	Describes a process of collection and evaluation of biological and fishery data that leads to an assessment of the status of a fish stock. Resource assessments may be produced to varying levels of detail, depending on the amount of relevant information available.
Threatened species	Species listed under NSW or Commonwealth legislation as endangered or vulnerable. For the purpose of this EIS, also includes species that are listed under the Fisheries Management Act as protected species.
Trophic	Relating to feeding by animals, in particular, the relationships (food-webs) between predators, prey and primary producers.
Validated catch history	The recorded catch history from the period 1986 to 1993 that has been assigned to each fishing business by the NSW Department of Primary Industries.
Vulnerable species	A species that is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

CHAPTER A EXECUTIVE SUMMARY

Introduction

The Ocean Trap and Line Fishery is currently a category 1 share management fishery. The fishery uses demersal fish traps, spanner crab nets and a variety of attended and unattended line methods to target species such as snapper, spanner crabs, kingfish and blue-eye trevalla along the coastal and offshore waters of NSW. The operation of the current activity poses environmental, social and economic risks, particularly impacts on some target species that have been identified as overfished, the endangered eastern population of grey nurse shark and on the economic viability of the fishery.

These risks must be adequately managed for the activity to proceed in a sustainable way and for the necessary approvals to be granted. A number of actions therefore have been proposed to address the risks including resource assessments, mapping major fishing grounds, changes to improve the selectivity of gear, introducing a code of practice and developing improved performance measures for assessing the economic viability of the fishery. The actions represent a balanced approach to meeting the objectives sought for commercial trap and line fishing and sustainable fisheries.

The Environmental Impact Statement for the Ocean Trap and Line Fishery presents a thorough, frank and transparent assessment of the risks associated with the current activity and the measures proposed to address the risks. Public exhibition of the Environmental Impact Statement for the Ocean Trap and Line Fishery provides an opportunity for the community to review the environmental performance of the activity of trap and line fishing and to have input into its future management.

The Development of Fishery Management Strategies and Environmental Impact Statements

In December 2000, the NSW Government made changes to ensure that fishing activities in New South Wales are managed in an environmentally sustainable way. The changes require the development of fishery management strategies and associated environmental assessments for each major fishing activity, including the Ocean Trap and Line Fishery.

The management strategy and environmental impact assessment for each activity are presented together in an Environmental Impact Statement (EIS). Its structure is based on guidelines issued by the NSW Department of Planning (formerly PlanningNSW).

This overview presents a summary of the EIS, being the first chapter (Chapter A). Chapter B of the EIS reviews the existing operation of the activity, including the current management arrangements, where trap and line fishing occurs, the gear used, the species harvested or otherwise affected by the operation of the fishery, and the socio-economics related to the activity. The risks associated with all aspects of the activity are assessed to identify those aspects that require modification by the fishery management strategy. Together these chapters (Chapters A and B) comprise Volume 1 of the EIS.

Chapter C provides an outline of the main alternative management options to those of the existing activity and Chapter D provides details of the proposed management arrangements for the activity (i.e. the draft strategy). Chapter E presents an assessment of the potential impacts of implementing the draft strategy, that is, the extent to which the draft strategy mitigates the risks that were identified in Chapter B. Chapter F provides a justification for the chosen strategy, taking into account its implications in terms of environmental, social and economic factors.

This overview provides an introduction to the environmental assessment process. It briefly outlines the context within which the Ocean Trap and Line Fishery operates, the management arrangements proposed in the draft strategy, and the findings of the environmental impact assessment.

The Existing Activity of Trap and Line Fishing

The Ocean Trap and Line Fishery is one of nine major commercial fisheries in New South Wales. It is a multi-method, multi-species fishery using demersal fish traps and numerous line methods to target demersal and pelagic fish along the NSW coast and offshore waters. The fishery also includes the taking of spanner crabs by nets (dillies) north of Korogoro Point (near Hat Head).

The Ocean Trap and Line Fishery extends from NSW coastal baselines seaward to the 4,000 metre isobath (approximately 60 to 80 nm offshore depending on the location). The ocean waters from the NSW coastal baseline to 3 nm offshore are State waters and fall under the jurisdiction of NSW. The waters from 3 nm to the 4,000 metre isobath are Commonwealth waters, however an Offshore Constitutional Settlement was established in 1990 to allow NSW to manage some of the fishing activities, including trap and line fishing, in those waters.

There are six types of endorsements in the Ocean Trap and Line Fishery, the following five of which are based on a zoning system described below, and the fish trap endorsement, which is not subject to the following zoning or regions:

- line fishing (western zone) endorsement which authorises the holder to use a line to take fish for sale from ocean waters that are less than 183 metres (100 fathoms) in depth
- line fishing (eastern zone) endorsement which authorises the holder to use a line to take fish for sale from ocean waters that are not less than 183 metres (100 fathoms) in depth
- spanner crab (northern zone) endorsement which authorises the holder to use a spanner crab net to take spanner crab from ocean waters that are north of a line drawn due east from the southern breakwall at Yamba
- spanner crab (southern zone) endorsement which authorises the holder to use a spanner crab net to take spanner crab from ocean waters that are south of a line drawn due east from the southern breakwall at Yamba
- school and gummy shark endorsement that authorises the taking of school shark and gummy shark by line methods south of a line drawn east from the northern point of the entrance to the Moruya River

Approximately 528 fishing businesses held an entitlement to operate in the fishery in 2002/03, however, not all endorsed fishing businesses operate in the fishery each year. This results in a significant level of latent (i.e. unused or seldom used) effort, estimated to be in excess of 40% across the fishery in 2001/02, and in excess of 50% for the trap and line sectors. The proportion of latent effort in this fishery has been steadily increasing over several years, tripling over the period 1997/98 - 2001/02 from 14% to 42%.

The Ocean Trap and Line Fishery produces approximately 2,000 tonnes of seafood product annually and is valued at approximately $10 million at first point of sale. The main species targeted are snapper, yellowtail kingfish, spanner crab, blue-eye trevalla, bonito, leatherjackets, bar cod, bream, silver trevally, rubberlip morwong and gummy shark. Other important species include bass groper, black-spot pigfish, dolphinfish, gemfish, hapuku, jackass morwong, mulloway, narrow-barred Spanish mackerel, pearl perch, teraglin, silver sweep, spotted mackerel and numerous shark species, particularly wobbegongs.

Risk, Response and Predicted Outcome

The following section briefly describes the risks of the current activity as they pertain to environmental, economic and social components (initial risk), the management responses proposed in the draft strategy to mitigate those risks (response), and a predictive assessment of the degree to which those measures may mitigate the risks (predicted outcome). This section is summarised in Table A1.

In order to address any perceived problems with the existing operation of the Ocean Trap and Line Fishery, it is first necessary to describe and evaluate the potential impacts arising from the manner in which trap and line fishing is conducted. It is also necessary to attempt to isolate those elements of the activity that are thought to contribute the most to those impacts and to propose adjustments to those elements through the draft strategy.

Broadly, the activity of trap and line fishing comprises eight elements that have the potential for a variety of environmental, social and/or economic impacts. Those elements (and their definitions) and some of their potential impacts include:

- harvesting (the capture and retaining of fish for sale) - may cause overfishing, changes in population structure, trophic cascades, social conflict, and sub-optimal economic yield
- discarding (the returning of unwanted catch to the sea) - mortality may contribute to overfishing, changes in population structure, trophic cascades, social conflict and reduced economic yield
- contact without capture (the contact of fishing gear with components of the environment which do not result in capture and handling by fishers) - may affect the behaviour of organisms and/or increase their likelihood of predation
- loss of fishing gear (the partial or complete loss from vessels of traps, lines, nets or other equipment) - may be a source of mortality not previously considered in fishing mortality estimates and may cause social conflict
- the use of bait (this includes imported bait, bait sourced from interstate or other regions of NSW, and non-fish baits such as chicken gut that are used to attract fish to traps, nets or lines) - may introduce viral and/or bacterial diseases into fish populations and the general environment
- disturbance due to presence in the area (the stationary fishing vessel on the water whilst on-board activities take place) - may affect the migratory, schooling or spawning behaviour of organisms and may cause social conflict

- boat operations and maintenance (movements between ports and fishing grounds, emissions, fuelling and other activities that could affect noise, air or water quality) - may cause a reduction in localised noise, air or water quality
- marketing (the sale and transport of fish to an authorised fish receiver) - may affect supply and demand and ultimately lead to concentration of effort on particular species or size of fish
- management structure, including input controls (the gear, effort and area of the fishery) and output controls (the quantity or species of the catch) that are used to limit catch, licensing and fee arrangements, and management transparency - may affect fisher viability, social conflict and stock sustainability

These elements of the activity can have both direct and indirect impacts. For example, the activity of harvesting has a direct impact on the abundance and productivity of retained species, and indirect impacts on oceanic food webs, social conflict through competition for resources and may impact cultural fishing practices.

To address the potential impacts, the draft strategy offers seven major long-term goals for the management of the fishery, which are supported by approximately 26 objectives and 64 management responses. Many of the management responses are existing programs. It is important to note that a single management response can mitigate a variety of risks and therefore it is not necessary to formulate direct responses for each risk. The responses with a direct relationship to an environmental, economic or social component are briefly described below and summarised in Table A1.

It is acknowledged that as a long-term strategy, details on the specific mechanisms for many of the management controls in the draft FMS are to be developed during the implementation of the strategy. A lot rests, therefore, and this assessment is done on the expectation that the details of the implementation arrangements, especially research and monitoring for resource assessments, will be adequate to fulfil the goals and objectives stated in the strategy and thereby reduce risk even to a minor degree. If key components, such as adequate resource assessments and effort controls are not implemented, there will be no reduction in the risks, for example of the target species being harvested at unsustainable levels.

Ecological Impacts

The purpose of this section is to critically evaluate the available information on the ecological impacts of trap and line fishing and the underlying mechanisms by which the impacts occur. An understanding of these mechanisms is important for the evaluation of future impacts and for evaluating the extent and magnitude of existing impacts.

The major potential impacts of the Ocean Trap and Line Fishery include growth overfishing and recruitment overfishing, disruption of ecological processes and impaired recovery of threatened species. The degree to which these impacts occur varies depending on the resilience of the species or ecological component and the intensity of the fishing activities. A qualitative risk matrix was developed and used to determine the potential degree of impact for the primary and key secondary species of the fishery and for threatened species that are likely to be affected by the fishery.

The risk assessment conducted on the existing Ocean Trap and Line Fishery found that of the elements discussed above, it was primarily harvesting and discarding that pose the greatest risk to ecosystem components, particularly ecological processes and biodiversity (which includes non-target species), the target species, and some threatened species. These aspects will be discussed in more detail. Risks to other ecosystem components, such as marine habitats and air and water quality, were generally considered to be low.

Although not all elements of the activity were found to affect all ecosystem components, it was apparent that inappropriate gear selectivity, lack of resource assessments for the primary and key secondary species, poor understanding of discard composition and magnitude, information gaps of the biology and ecology of species and ecological interactions, a lack of information about gear loss/ghost-fishing, and a lack of information about the distribution and types of marine habitats with respect to fishing activities all pose a risk to the environment.

It is important to note when reading the following sections that despite a detailed risk assessment on numerous components of the environment, the substantial information gaps about the impacts of the fishery on the oceanic environment leaves a high level of uncertainty surrounding the activity. There are still many aspects that remain uncertain, and in the absence of scientifically rigorous data, this assessment has been necessarily cautious. It should also be noted that this situation is not unique to NSW and applies to many other fisheries in Australia and around the world.

Further, the appraisal of the management responses in the draft strategy in the following sections has been made on the basis that they will be undertaken, especially the resource assessments and effort controls, and that appropriate research will be undertaken to clarify many issues of the fishery. Research will remove a high proportion of the uncertainty surrounding the activity and this assessment, and allow a retrospective analysis of the accuracy of the assessment and the development and implementation of new management measures, if necessary.

Species assemblages, species diversity and ecological processes

Initial risk

Species diversity is the variety of marine organisms and the genetic diversity they contain. Given the poor knowledge of the spatial and temporal patterns of species diversity for major groups of animals and plants in marine waters, risk relating to species diversity can only be determined at the largest scale of ecosystem components. The risks to species diversity are closely linked to the risks to habitats and ecological processes, and as previously noted, the risk to habitats was considered to be low.

An ecological process, broadly defined, is any process that affects the distribution and abundance of living organisms. These processes include interactions such as competition, predation, parasitism and physiological effects of temperature, light, nutrient availability on individual organisms. Ecologists are generally concerned with the cumulative effects of such interactions at the population or species assemblage level. Fisheries management takes into account the effects of fishing on parts of the system other than the harvested species, and acknowledges that effects on these other parts of the system may also have consequences for target species. The risk assessment concluded that there were three issues that would need to be addressed by the draft FMS to reduce the risks: the way ecological processes function and change through time and along the coast; linkages between processes and the spatial and temporal distribution patterns of habitats, biodiversity and species assemblages; and the association between different habitat types and fish assemblages in the fishing grounds and adjacent areas.

Response

The primary management responses proposed to manage the fishery in a manner that promotes the conservation of biological diversity in the marine environment include, but are not limited to:

- mapping fishing grounds (including available information on geological features) and determining the intensity of fishing on each ground
- collecting information on the number of lost fish traps
- complying with marine protected area rules (e.g. Marine Park zoning plans) and using fishing closures to control fishing activities
- designing and implementing an industry-funded scientific observer program to document the degree of interaction of commercial designated fishing activities, including the Ocean Trap and Line Fishery, with non-retained and threatened species
- implementing fish escape panels in fish traps to minimise bycatch and the retention of juvenile and small fish
- implementing the exclusive use of circle hooks for all unattended line fishing methods to reduce gut hooking of prohibited size and other non-retained fish

Predicted outcome

The risk assessment methodology used a ranking system of None, Minor, Moderate and Major to describe the degree of risk reduction that could be reasonably expected from the management responses. Overall, the draft FMS is assessed as potentially affording only a minor reduction in the risk to ecological processes and biodiversity. In general, the responses do not contain sufficient detail, which limits the ability to assess their potential outcomes, and/or are indirect responses that provide limited information.

Of the three issues mentioned above, only one (information about habitat types) is directly addressed in the draft FMS. A second issue (information on species inter-relationships) is the subject of an existing collaborative research project between NSW DPI and experts in the field from the University of British Columbia, but this project is considered to be too broad in scope to afford a moderate or greater risk reduction with respect to the Ocean Trap and Line Fishery. This is not surprising given the complex task of gaining a better understanding of ecological processes and biodiversity of the marine environment in which the fishery operates, particularly if trying to separate fishery-related impacts from other fisheries and other important factors. Although the fishery could make contributions, financial or in-kind to such studies, they are likely to be beyond the scope of the draft FMS and fishery alone.

If an extensive fishery-specific observer program was implemented, then the draft FMS would address some of the information gaps highlighted in the risk assessment, in particular the lack of information about the spatial and temporal rates and composition of discards (commercial and non-commercial). However, a cross-fishery observer program as proposed in the draft FMS may not, depending on the level of available funding and the priorities set between fisheries, be able to provide sufficient coverage of the various methods used in the fishery to collect robust information upon which future management decisions can be based. Instead, in the absence of that information, responses will have to be precautionary to account for the uncertainty about this aspect of the fishery. Irrespective of the coverage issue, investigating the mortality of discards is an outstanding issue that would need to be addressed through a separate research program.

Target species

Initial risk

For the purposes of this assessment, the target species of this fishery were the 25 species or groups that comprise the primary and key secondary species. Total reported landings across all commercial fisheries for most of the 25 target species have been declining over the last 10 years, with more than half at or near the historical lowest catch levels for the species. However, catch-per-unit-effort within the Ocean Trap and Line Fishery has increased or remained relatively stable for 18 of the 25 species. Of the 25 species that were subject to a detailed assessment, five were at high risk due to the existing activity, nine were at moderately high risk, eight were at moderate risk, two were at moderately low risk and one was at low risk.

Consistent with other fishery assessments and general research into sharks, the three groups of sharks targeted by this fishery are considered to be at high risk. The two other species at high risk were bar cod and black-spot pigfish, which despite their moderate resilience, were considered high risk because of their high fishery impact profile: notably no resource assessments, lack of known refuge areas, proportion of catch by this fishery and declining catches of pigfish and highly variable catch-per-unit-effort for bar cod. Most of the moderately high risk species also have high potential overlap and interaction with the fishery, whereas those at moderate or lower risks are generally characterised by moderate to low potential overlap and interaction with the fishery.

Issues arising

There were six main issues arising from the risk assessment for the species that are retained by the fishery. Of the five species at high risk, three were sharks. This group of species is recognised both nationally and internationally as being at risk from commercial fishing. Sharks are particularly vulnerable to overfishing because their slow growth rate, long life span and life history strategy are not conducive to rapid recovery after populations have been depleted. Specific and immediate action should be implemented to reduce the high risk to these species.

The nine species at moderately high risk would also require direct action. Snapper and kingfish are considered growth overfished, i.e. the size at which they are caught reduces the potential yield. Of the five other species taken by this fishery that have also been subject to formal resource assessments, one is considered recruitment overfished (gemfish), one growth overfished (silver trevally) and three are fully fished (blue-eye trevalla, bream and spanner crab). The remaining 18 species are yet to be subject to a formal resource assessment, and biological data for many of those species suggests that their size at first capture is below their size at maturity. Direct and overlapping action in the form of resource assessments, changes to gear selectivity (particularly of trap mesh), effort reduction and the determination of appropriate minimum legal lengths would be required to reduce the risks for all primary and key secondary species of this fishery.

All eight species at moderate risk are caught in larger quantities in other fisheries, particularly the recreational fishery of NSW, the Commonwealth’s South Eastern Scalefish and Shark Fishery, and Queensland fisheries. There are different management regimes across the Commonwealth and State jurisdictions, with quota management for many species in the Commonwealth fisheries and predominantly effort control management in NSW and Queensland (except for spanner crabs). The different management regimes increase the risk to species with common stocks becoming ecologically unsustainable because the controls do not fully complement each other (NB. some complementary arrangements are in place, such as daily trip limits for selected species). For these and other species taken by the fishery, action is required for more complementary management arrangements. In addition, catch levels across all sectors need to be monitored, as any large changes may shift the onus of risk mitigation to other fisheries.

Bycatch is poorly understood in this fishery and the research that has been undertaken has focussed on a limited number of species and/or methods. There is no information that addresses each species across all methods of the fishery. In addition to gathering information on the quantity, composition, frequency and temporal and spatial variability of discarding, there is also a need for estimates of discard mortality. Understanding this source of fishery mortality is vital in determining appropriate mesh sizes and minimum legal lengths, as it provides an estimate of the potential repercussions of adopting those measures.

The Department of Primary Industries' catch database has a number of limitations which reduces its capacity to provide reliable information on which to base appropriate management regimes (an example is the lack of separate reporting of landings from Commonwealth and State fisheries prior to 1997). This is a major obstacle to reducing the risk of the key species in the fishery. Improving the way information is recorded on the catch returns, coupled with validation of reported landings and improved species identifications by independent observers either on vessels and/or at local fish cooperatives would greatly increase the reliability of the database.

There are a number of substantial information gaps that hinder an assessment of whether the Ocean Trap and Line Fishery is being managed and fished in an ecologically sustainable manner. Specific information is needed on the ecology and basic biology of the primary and key secondary species. There is little to no recorded information on the location of fishing grounds for each sector of the fishery, the frequency and intensity of fishing and of the habitats and assemblages that are potentially affected by the fishery, at a localised level. Research on the interactions among fish species and non-target species, interactions of fish with the environment and habitats, stock and community structure, and spatial and temporal complexity of fish stocks, while complex, has received little attention in the past.

Response

The draft FMS contains a number of policies and measures that contribute to the sustainable harvest of the primary and key secondary species of the fishery, the most direct and influential of which include:

- resource assessments involving monitoring the quantity, length, age and/or sex composition of landings of primary and key secondary species, including the use of trigger levels
- annual monitoring of commercial landings of all secondary species for comparison against trigger levels
- reviewing and where appropriate implementing minimum legal lengths for the primary and key secondary species, including the specific action of a 130 cm minimum legal length for wobbegong sharks
- capping the NSW catch of school and gummy sharks and participating in the development of a multi-jurisdictional quota scheme with the Commonwealth and southern States
- modifying the gear controls applicable to the spanner crab fishery and investigating the feasibility of a quota system to manage the harvest of spanner crabs in the longer term

- capping fishing effort at currently active levels, implementing new gear limits, restructuring the fishery and establishing a maximum level of effort that should be achieved within ten years of the commencement of the first share management plan
- developing and implementing recovery programs for recruitment overfished species and, when necessary, for growth overfished species
- implementing 50 x 75 mm mesh escape panels in fish traps to select species at larger sizes, with a review of their appropriateness after five years unless otherwise specified in the share management plan, in a species recovery program, or if the minimum legal length for snapper is further increased
- developing and implementing a cross-fishery observer program to collect biological information on sharks, the size and sex composition of primary and key secondary species, and the quantity and composition of discards
- prohibiting the use of on-board automatic baiting machines in the fishery

Predicted outcome

The risk assessment methodology used a ranking system of None, Minor, Moderate and Major to describe the degree of risk reduction that could be reasonably expected from the management responses. Overall, the draft FMS is assessed as potentially affording a minor reduction in the risk of overfishing to the target species of the fishery. In other words, according to this assessment, the management responses may go some way towards achieving the goal of sustainable harvest levels for some species, but more work is needed to address three of the six issues that were identified in the risk assessment for the majority of target species. Although some of the individual management responses are predicted to be effective at reducing the risk, collectively, and without having further details about the specific mechanisms to be used or how some responses will be implemented, the overall regime does not sufficiently address the overall risk to target species. The changes in risk levels for individual primary and key secondary species as a result of the draft FMS could see the number of species at high risk decrease from five to three; at moderately-high risk decrease from nine to eight; at moderate risk decrease from eight to four; at moderately-low risk remain at two; and seven species moving from moderate risk into the low risk category.

The draft FMS has described the framework and set resource assessment levels for all primary and key secondary species of the fishery, and the assessments will be externally reviewed every four years. Of the five species at highest risk, pigfish and bar cod will appropriately receive Class 2 levels of assessment, whereas the sharks will receive Class 3 assessments with additional data collected through the observer program. Whilst it is acknowledged that Class 2 resource assessments will not be possible for the sharks of this fishery until species identifications and reporting procedures are resolved, which is proposed in the draft FMS, as the observer program is not fishery-specific it may not be able to collect sufficient data to enable better levels of assessments and, instead, more specific research projects may be needed. The species at moderately-high and moderate risk will also receive appropriate levels of resource assessment. This indicates that with the exception of the shark species of this fishery, the levels of resource assessment as proposed in the draft FMS for the primary and key secondary species are commensurate with the risk. Resource assessments, supported by the monitoring programs, will make a substantial contribution to reducing the risk to most of the primary and key secondary species of the fishery, although the three groups of sharks will remain at high risk and snapper and kingfish at moderately high risk.

The draft FMS is unlikely to adequately address the issue of overfishing of snapper and kingfish, and potentially wobbegong sharks. The other overfished species taken by the fishery, namely gemfish (recruitment) and silver trevally (growth), should be adequately addressed through the draft FMS. Snapper and kingfish are already considered growth overfished (i.e. the sizes at which they are harvested are too small to provide an optimum yield from the fishery), and the limited studies of wobbegongs suggest that they are fully fished and are at high risk of being overfished. The proposed recovery program to address the growth overfishing of snapper will not aid its recovery as the issues of inappropriate harvest size, effort levels and mesh selectivity have not been directly addressed. Despite a process being outlined in the draft FMS for conducting an economic assessment prior to further increasing in the size limit for snapper and for describing the conditions under which the size of escape panel mesh sizes will be reviewed, it does not provide any assurances that these changes will be made. To reduce the risk of continued growth overfishing and the potential for recruitment overfishing of snapper, the minimum legal length would need to be increased to at least 32 cm from the existing 30 cm, and the mesh escape panels would need to be larger than the proposed 50 x 75 mm mesh, which was more appropriate when the minimum legal length was 28 cm. The potential losses of other important species, such as bream, leatherjackets and pigfish, could be mitigated by defining specific times and places when traps with 50 x 75 mm or other mesh sizes could be used, although this would create additional complexities in the management regime. A formal process for implementing alternate mesh configurations is not included in the draft FMS and the specified five year (maximum) review period for escape panels is considered too lengthy given the undefined and/or overfished status of most species caught in the trap sector.

The draft FMS does not propose to directly address the growth overfishing of kingfish through a recovery program, and the gear modifications and limits proposed are expected to have little or no effect on the main harvest method for kingfish. Recovery programs may not necessarily be the appropriate tool for mitigating the risk to growth overfished species, as growth overfishing is more of an economic than biological condition, and the ‘recovery’ that is sought is usually addressed by setting an appropriate size at first harvest, which is proposed to be investigated in the draft FMS. In conjunction with other proposals such as monitoring lengths and catch rates of the landed catch, the draft FMS should provide the data with which to effectively mitigate the risk to the species in the longer term, subject to appropriate actions being implemented. They do not, however, reduce the risk of ongoing growth overfishing in the short to medium term.

A recovery program is not proposed for wobbegong sharks as they have not been formally assessed as overfished. Considering resource limitations, such an approach is probably justified provided that the general management responses mitigate the risk to the species in the short to medium term. However, such a risk reduction for wobbegong sharks is unlikely because, due to difficulties with species identification and the way sharks are processed prior to market, the port monitoring program is unable to monitor these species like the other primary and key secondary species. Instead, it is proposed to use the cross-fishery observer program, the limitations of which are discussed above, to collect additional information on wobbegong sharks. Further, the draft FMS proposes to implement a 130 cm minimum legal length for wobbegong sharks, but there are two known species (and probably a third), each with different sizes at first maturity. There are also identification problems with the two better known species. The 130 cm minimum legal length is inappropriate for one of the two better known species, as at least half of the females of the larger species do not mature until approximately 175 cm, and so a size closer to 175 cm would be more precautionary in the absence of better biological information and improved identifications. However, it is acknowledged that at such large sizes, handling captured sharks may be hazardous to fishers, and other options should be considered for managing these and other sharks taken by the fishery.

The issue of bycatch is only partially addressed by the mandatory adoption of fish escape panels and the monitoring proposed through the cross-fishery observer program. As discussed above, the observer program may not be sufficiently extensive in its coverage of this fishery depending on funding availability. Bycatch affects many aspects of this fishery, not just the primary and key secondary species, and this could remain a significant information gap of this fishery even after taking the draft FMS into account. It is important to monitor bycatch in order to be able to measure the effectiveness of some of the fishing controls aimed at reducing bycatch, such as escape panels in fish traps, and to strengthen resource assessments by better understanding all potential sources of fishing mortality.

Listed threatened and protected species, populations or communities

Initial risk

Fifty-five of the 58 threatened and protected species or populations that were assessed were considered to be at moderately-low risk from the existing activity. These levels of risk are primarily due to the apparently low rate of interaction between the fishery and these species or populations. The endangered grey nurse shark was found to be at high risk, the vulnerable black cod at moderately-high risk and the vulnerable great white shark at moderate risk. The EIS incorporates a Species Impact Statement with respect to the grey nurse shark given the potential significant impacts that the fishery has on this listed threatened species.

Issues arising

It is noted that the Ocean Trap and Line Fishery is not the sole contributor to the original or ongoing decline of the grey nurse shark, however, the current protective measures would need to be strengthened to reduce risks to the grey nurse shark and to address the Key Threatening Process of Hook and Line Fishing. This would involve gear restrictions and/or modifications in the shark’s Critical Habitats as a minimum. Any measures developed for grey nurse shark are also likely to provide increased protection for black cod, about which little is known.

Ongoing monitoring of the interaction between the fishery and threatened species would be required to ensure that the level is as low as determined in the initial assessment and that it does not increase in the future. Such monitoring should quantify the species, type of interaction (e.g. direct capture, boat strike, etc.) and outcome (i.e. level of injury, if any, endured by the organism).

The strategy will need a mechanism to respond to future listings of species under the threatened species legislation. Such a mechanism will be necessary to ensure any species regularly caught by the fishery is protected in a timely manner.

Response

Specific management responses aimed at improving knowledge of, and mitigating any future risks to threatened species, are:

- modifying, in consultation with Ocean Trap and Line Management Advisory Committee, the mandatory reporting arrangements to enable the collection of information on interactions with or sightings of threatened or protected marine species and interactions with other threatened or protected species

- implementing, in consultation with the Ocean Trap and Line Management Advisory Committee, the provisions of any relevant threatened species recovery plans, threat abatement plans, or other similar management arrangements designed to protect critical habitat areas
- implementing changes to reduce or prevent the impact of the Ocean Trap and Line Fishery on grey nurse sharks, in particular:
    - the exclusive use of circle hooks for all unattended line fishing methods
    - prohibiting the use of wire trace on bottom setlines
    - investigating the effectiveness of the use of circle hooks for all attended line fishing methods, and
    - working with Ocean Trap and Line fishers to develop appropriate arrangements to close key grey nurse shark areas to commercial fishing, consistent with broader management arrangements for grey nurse sharks
- using the code of practice, promote the use of fishing techniques that avoid the capture of or interaction with protected fish and fish protected from commercial fishing

Predicted outcome

The draft FMS is likely to further reduce any potential impacts on the majority of threatened species or populations with which it may interact, including great white sharks.

However, the Species Impact Statement for grey nurse shark concludes that although the draft FMS may provide a minor reduction in the risk posed by the fishery, the risk that the fishery will have a significant impact on grey nurse shark remains high in all areas outside existing Marine Park sanctuary zones. This will remain the case until adequate controls are implemented under the FMS (e.g. closing key areas to fishing), through the NSW marine protected areas program (e.g. Marine Parks) or through the threatened species recovery planning process. The Species Impact Statement notes that the alternative measures examined, which would provide a significant reduction in the risk to grey nurse shark, would lead to a high to medium socio-economic impact (depending on the percentage of income derived from the fishing within identified grey nurse shark aggregation sites) on an estimated 87 ocean trap and line fishers directly affected by the controls, and a low to negligible socio-economic impact on an estimated 581 indirectly affected ocean trap and line fishers. The socio-economic impact at the State level of the alternatives was assessed to be minor.

The draft FMS does not substantially alter the moderately-high risk that the fishery will have a significant impact on black cod. However, the controls discussed above for grey nurse shark, if implemented, would also provide protection for black cod such that the risk to the species posed by the Ocean Trap and Line Fishery would be reduced.

Economic Impacts

Initial risks

In the 1997/98-2001/02 period, the Ocean Trap and Line Fishery had annual average revenues of $9.8M.

Out of 624 Ocean Trap and Line Fishery fishing businesses, only 443 were actively involved in fishing in 2001/02 and the remaining 181 were considered to be latent effort.

The NSW fishing industry creates direct and indirect employment. Current information on direct fisher employment collected through social survey of all fishers in 2001 indicates there are between 991 and 1925 persons employed full-time and part-time in fishing businesses involved in the Ocean Trap and Line Fishery.

The fishery comprises predominantly one person businesses, partnerships between fishers and limited corporate involvement. Capital investment levels are highly variable, ranging between $50,000 and $250,000. These differ with the diversity of business activities and assets. Based on available information, the total capital investment in the 443 active ocean trap and line fishing businesses is estimated at approximately $48.7M. These are conservative capital investment estimates and should be treated with caution.

An economic survey carried out on fishing businesses for 1999-2000 indicates that 28% of Ocean Trap and Line Fishery business respondents are earning an economic surplus under the levels of opportunity costs and economic depreciation assumed for long-term viability. The remaining 72% were operating below long-term viability benchmarks, showing that economic viability is an issue in the fishery. The businesses that held Ocean Trap and Line Fishery entitlements only compared to businesses that held Ocean Trap and Line Fishery entitlements and entitlements in other fisheries had negative net economic returns of -11% and -18%, respectively. The average net return was -4%, with 50% of all Ocean Trap and Line Fishery businesses having less than -23% net return. This is an indicator that the existing conditions are not promoting profitability in the fishery.

The high level of active fishing effort reduces the overall economic performance in the fishery. Reduced economic rent and depletion of fish stocks are both losses to the community. The available information is inadequate to estimate the amount of resource rent in the fishery, as a bio-economic study would be required to determine optimal effort levels.

Currently, Ocean Trap and Line Fishery fishing businesses are required to meet only existing management costs and the existing government policy is to phase in full cost recovery over several years from 2005/06.

Based on available information the overall risks to the economic viability of the fishery from the current operational arrangements are:

- overfishing of some of the primary and key secondary species on which the fishery is based, possibly caused by insufficient management controls
- excess endorsement numbers and vessel capacity and the potential activation of latent fishing effort
- current levels of fishing effort are in excess of the profit maximising level
- loss of economic rent
- insufficient economic incentives to fishers
- lack of adequate access security for long-term business certainty
- increasing operating costs and the costs of restructuring the fishery
- lack of economic information to monitor the economic viability of the fishery, and
- lack of biological information on the status of stocks in the fishery.

Response

The draft FMS aims to address these issues by proposing a number of management responses, and these have been assessed as follows:

- promoting the recovery of overfished species and managing levels of active fishing capacity in the fishery is likely to have positive impacts on overfished stocks of the primary and key secondary species
- the commitment to cap each endorsement type at currently active levels is intended to impede the activation of latent effort, however how this is to be achieved is unclear. In addition, the timetable and methods through which capping of endorsement numbers will be achieved are not specified
- appropriate maximum level of fishing effort in the fishery is to be established within 10 years, however the methods through which this will be achieved and the extent of adjustment required is not specified. It is appropriate to undertake further investigation to determine the total level of effort and the best way to achieve it. Setting a total level of effort warrants careful examination and consultation with industry in order to ensure an effective outcome
- as fishers will face higher management charges they may have an incentive to activate and increase fishing effort in order to increase gross revenue
- more clarity on the input based effort controls to be implemented is required. Output based controls should also be investigated as several species in the Ocean Trap and Line Fishery may be suited to Individual Transferable Quota management. The production relationships of fishers needs to be investigated to see the suitability of target species for output based management
- category 1 shares provide more security of access for fishers, creating a market for trading shares and providing an opportunity to exit the fishery by selling fishing businesses
- the annual management charges for an average fishing business are estimated to increase from current $510 in 2003-04 to $910 by 2005/06; and $1,799 by 2007/08, although the actual costs attributable to industry, the distribution of costs across industry and the change in arrangements are yet to be determined
- it is expected that businesses unable to pay higher management charges will exit the fishery, thereby assisting the process of structural adjustment
- developing performance measures for monitoring economic viability are to implemented based on net returns, and
- fuller incorporation of cost-effective management requires a framework for improving the quality of service delivery.

Predicted outcome

As a result of implementing a share management system with category 1 shares, fishing businesses will have more secure access rights and provide a platform on which to build increased incentives to improve economic viability and stewardship of the resource. Hence, the risk to economic viability from lack of economic incentives to fishers will be reduced.

Whilst the risk to economic viability from potential activation of latent effort is likely to be reduced as a result of the draft FMS, it is not clear if it will be completely removed. However, the risk of excessive effort levels may be reduced by specifying a maximum level of fishing effort.

Levels of active effort will require continuous monitoring, as the potential for technological creep must be taken into account and fishers may respond to improved economic conditions by fishing longer. Reduction in active effort will increase economic efficiency in the fishery as more efficient fishers will be likely to remain in the fishery. Society will benefit from greater efficiency as the resource will be harvested at a lower cost and for a greater return.

Social Impacts

Fishers' social capital

Initial risk

Fishers in the Ocean Trap and Line Fishery were found to be an aged, highly resident population, with substantial fishing experience and strong family involvement with fishing. Approximately 60% of fishers were insistent about their identity as fishers and were unable, or unwilling, to consider re-training.

Between 991 and 1,925 persons are employed full-time and part-time in fishing businesses which hold an Ocean Trap and Line Fishery endorsement. Fishers are highly dependent on fishing for their income. Approximately 78% of fishers have 90-100% income from fishing, and another 10% have over 50% income from fishing. Part-time fishing involvement is limited (9%). Approximately 34% of fishers have financial dependents.

Unemployment rates are higher in rural areas in NSW, which is a significant issue for fishers considering alternative employment to fishing. The ability and willingness of fishers to undertake full-time work in other sectors were examined through the social survey and only 20% of fishers worked outside fishing, 15% being capable of working in another occupation full-time.

Based on available information, the overall social risks to fishers from the current operational arrangements are:

- uncertainty and lack of secure, well developed access rights
- excess endorsement and vessel capacity and the potential activation of latent fishing effort
- reduction in employment opportunities and increased impacts on fisher's income levels and on their families and dependents
- lack of alternative employment opportunities and risk of increased unemployment
- lack of incentives for fishers to leave the fishery
- only a small number of fishers have the capacity and/or willingness to work full-time outside the fishing sector
- loss of fishing lifestyle
- inadequate involvement in fishery policy decision making and management
- conflicts among Ocean Trap and Line Fishery fishers and also with other fishers, and
- inadequate information to monitor social issues in the fishery.

Response

The draft strategy proposes a number of management responses to address the key social issues in the fishery. The potential social impacts on fishers, families and local communities are:

- secure access rights under category 1 share management system will provide a platform that can be built on to aid the development of long-term business plans and facilitate the future involvement of family members. The share management system enables elderly fishers to retire with a payment from the sale of shares/businesses or for fishers to exit the fishery more easily than at present
- the ocean trap and line fisher communities are based all along the NSW coast and they and their employees depend on fishing for their income, employment and lifestyle. Underperformance of the Ocean Trap and Line Fishery is a threat to viability and poses the social risks that could come from an overexploited fishery. Adjustment is required to secure a healthy future for the fishery and the communities which depend on it. The fishing communities in the Montague, Clarence areas are most vulnerable to unemployment impacts, followed by the Wallis Lake and Coffs Harbour areas because of relatively high unemployment in these areas
- social impacts of the draft FMS also involve the potential displacement of fishers through structural adjustment, using minimum shareholdings. This may have a greater impact on part time, older fishers, latent endorsement holders, or fishing businesses grossing less than $10,000 per year. The impact of removing latent effort is unknown as fishing businesses involved in Ocean Trap and Line Fishery may hold endorsements in other fisheries, and hence, may be able to continue to fish
- fishing will be seen more as a commercial activity than a lifestyle, which may have negative impact on some fishers as their main objective is not maximising economic returns from the fishery. However the reduction in fishing effort to more sustainable levels will have future benefits for all remaining fishers
- responses involving awareness, communication, compliance, code of practice are likely to have a positive impact on resolving conflicts and increasing compliance in the fishery, but they require cooperation between management and industry to reduce these risks
- the importance of an increased emphasis on socio-economic monitoring has been recognised. Further research should prioritise understanding of fishing communities to reduce the cumulative impacts from successive management strategies and to enable fishers to work collectively.

Predicted outcome

In summary, under category 1 share management fishers have an increase in their security through a more secure access right and ability to exit the fishery. Most social issues arise from reduction in total endorsement numbers and containment of effort levels. These adjustments will impact fishers, employees, their families and communities through loss of employment. Some of the outgoing fishers will retire and others may have difficulty in finding alternative employment opportunities. However the extent of the impacts will depend on the scale and rate of restructuring. The long term viability of the fishery requires these steps to be taken.

The positive social impacts of the draft FMS are secure fishing access rights, opportunities to transfer/trade shares or fishing businesses, the potential to build greater incentives for investing in long term businesses and involving their families in the fishery. Fishing activities will be efficiently monitored and user conflicts are likely to be reduced through a series of communication initiatives. The socio-economic monitoring of the fishery will be increased as a result of implementing the draft FMS, which is a significant improvement over the current situation.

Indigenous issues

Initial risk

The review of existing information and responses to surveys from Aboriginal communities made it apparent that ocean fishing is part of their cultural identity. Most often, the fishing described is inshore fishing, based on beaches or rock platforms, although there is no doubt that some people also historically fished the ocean from canoes and continued this tradition as ocean fishing from small boats in contemporary times. This fishing is for subsistence and socio-cultural purposes. People fish to feed their families, but also to meet obligations for looking after other people in their community, either as part of daily routines, or for special events such as funerals. Aboriginal Elders still pass on stories and information about places and species of traditional importance to their children and grandchildren.

The views expressed by local Aboriginal community representatives during this assessment process and other recent research on Indigenous fishing indicated a strong community perception that Aboriginal fishers consider themselves as custodians of valuable natural resources, who participate in fishing activities both for subsistence reasons and to continue to transfer cultural values and ecological knowledge. They also expressed strong interests in rights to access ocean resources, in the sustainability of ocean fisheries, and interests in the well being of particular species. Broadly, totemic marine species were thought to be at moderate risk due to the current operation of the fishery, but it was also recognised that the relationship between those species and the fishery was poorly understood.

The existence of commercial ocean fisheries, such as the Ocean Trap and Line Fishery, does not in itself detract from Aboriginal access to traditional fisheries. Community members believe, however, that the low representation of Aboriginal people in the commercial sector, the regulation of the commercial fishery and the imposition of strict bag limits for non-commercial fishers disadvantages them and conflicts with traditional fishing customs.

No Aboriginal people currently appear to hold a commercial licence in the Ocean Trap and Line Fishery and there appears to be little direct engagement between Aboriginal people and the commercial fishing sector. During consultation, Aboriginal people have expressed strong views that the wealth generated from use of marine resources (including, but not restricted to the Ocean Trap and Line Fishery) does not accrue fairly and that Aboriginal people have been disadvantaged in their participation in the commercial sector. It was also apparent that Aboriginal people do not participate because they do not have the capital to invest in commercial vessels and equipment.

The physical evidence of past ocean fishing practices is (poorly) preserved in midden sites on headlands and behind ocean beaches along the NSW coast. There are also places of contemporary value, where social activities associated with fishing have occurred within memory and continue to occur. There is minimal risk that the operation of the Ocean Trap and Line Fishery will impact on these archaeological sites or other sites of cultural value.

In addition to addressing some concerns about participation in commercial fisheries, the draft strategy is viewed as an opportunity to raise awareness about Aboriginal fishing practices, to improve communication and to support in implementing many of the actions within the Indigenous Fisheries Strategy.

Response

The draft strategy proposes to address Indigenous issues as they relate to the fishery by:

- promoting harmony between the commercial fishery and other resource users, including recreational fishers, Indigenous fishers and local communities, through fair and equitable sharing of the resource
- by consulting with the Ocean Trap and Line Management Advisory Committee, identify areas of high interaction between the Ocean Trap and Line Fishery and other resource users and respond appropriately to resolve any conflicts
- managing the fishery in a manner that is consistent with the Indigenous Fisheries Strategy and Implementation Plan
- modifying the activity of ocean trap and line fishing, where relevant, in response to new information about areas or objects of cultural significance, and
- continuing to provide a dedicated position on the Ocean Trap and Line Management Advisory Committee for an Indigenous person.

Predicted outcome

The initial risks due to the current fishery were generally low for most aspects of Aboriginal culture, and so there was limited need for changes under the draft strategy. In particular, there was a low risk to: the physical evidence of past Aboriginal land use; locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world; and distribution of Aboriginal foods and medicines in the marine landscape. Under the draft strategy, these risks will not be increased and in some cases will decrease further due to involvement of Aboriginal people in the Management Advisory Committee, and as better information about species of concern to communities along the whole coast become better documented and Indigenous participation in fishery management is enhanced.

The assessment reported moderate risk to marine totem species and to Aboriginal socio-economic participation in the commercial fishing sector. There is limited detailed documentation about Indigenous totem species in the NSW marine environment and until such information is available, there is little that can be changed through the ocean trap and line strategy. The draft strategy may facilitate enhanced opportunities for economic participation and skill development, in association with the actions that are priorities in the Indigenous Fisheries Strategy and are further explored in the Indigenous commercial fishing opportunities action plan. Adoption of key recommendations of the Indigenous Fisheries Working Group will help to open up opportunities and reduce the risk that commercial fishing strategies present to Indigenous rights.

Sites of historic, heritage or cultural significance

The assessment of the existing activity found that there was a very low potential for the fishery to interact with, or impact on, heritage items of known historical significance, primarily shipwrecks.

Continuation of the fishery as proposed under the draft strategy will not increase the risk of impacts on these items.

Justification for the draft Fishery Management Strategy

The EIS highlights the importance of the Ocean Trap and Line Fishery in terms of employment, supply of seafood to the community and economic benefits. The fishery directly employs up to 2,000 people, and produces approximately 2,000 tonnes of seafood annually, valued at about $10 million at first point of sale. The economic and employment flow-on effects to local and regional communities are important, and across the fishery the multiplier values range from 1.3-1.6 (i.e. every dollar spent directly in the fishery is worth $1.30-$1.60 in the community).

The nature of trap and line fishing, its potential effects on retained, non-retained and threatened species demand that species sustainability, selectivity and bycatch issues are appropriately addressed, and the draft FMS proposes means to investigate these issues and develop effective responses. The draft FMS also provides for an improvement in the information base for the fishery and development of resource assessments for the target species. Ongoing assessment of the need for further management reforms, such as further closures for grey nurse sharks, is also proposed under the draft FMS.

The draft strategy contains a range of immediate and short term actions, and establishes a range of programs that will require ongoing consultation with key stakeholders and the conclusion of implementation details. Given that the draft strategy has been assessed as providing, in general terms, a minor reduction to the environmental risks, a significant level of work will be required to undertake the tasks which the EIS has found as being crucial to the long term sustainable management of the Ocean Trap and Line Fishery.

In order to ensure that the fishery operates in a sustainable manner into the future and that the environmental risks are meaningfully reduced, it will be important to ensure that the strategies and plans subsequently developed under the fishery management strategy are implemented so as to fulfil the stated goals and objectives. This is particularly pertinent in respect of resource assessments, a comprehensive and adequately funded observer program, and research into the spatial and temporal rates, composition and mortality of discards, which need to be addressed to fill the significant information gaps associated with the existing fishery.

The draft FMS is consistent with the principles of Ecologically Sustainable Development, in that it acknowledges the potential for ongoing environmental impacts, balances those against potential socio-economic impacts, and proposes measures to mitigate those impacts.

Table A1 The environmental impact statement summary table showing the risks associated with the current fishery, the programs proposed in the draft strategy to mitigate those risks, and an assessment of the predicted effectiveness of the draft strategy.

* denotes that it is important to note that many components are related and as such the listed programs address more components than is possible to list in table format.

Component	Sub-Component	Current Risk Level	Number of Entities	Potential Risk Reduction by Draft Strategy	Issues Arising from Risk Assessment	*Programs in Draft Strategy to Mitigate Risk
Ecological	Marine habitats	ML	-	No change	Lack of information about distribution of habitats and fishing intensity	Mapping of fishing grounds and fishing intensity Use fishing closures to control fishing where necessary Modify fishing practices to reduce impacts on habitats
	Section in EIS	B2.2		E1.2	B2.2.4	
	Ecological processes, biodiversity and assemblages	H	5	Minor	Lack of information Linkages to other components Information about habitat types and their associated assemblages	Mapping of fishing grounds and fishing intensity Use fishing closures to control fishing where necessary Modify fishing practices to reduce impacts on non-retained fish and other species Collect information on the number of lost traps Observer program to document rate and composition of discarding
		M	2	Minor		
		N	2	Minor		
	Section in EIS	B2.3		E1.2	B2.3.4, E1.1.1	
	Primary and key secondary species	H	5 spp.	Minor, but reduced to 3 spp.	Potential for overfishing and the need for direct measures for 14 species at greatest risk Monitoring, as a minimum, for the 8 species at moderate risk Data quality, identifications and recording procedures Biological and ecological data and resource assessments for all primary and key secondary species Recovery programs for overfished species Discarding rates and mortalities	Monitoring quantity, length age &/or sex composition of landings of primary and key secondary species for resource assessments Use of trigger points for landings Collect biological information on elasmobranch species through the onboard observer survey Review minimum legal lengths Capping effort at existing active levels and working towards maximum effort level through restructure and minimum shareholdings Recovery programs for snapper and gemfish
		MH	9 spp.	Minor, but reduced to 8 spp.		
		M	8 spp.	Minor, but reduced to 4 spp.		
		ML	2 spp.	Minor, remains at 2 spp.		
		L	1 sp.	Minor, increases to 8 spp.		
	Section in EIS	B2.4		E1.3	B2.4.5, E1.1.1	

Table A1 cont.

Component	Sub-Component	Current Risk Level	Number of Entities	Potential Risk Reduction by Draft Strategy	Issues Arising from Risk Assessment	*Programs in Draft Strategy to Mitigate Risk
Ecological cont.	Threatened and protected species, populations and communities	H	1 species	Minor, remains High risk	Need to strengthen existing protective measures for grey nurse sharks Levels of interactions and their consequences Ability to account for future listings	Implement provisions of relevant recovery plans Gear modifications Introduce reporting of interactions with threatened or protected species Promoting fishing techniques that avoid capture of threatened and protected species
		MH	1 species	Minor, remains MH risk		
		M	1 species	Minor		
		ML	55 spp.	Minor		
	Section in EIS	B2.5		E1.4	B2.6	
Biophysical	Water quality	N		No change	None	None required
	Noise & light	N		No change	None	
	Air quality and greenhouse gases	N		No change	None	
	Section in EIS	B3		E2		
Economic	Fishery viability	H		Moderate	Overfishing Excess fishing effort Loss of economic rent Insufficient economic incentives to fishers Lack of adequate access security for long-term business certainty Increasing operating costs and the costs of restructuring the fishery Inadequate economic information to monitor the economic viability of the fishery	Recovery programs for overfished species Capping effort at existing active levels and working towards maximum effort level through restructure and minimum shareholdings Cost recovery Performance measures of economic viability
	Section in EIS	B4		E3	B4.6	

Table A1 cont.

Component	Sub-Component	Current Risk Level	Number of Entities	Potential Risk Reduction by Draft Strategy	Issues Arising from Risk Assessment	*Programs in Draft Strategy to Mitigate Risk
Social	Social capital	M		Moderate	Uncertainty and lack of secure, well developed access rights Excess fishing effort Lack of alternative employment opportunities Loss of fishing lifestyle Inadequate involvement in fishery policy decision making and management Conflict Inadequate information to monitor social issues in the fishery	Capping effort at existing active levels and working towards maximum effort level through restructure and minimum shareholdings Cost recovery Monitoring levels of resource allocation
	Section in EIS	B5.1		E4.1	B5.1.4	
	Health and safety	L		No change		
	Section in EIS	B5.2		E4.2		
	Indigenous issues	L	2	No change	Aboriginal sites Aboriginal places Aboriginal marine totem species Aboriginal cultural landscapes Aboriginal socio-economic participation in the commercial fishing sector	Managing the fishery consistent with the Indigenous Fishing Strategy Promoting harmony between fishing sectors through fair and equitable sharing of the resource Modifying the activity in response to new information about areas or objects of cultural significance Continuing to provide a dedicated position on the Ocean Trap and Line Management Advisory Committee for an Indigenous person.
		ML	1	Moderate		
		M	2	Moderate		
	Section in EIS	B5.3.6		E4.3	B5.3.6	
	European heritage	L		No change	None	None required
	Section in EIS	B5.6		E4.4		

N = Negligible, L = Low, ML = Moderately Low, M = Moderate, MH = Moderately High, H = High. N/A = not applicable. U* = uncertain (insufficient information available to assess risk)

How the Environmental Impact Statement was Developed

This EIS was developed using a modified framework of the generic risk management process (AS/NZS 4360) acknowledged by Standards Australia and Standards New Zealand. AS/NZS 4360 uses a seven-step process for risk management, but this EIS has added an eighth step in that following the treatment of risk (i.e. the draft strategy), it has re-evaluated the level of risk that would eventuate if the draft management strategy was to be implemented.

As well as satisfying the environmental assessment requirements of the NSW *Environmental Planning and Assessment Act 1979*, the EIS will also be submitted to the Commonwealth government to meet the assessment requirements of the *Environment Protection and Biodiversity Conservation Act 1999*.

Development of the draft strategy

The draft strategy for the Ocean Trap and Line Fishery was compiled with significant input from the Ocean Trap and Line Management Advisory Committee (OTLMAC). The OTLMAC includes elected representatives from the fishery, recreational fishers, and the Nature Conservation Council. Input into the draft strategy was also sought from the Minister for Primary Industries' advisory councils on commercial fishing and recreational fishing. Government agencies, such as the Department of Planning and the Commonwealth Department of the Environment and Heritage (DEH), have been consulted during the drafting of the EIS.

The draft strategy for the Ocean Trap and Line Fishery contains the proposed rules for management of the fishery, but it is much more than a collection of rules. The strategy contains the objectives for the fishery, a detailed description of the way the fishery operates, and describes the management framework for at least the next five years. It also outlines a program for monitoring the environmental, social and economic performance of the fishery, establishes trigger points for the review of the strategy, and requires regular reporting on performance in order to ensure that the strategy meets its objectives.

Development of the environmental impact assessment

The environmental impact assessment and the draft strategy have been developed concurrently, in a series of steps. The draft strategy assessed here is in fact the third draft of the strategy. The process has been designed to give early feedback and allow a response to the predicted environmental impacts of the management proposals. Each draft of the strategy is then modified with the aim of addressing the environmental impacts identified during the assessment process.

One difference between assessing the impacts of an existing activity and assessing, for example, a new building development is that the activity being assessed already exists. Consequently, any changes to the fishery and levels of production will have direct social and economic impacts on already-established businesses, commercial fishing and related industries. It is important that when the impacts of proposed changes are assessed time is allowed, where appropriate, for industry to adjust to any required changes.

The assessment of fishery impacts is also much more difficult than is the case with many other natural resources because, in comparison to our knowledge of terrestrial resources, much less is known about aquatic ecosystems. The environmental assessment acknowledges such uncertainty and, where there is little information upon which to draw definitive conclusions, the precautionary principle is applied. The precautionary principle, a key component of the principles of ESD, states that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent that environmental degradation.

Consulting the Community

You are invited to make written submissions on the Environmental Impact Statement on the Ocean Trap and Line Fishery in NSW, which is on public exhibition until **21 April 2006**. The full EIS can be viewed at fisheries offices of the NSW Department of Primary Industries, the head office and regional offices of the Department of Planning, NSW Government Chief Information Office, local councils and the Sydney office of the Total Environment Centre (NSW) during normal business hours. A paper or CD copy can be purchased for $25 (includes GST) by contacting the Department of Primary Industries on 1300 550 474. It is also available on the Fisheries section of the NSW Department of Primary Industries website at www.dpi.nsw.gov.au.

For more information, visit: www.dpi.nsw.gov.au

Would you like to comment?

Write to: Environmental Impact Statement Submission

Ocean Trap and Line Fishery

PO Box 21

CRONULLA NSW 2230

Fax: (02) 9527 8576 (marked attention "Ocean Trap and Line Fishery EIS Submission")

Email: otl.eis@fisheries.nsw.gov.au

If you wish your name and address to remain confidential, your submission should be so marked.

Submissions must be received by 21 APRIL 2006.

CHAPTER B REVIEW OF THE EXISTING OPERATION OF THE FISHERY

B1 Fishery Description

The Ocean Trap and Line Fishery (OTLF) is one of nine major commercial fisheries in New South Wales. It is a multi-method, multi-species fishery using demersal fish traps and numerous line methods to target demersal and pelagic fish along the NSW coast. The fishery also includes the taking of spanner crabs by nets (dillies) north of Korogoro Point (near Hat Head). Other commercial fisheries and the recreational fishery also target many of the species important to the fishery.

B1.1 Number of Fishers

At August 2005, NSW Department of Primary Industries (DPI) commercial fishing license database showed that 501 fishing businesses held entitlements to operate in the OTLF. The number of operators in the fishery, however, constantly varies due to a number of factors including the transfer and amalgamation of fishing businesses and late payments on renewal of fishing licences. Between 1997/98 and 2001/02, the number of active fishing businesses in the OTLF declined from 492 to 358.

B1.1.1 Overall catch levels and value

Total landings of the ocean trap and line catch have generally been stable between 1993/94 and 2001/02 (see Table B1.1). The total reported landed catch of 1,882 tonnes for the 2001/02 fiscal year was worth an estimated $10.4 million, though the value figures do not take into account export, interstate or local markets, where higher prices may be obtained.

The main species landed by the OTLF for the year 2001/02 were snapper (206 t valued at $1.8M), yellowtail kingfish (252 t valued at $1.8M), spanner crab (150 t valued at $1.1M), blue-eye (92 t valued at $0.8M), bonito (101 t valued at $0.6M), leatherjacket mixed species (213 t valued at $0.4M), bar cod (29 t valued at $0.3M), bream (34 t valued at $0.3M), silver trevally (101 t valued at $0.3M), rubberlip morwong (56 t valued at $0.2M) and gummy shark (36 t valued at $0.1M).

Table B1.1 Catches and value for the Ocean Trap and Line Fishery from 1993/94 to 2001/02.

Period	Catch (t)	Value ($M)
1993/94	1,928	12.8
1994/95	1,861	10.9
1995/96	2,073	10.0
1996/97	2,016	10.5
1997/98	2,234	11.1
1998/99	1,995	9.6
1999/00	1,931	10.7
2000/01	1,808	9.6
2001/02	1,882	10.4

Note: figures based on database extraction and validation of January 2004.

B1.2 Species

B1.2.1 Species taken in the fishery

The OTLF is a multi-species fishery that lands more than 200 species. Table B1.2 is a list of the species as reported by fishers in the fishery from 1997-2002. Each method has a different range of species that are commonly targeted, but across the fishery there generally three recognised categories of species. Primary species are the main target species of the fishery and include: Australian bonito, bar cod, blue-eye trevalla, gummy sharks, leatherjackets, rubberlip morwong, silver trevally, snapper, spanner crab, yellowfin bream, and yellowtail kingfish.

Key secondary species include: bass groper, black-spot pigfish, dolphinfish, gemfish, hapuku, jackass morwong, mulloway, narrow-barred Spanish mackerel, pearl perch, teraglin, silver sweep, sharks-mixed (other than gummy and wobbegong), spotted mackerel and wobbegong sharks (see Appendix B1 for descriptions and 30 year catch trends for the primary and key secondary species).

Secondary species are all other species that are marketable and thus landed in the fishery, many of which are targeted on an infrequent basis.

Table B1.2 Species landed in the Ocean Trap and Line Fishery during the period 1997-2002.

Note: common names appear as reported in the DPI catch database

Common name	Scientific name	Taxonomic Family / Class name
Anchovy	*Engraulis australis*	ENGRAULIDAE
Batfish	*Platax teira*	EPHIPPIDAE
Blackfishes		
Drummer	*Kyphosus sydneyanus* & *K. vaigiensis*	KYPHOSIDAE
Luderick / Blackfish / Nigger	*Girella tricuspidata* & *G. elevata*	GIRELLIDAE
Zebra Fish	*Girella zebra*	GIRELLIDAE
Boarfish / Penfish	Various	PENTACEROTIDAE
Bream, Black and Yellowfin mixed	*Acanthopagrus* spp.	SPARIDAE
Bullseye, Red	*Priacanthus macracanthus*	PRIACANTHIDAE
Calamari, Southern	*Sepioteuthis australis*	LOLIGINIDAE
Catfishes		
Catfish, Forktailed / Silver	*Arius graeffei*	ARIIDAE
Catfish, Mixed	Various	PLOTOSIDAE
Catfish, Striped	*Plotosus lineatus*	PLOTOSIDAE
Cobia / Black Kingfish	*Rachycentron canadum*	RACHYCENTRIDAE
Cod, Bearded	*Pseudophycis breviuscula*	MORIDAE
Cod, Mixed / Unspecified	Various	Various
Coral Snappers		
Emperor, Red	*Lutjanus sebae*	LUTJANIDAE
Hussar	*Lutjanus amabilis*	LUTJANIDAE
Mangrove Jack	*Lutjanus argentimaculatus*	LUTJANIDAE
Perch, Moses	*Lutjanus russelli*	LUTJANIDAE
Rosy Jobfish	*Pristipomoides filamentosus*	LUTJANIDAE
Crabs		
Crab, Blue Swimmer	*Portunus pelagicus*	PORTUNIDAE
Crab, Coral	*Charybdis cruciata*	TRAPEZIIDAE
Crab, Hermit	Various	DIOGENIDAE
Crab, Mixed / Unspecified	Various	Various

Table B1.2 cont.

Common name	Scientific name	Taxonomic Family / Class name
Crabs cont.		
Crab, Mud / Black	*Scylla serrata*	PORTUNIDAE
Crab, Red-Spot	*Portunus sanguinolentus*	PORTUNIDAE
Crab, Sand	*Ovalipes* spp.	PORTUNIDAE
Crab, Spanner	*Ranina ranina*	RANINIDAE
Cuttlefish	*Sepia* spp.	SEPIIDAE
Diamond Fish	*Monodactylus argenteus*	MONODACTYLIDAE
Dolphinfish	*Coryphaena hippurus*	CORYPHAENIDAE
Dorys		
Dory, John	*Zeus faber*	ZEIDAE
Dory, Mirror	*Zenopsis nebulosus*	ZEIDAE
Dory, Spiky / Spiky Oreo	*Neocyttus rhomboidalis*	OREOSOMATIDAE
Dory, Mixed / Unspecified	Various	ZEIDAE
Eels		
Eel, Common Pike	*Muraenesox bagio*	MURAENESOCIDAE
Eel, Longfin / River / Spotted	*Anguilla reinhardtii*	ANGUILLIDAE
Eel, Mixed / Unspecified	Various	Various
Eel, Shortfin / River	*Anguilla australis*	ANGUILLIDAE
Eel, Short-finned Conger	*Conger wilsoni*	CONGRIDAE
Eel, Southern Conger	*Conger verreauxi*	CONGRIDAE
Emperor, Spangled	*Lethrinus nebulosus*	LETHRINIDAE
Emperor, Sweetlip	*Lethrinus miniatus*	LETHRINIDAE
Fish, Estuarine, Mixed / Unspecified	Various	Various
Fish, Ocean, Mixed / Unspecified	Various	Various
Flatheads		
Flathead, Dusky / Black / River	*Platycephalus fuscus*	PLATYCEPHALIDAE
Flathead, Marbled	*Platycephalus marmoratus*	PLATYCEPHALIDAE
Flathead, Mixed / Unspecified	Various	PLATYCEPHALIDAE
Flathead, Sand & Blue-Spotted	*Platycephalus* spp.	PLATYCEPHALIDAE
Flathead, Tiger	*Neoplatycephalus richardsoni*	PLATYCEPHALIDAE
Flounder, Mixed	Various	PLEURONECTIDAE/BOTHIDAE
Flutemouth	*Fistularia* spp.	FISTULARIIDAE
Fusilier	Various	CAESIONIDAE
Garfish, Mixed / Unspecified	*Hyporhamphus* spp.	HEMIRAMPHIDAE
Garfish, Sea	*Hyporhamphus australis*	HEMIRAMPHIDAE
Gemfishes		
Barracouta / Snoek	*Thyrsites atun*	GEMPYLIDAE
Gemfish	*Rexea solandri*	GEMPYLIDAE
Oilfish	*Ruvettus pretiosus*	GEMPYLIDAE
Goatfish, Blackspot	*Parupeneus signatus*	MULLIDAE
Goatfish, Blue-striped	*Upeneichthys lineatus*	MULLIDAE
Goatfish / Red Mullet / Barbounia	*Upeneichthys lineatus*	MUGILIDAE
Grenadier, Blue	*Macruronus novaezelandiae*	MERLUCCIIDAE
Gurnards		
Gurnard, Mixed / Unspecified	Various	TRIGLIDAE
Gurnard, Red	*Chelidonichthys kumu*	TRIGLIDAE
Latchet / Sharp-beaked gurnard	*Pterygotrigla polyommata*	TRIGLIDAE
Hairtail	*Trichiurus lepturus*	TRICHIURIDAE

Table B1.2 cont.

Common name	Scientific name	Taxonomic Family / Class name
Jacks and Trevallies		
Amberjack	*Seriola dumerili*	CARANGIDAE
Dart	*Trachinotus* spp.	CARANGIDAE
Kingfish, Yellowtail	*Seriola lalandi*	CARANGIDAE
Mackerel, Jack/Cowanyoung/Horse	*Trachurus declivis*	CARANGIDAE
Queenfish	*Scomberoides lyson*	CARANGIDAE
Rainbow Runner	*Elegatis bipinnulata*	CARANGIDAE
Samson	*Seriola hippos*	CARANGIDAE
Trevally, Bigeye	*Caranx sexfasciatus*	CARANGIDAE
Trevally, Silver	*Pseudocaranx dentex*	CARANGIDAE
Yellowtail	*Trachurus novaezelandiae*	CARANGIDAE
Leatherjacket, Mixed	Various	MONACANTHIDAE
Ling	*Genypterus* spp.	OPHIDIIDAE
Lobsters		
Bug, Deepwater	*Ibacus* spp.	SCYLLARIDAE
Lobster, Painted (Crayfish)	*Panulirus longipes, P. ornatus*	SCYLLARIDAE
Lobster, Slipper	Various	SCYLLARIDAE
Lobster, Southern Rock (Crayfish)	*Jasus edwardsii*	PALINURIDAE
Lobster, Mixed / Unspecified	Various	Various
Longtom	Various	BELONIDAE
Mackerels and Tunas		
Albacore	*Thunnus alalunga*	SCOMBRIDAE
Bonito	*Sarda australis*	SCOMBRIDAE
Bonito, Leaping / Spotted	*Cybiosarda elegans*	SCOMBRIDAE
Leadenall (Frigate mackerel)	*Auxis thazard*	SCOMBRIDAE
Mackerel Scaley	*Grammatorcynus bicarinatus*	SCOMBRIDAE
Mackerel, Other mix / Unspecified	*Scomberomorus* spp.	SCOMBRIDAE
Mackerel, Slimy / Common / Blue	*Scomber australasicus*	SCOMBRIDAE
Mackerel, Spanish (Narrow-banded)	*Scomberomorus commerson*	SCOMBRIDAE
Mackerel, Spotted	*Scomberomorus munroi*	SCOMBRIDAE
Tuna, Bigeye	*Thunnus obesus*	SCOMBRIDAE
Tuna, Mackerel	*Euthynnus affinis*	SCOMBRIDAE
Tuna, Mixed / Unspecified	Various	SCOMBRIDAE
Tuna, Northern Bluefin	*Thunnus tonggol*	SCOMBRIDAE
Tuna, Skipjack / Striped	*Katsuwonus pelamis*	SCOMBRIDAE
Tuna, Southern Bluefin	*Thunnus maccoyii*	SCOMBRIDAE
Tuna, Yellowfin	*Thunnus albacares*	SCOMBRIDAE
Wahoo	*Acanthocybium solandri*	SCOMBRIDAE
Marlins		
Marlin, Striped	*Tetrapterus audax*	ISTIOPHORIDAE
Sailfish	*Istiophorus platypterus*	ISTIOPHORIDAE
Spearfish, Shortbill	*Tetrapturus angustirostris*	ISTIOPHORIDAE
Morwongs		
Morwong, Jackass	*Nemadactylus macropterus*	CHEILODACTYLIDAE
Morwong, Mixed / Unspecified	*Nemadactylus* spp.	CHEILODACTYLIDAE
Morwong, Red	*Cheilodactylus fuscus*	CHEILODACTYLIDAE
Morwong, Rubberlip	*Nemadactylus douglasii*	CHEILODACTYLIDAE
Snapper, Queen	*Nemadactylus valenciennesi*	CHEILODACTYLIDAE
Mullet, Mixed / Unspecified	Various	MUGILIDAE

Table B1.2 cont.

Common name	**Scientific name**	**Taxonomic Family / Class name**
Mulloway / Jewfish	*Argyrosomus japonicus*	SCIAENIDAE
Nannygais		
Alfonsino	*Beryx splendens*	BERYCIDAE
Imperador	*Beryx decadactylus*	BERYCIDAE
Redfish / Nannygai	*Centroberyx affinis*	BERYCIDAE
Octopus	*Octopus* spp.	OCTOPODIDAE
Old Wife	*Enoplosus armatus*	ENOPLOSIDAE
Opah / Moonfish	*Lampris guttatus*	LAMPRIDAE
Orange Roughy / Deep Sea Perch	*Hoplostethus atlanticus*	TRACHICHTMYIDAE
Perch, Pearl	Glaucosoma scapulare	GLAUCOSOMIDAE
Pike	Various	DINOLESTIDAE
Pilchard / Herring / Pilchards	Sardinops neopilchardus	CLUPEIDAE
Ray's Bream	*Brama brama*	BRAMIDAE
Ribbonfish / Southern Frostfish	*Lepidopus caudatus*	TRICHIURIDAE
Salmon, Australian	*Arripis trutta*	ARRIPIDAE
Scorpionfishes		
Cod, Red Rock	*Scorpaena cardinalis*	SCORPAENIDAE
Perch, Ocean / Coral cod	*Helicolenus percoides & H.barathri*	SCORPAENIDAE
Perch, Orange	*Anthias pulchellus*	SCORPAENIDAE
Sea Basses		
Bass Groper	*Polyprion americanus*	POLYPRIONIDAE
Hapuku / Hapuka	*Polyprion oxygeneios*	POLYPRIONIDAE
Hapuku/Bass Groper species	*Polyprion* spp.	POLYPRIONIDAE
Seaperches		
Cod, Bar / Grey-banded	*Epinephelus ergastularius*	SERRANIDAE
Cod, Maori	*Epinephelus undulatostriatus*	SERRANIDAE
Perch, Longfinned	*Caprodon longimanus*	SERRANIDAE
Perch, Mixed / Unspecified	Various	SERRANIDAE
Wirrah	*Acanthistius ocellatus*	SERRANIDAE
Sergeant Baker	*Aulopus purpurissatus*	AULOPODIDAE
Sharks		
Bronze Whaler	*Carcharhinus brachyurus*	CARCHARHINIDAE
Gummy Shark	*Mustelus antarticus*	TRIAKIDAE
Wobbegongs	*Orectolobus ornatus & O.maculatus*	ORECTOLOBIDAE
Shark, Mixed / Unspecified	Various - known spp listed below	Various
Angel	*Squatina australis*	SQUATINIDAE
Black Tip	*Carcharhinus* spp.	CARCHARHINIDAE
Blue Whaler	*Prionace glauca*	CARCHARHINIDAE
Dogfish Endeavour	*Centrophorus* spp.	SQUALIDAE
Dogfish Greeneye	*Squalis* spp.	SQUALIDAE
Dogfish unspecified	Various	SQUALIDAE
Fiddler	*Trygonorrhina* sp. A	RHINOBATIDAE
Ghost	*Callorhinchus milli*	CALLORHINCHIDAE
Hammerhead	*Sphyrna* spp.	SPHYRNIDAE
Mako	*Isurus oxyrinchus*	LAMNIDAE
Port Jackson	*Heterodontus portusjacksoni*	HETERODONTIDAE
Roughskin	*Deania* spp.	DALATIIDAE
Saw	*Pristiophorus* spp.	PRISTIOPHORIDAE
School	*Galeorhinus galeus*	TRIAKIDAE

Table B1.2 cont.

Common name	Scientific name	Taxonomic Family / Class name
Sharks cont.		
Shovelnose	*Aptychotrema rostrata*	RHINOBATIDAE
Spinner	*Carcharhinus brevipinna*	CARCHARHINIDAE
Tiger	*Galeocerdo cuvier*	CARCHARHINIDAE
Whaler	*Carcharhinus* spp.	CARCHARHINIDAE
Shellfish, Mixed / Unspecified	Various	Various
Shells	Various	Class: GASTROPODA
Snapper / Red bream	*Pagrus auratus*	SPARIDAE
Sole, Black	*Synaptura nigra*	SOLEIDAE
Squid, Arrow	*Nototodarus gouldi*	CEPHALOPODA
Squid, Mixed / Unspecified	Various	LOLIGINIDAE & OMMASTREPHIDAE
Stargazer	Various	URANOSCOPIDAE
Stingray / Ray / Flaps mix	Various	DASYATIDIDAE / UROLOPHIDAE
Surgeon	Various	ACANTHURIDAE
Sweeps		
Mado	*Atypichthys strigatus*	SCORPIDIDAE
Old Maid / Butterfish	*Microcanthus strigatus*	SCORPIDIDAE
Sweep	*Scorpis lineolatus*	SCORPIDIDAE
Sweet Lip	Various	Various
Swordfish, Broadbill	*Xiphias gladius*	XIPHIIDAE
Tailor	*Pomatomus saltatrix*	POMATOMIDAE
Tarwhine	*Rhabdosargus sarba*	SPARIDAE
Teraglin / Trag	*Atractoscion aequidens*	SCIAENIDAE
Trevallas		
Rudderfish	*Centrolophus niger*	CENTROLOPHIDAE
Trevalla, Deepsea / Blue-eye	*Hyperoglyphe antarctica*	CENTROLOPHIDAE
Warehou, Blue	*Seriolella brama*	CENTROLOPHIDAE
Warehou, Spotted / Silver	*Seriolella punctata*	CENTROLOPHIDAE
Warehou, Blue and Silver mixed	*Seriolella brama and S. punctata*	CENTROLOPHIDAE
Trevally, Black / Happy Moments	*Siganus nebulosus*	SIGANIDAE
Trumpeter	*Pelates quadrilineatus*	TERAPONTIDAE
Trumpeter, Bastard/Moki	*Latridopsis forsteri*	LATRIDIDAE
Trumpeter, Mixed / Unspecified	Various	Various
Trumpeter, Tasmanian	*Latris lineata*	LATRIDIDAE
Whiting, Rock / Grass	*Halatta semifasciata*	ODACIDAE
Whitings		
Whiting, Sand	*Sillago ciliata*	SILLAGINIDAE
Whiting, Red Spot / School / Trawl	*Sillago flindersi*	SILLAGINIDAE
Whiting, Stout	*Sillago robusta*	SILLAGINIDAE
Whiting, Unspecified	Various	SILLAGINIDAE
Wrasses		
Parrot Fish	Various	LABRIDAE
Pigfish	*Bodianus vulpinus*	LABRIDAE
Tuskfish, Venus	*Choerodon venustus*	LABRIDAE
Wrasse, Crimson Banded	*Notolabrus gymnogenis*	LABRIDAE
Wrasse, Maori	*Ophthalmolepis lineolatus*	LABRIDAE
Wrasse, Mixed	*Labridae* spp.	LABRIDAE

B1.2.2 Bycatch species

Bycatch is that part of the catch that is discarded, and can contain both commercial and non-commercial species. Fish and invertebrates are discarded at sea either because they are below their minimum legal length (MLL), they are too small to be marketed, and/or because of low price/demand at market. This can include fish that are at or above their MLL.

There has not been a fishery-wide estimation of either the composition or rate of discarding. Stewart and Ferrell (2001) collected discard information from 34 trap fishers, ranging from Kingscliff to Tathra, using a combination of onboard observers and a voluntary logbook as part of an investigation into mesh selectivity within the fishery. The study was not designed to be a comprehensive assessment of discarding in the trap component of the fishery, but the available data (Table B1.3) indicate that large numbers of small or undersized fish (for those that have a minimum legal size) are captured and subsequently discarded, with unknown mortality. Note that not all fish caught for each species listed in Table B1.3 are discarded, it is up to fishers, as most species that are caught are marketable provided they are above their MLL where appropriate. The release of small fish of some species without a MLL, such as pearl perch, sweep and velvet leatherjackets, indicates that some fishers adopt a self-enforced size limit for those species.

Table B1.3 List of species reported to be discarded from demersal fish traps using 50 mm mesh.

Bastard trumpeter	Catfish	Pearl perch (65%)	Turret fish
Bearded ling	Conger eel	Port Jackson shark	Velvet leatherjacket (10%)
Blind shark	Dusky surgeonfish	Rubberlip morwong* (25%)	Wirrah
Blue groper	Kingfish*	Sergeant Baker	Wobbegong shark
Blue swimmer crab	Mado	Snapper* (30%)	
Boxfish	Ocean leatherjackets	Sweep (18%)	
Bream* (15%)	Old wife	Tarwhine* (<10%)	

Source: Stewart and Ferrell, 2001; Stewart and Ferrell, unpublished data

Note: Bracketed number indicates proportion of observed catch that was discarded. Asterisk denotes species with MLL, which at the time of the study was bream 25 cm, kingfish 60 cm, rubberlip morwong 28 cm, tarwhine 20 cm, and snapper 28 cm (subsequent increase in snapper MLL to 30 cm estimated to have increased rate from 30% to 52%). This list is indicative only, and the actual number of species discarded across the fishery is likely to be much greater and the percentages discarded would also vary.

B1.2.3 Status of species within the fishery

For most of the species taken in the fishery, current knowledge of stock status is poor or non-existent. Whilst reasonable information is available for some of the primary and key secondary species, particularly those that are also targeted in other fisheries such as bream, gemfish and trevally, little is known about the majority of species retained within the OTLF.

A number of different methods are used to provide information on the status of exploited stocks. These include relatively simple but usually imprecise methods such as analysis of catch and catch rates, to more sophisticated assessments that involve auxiliary information such as age structure, independent surveys and simulation modelling where estimates of exploitable biomass and spawning biomass are calculated. The method of reporting for the status of the stock has been standardised across all commercial fisheries in NSW. Up until 2003, reporting comprised of an appraisal of the status of exploited stocks (Table B1.4), and an indication of the reliability or confidence given to the data used in the appraisal (Table B1.5).

Table B1.4 Definitions of exploitation status of fish stocks, and the status of the primary and key secondary species within the fishery.

Exploitation status	Definition	Primary and key secondary species of the fishery
Under Fished	The appraisal of the stock suggests that it has the potential to sustain catches significantly higher than those currently being taken.	
Moderately Fished	The appraisal of the stock suggests it to be fished at levels which would probably allow only limited increases in catches.	
Fully Fished	The appraisal of the stock suggests that current catches are sustainable and close to optimum levels (the definition of which may vary between fisheries; e.g. catches are close to maximum sustainable yield, or fishing effort is close to a biological reference point). In a fully fished fishery, significant increases in fishing effort above current levels may lead to overfishing.	Bream[3], blue-eye[3], spanner crab[2],
Over Fished / Depleted	The appraisal suggests that current fishing levels may not be sustainable, and/or yields may be higher in the long term if the fishing level is reduced in the short term. This may be due to recruitment overfishing, growth overfishing and/or as a result of habitat degradation or loss.	Kingfish[3], snapper[3], gemfish[1], trevally[3],
Undefined	Fishery-dependent catch data exists but has not yet been appraised. The data may also be of limited value, particularly where the reported catch comprises multiple species or only very recent species-specific catch data.	Leatherjackets, bonito, all sharks, sweep, dolphinfish, pearl perch, black-spot pigfish, rubberlip morwong, bar cod, mulloway, teraglin, jackass morwong, spotted mackerel, hapuku, bass groper, narrow-barred Spanish mackerel

Source: Adapted from Kennelly and McVea, 2001 & 2003; Stewart *et al*., 2004. Superscripted number indicates assessment reliability as defined in Table B1.5.

Table B1.5 Categories used to indicate reliability of the appraisal of stock status.

Assessment Reliability	Definition
1	The assessment has been externally reviewed and represents a best practice approach. Data underlying the assessment are considered reliable and ideally have a fishery-independent component. A risk analysis of the consequences of alternative harvest strategies has been completed.
2	The assessment is comprehensive and has been internally reviewed. Data underlying the assessment are the best available and are used within a simulation model.
3	The assessment is completed using both fishery dependent indices of abundance and ancillary information such as age structures or independent surveys but not yet in a formal model framework.
4	The assessment is still under development or is only completed at an elementary level. Data underlying the assessment may be questionable (such as the use of only fishery-dependent effort). Overly simple assumptions may have been used.
No Assessment	No formal assessment of the stock status has been completed.

Since 2003, the DPI has been revising the stock assessment process and has developed a new resource assessment framework (see Scandol, 2004). Broadly, species will no longer be thought of in terms of their exploitation status based on a full and detailed stock assessment (as described above), rather the framework will use performance reports based on trigger points of pre-agreed indicators, such as CPUE, to produce species reports. Analogous to assessment reliability (Table B1.5), the framework will set a specific class of resource assessment for all species, which will be determined by a variety of attributes. For example, a Class 1 assessment would be a dynamic model that uses indices of abundance and other information about population structure, whereas the lowest class, Class 5, would be based on non-local information for growth, mortality, selectivity and maturity.

B1.3 Methods of Harvest

B1.3.1 Gear used in the fishery

The main fishing methods, ranked by 2001/02 product value were, fish trapping (38% of total), handline fishing (20%), dropline fishing (13%), spanner crab nets 'dillies' (13%), with various other line fishing methods making up the remainder. The types of fishing gear and the method by which they are generally used are described below.

Gears such as electric winches, hydraulic line haulers and lead lines have traditionally been used by commercial fishers to assist with the efficiency of their operations. Due to the oceanic nature of the fishery, the number of days actually fished is below the maximum number of days that could be theoretically fished since weather and ocean conditions can severely hamper operations.

B1.3.1.1 Fish trap (bottom/demersal)

Fish traps are generally timber framed with a wire mesh covering (not less than 50 mm mesh size), which are baited and set on or adjacent to reefs at depths of 10 to 150 metres (Figure B1.1). The *Fisheries Management (General) Regulation 2002* provides for fish traps used in ocean waters to have maximum dimensions of 2 metres x 2 metres x 2 metres, although most traps used in the fishery measure approximately 2 metres x 1 metre x 1 metre. Fish traps must be marked with a surface buoy (> 150 mm diameter) and traps must rest on the seabed not less than 5 metres apart. Fish traps are set with bait secured in the middle to lure fish through wire funnels into the trap.

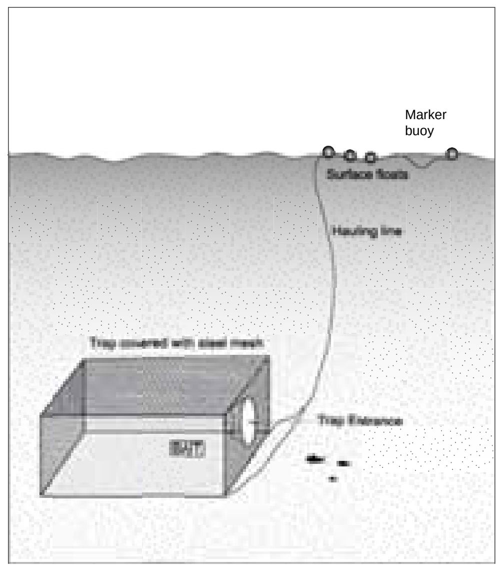


Figure B1.1 Diagram of a fish trap used in the Ocean Trap and Line Fishery

Fish trapping is carried out on suitable grounds between Tweed Heads and Eden. Information from observer work showed an average of 15 trap lifts per day and a maximum of around 30. However, fishers suggest that it is common for them to use around 40 traps per boat. They also report that some fishers may use up to 70 traps to "hold" fishing grounds and exclude other fishers from working there.

Typically, fishers make multiple trips to sea to place and bait traps for fishing since most boats can only carry between 4-6 traps at any one time. Each subsequent trip is used to land catch, re-bait traps or to move traps to more favourable locations. Traps are generally lifted and re-baited each day. Each trap has an approximate 12 month life-span, however new wire available may last for several years, hence increasing the life-span of the trap. This method of fishing is used to target species such as snapper, silver trevally, rubberlip morwong, bream and leatherjackets.

B1.3.1.2 Spanner crab net

Spanner crab nets (often called 'dillies') are flat, rectangular steel frames which have a net over the frame and bait in the centre of the net (Figure B1.2). The frame must not exceed 1.6 metres in length and 1 metre in width. The net must not extend more than 0.1 metres beneath the frame when it is held in a horizontal position.

Baited spanner crab nets are generally left for one hour before they are lifted into the boat by a line hauler. Multiple spanner crab nets are often set along one line to assist in retrieving the nets. A single commercial fisher can use a maximum of 20 nets at any one time, and a commercial fisher operating with a crew member can use a maximum of 30 nets.

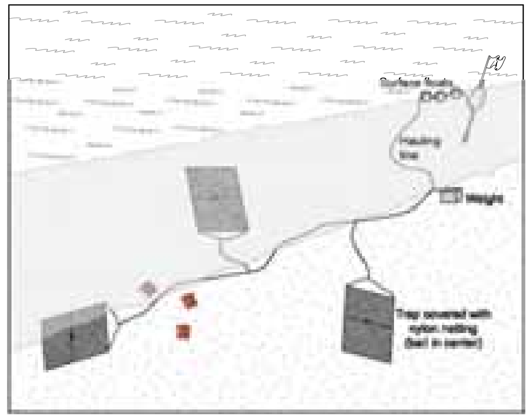


Figure B1.2 Diagram of a spanner crab net used in the Ocean Trap and Line Fishery

B1.3.1.3 Line methods

The regulations set out controls that apply to the number of lines and hooks used in commercial line methods within 3 nautical miles (nm) of the NSW coast. Variations to these controls apply to fishers with a school and gummy shark endorsement. No limit on the number of hooks or lines currently applies beyond 3 nm. OTLF endorsements can only be activated outside of 3 nm if the fishing boat has been issued an authority (called an OG1) to continue work in offshore waters (see B1.4.1). For further information, refer to the *Fisheries Management Act 1994* or the following website: www.dpi.nsw.gov.au. The information provided below gives a general outline of the different line methods.

Setlines/trotlines

Setlines and trotlines are similar gear types and can be used in multiple configurations, day or night, in different areas to target particular species. Setlines are attached to a row of floats and suspended below the water surface with weights. Trotlines (also known as demersal longlines) are weighted to the seabed by a series of weights, with mooring ropes and buoys at one end or both ends of the line (Figure B1.3). Fishers advise that weights can be placed at the ends of the line, at the junction of the float line and setline or from ropes attached to the setline.

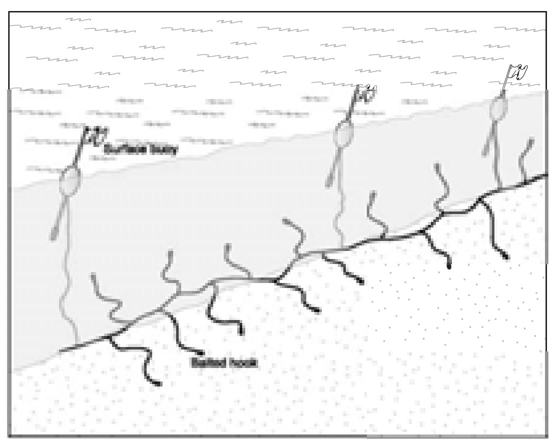


Figure B1.3 Diagram of a setline/trotline used in the Ocean Trap and Line Fishery

The number of hooks used and the soak time of the lines may depend on the Regulation (where applicable), weather, ocean conditions, size of vessel, area to be worked, and target species. Under the Regulation, a maximum of 10 lines with no more than 6 hooks or gangs of hooks attached per line may be used within the 3 nm boundary. There are no gear restrictions imposed on fishers working outside 3 nm. Fishers with a school and gummy shark endorsement have no limit on the number of hooks that can be used, however, the minimum size hook that can be used within 3 nm is 9/0.

Setlines are generally used to target species such as snapper and wobbegong shark, whereas trotlines are used to target these species as well as species such as school and gummy sharks from shallow waters out to about 80 fathoms. Redfish, blue-eye, hapuku and other deepwater species are targeted with these methods from 100 fathoms to around 600 fathoms with the number of hooks used ranging from 60 to over 3000.

Driftline

A driftline is a baited hook or gang of hooks suspended by line from a single float or buoy which drifts freely on the ocean surface. Under the Regulation, commercial operators may use, out to 80 nm, a maximum of 30 driftlines with 1 hook attached, or 1 gang of hooks comprising no more than 5 hooks, and each line must not be attached to another driftline or any object which prevents it from floating freely. Driftlines are generally used to target spotted and Spanish mackerel, sharks, snapper and kingfish.

Handline

Handlines are single lines with hooks or gangs of hooks lowered into the water by a rod or by hand. There are no specific gear requirements which apply to hand-held lines used by commercial fishers and there are no restrictions on the number of lines or hooks that can be used. Handlines are used to target species such as kingfish, mulloway and bonito.

Dropline

Droplines, as described by fishers, are vertically set lines attached to a surface float, with hooks attached by approximately 50-150 snoods per line (Figure B1.4). Generally, hooks are set 1 m apart and a 3-7 kg weight is attached to the bottom of the line in order to secure it to the seabed, however configurations may differ. Lines are suspended vertically and may be weighted so that hooks are suspended vertically near the seabed, so that hooks are part suspended vertically and part weighted along the seabed, or hooks may be suspended higher in the water column.

Fishers on the north coast use fewer lines than those on the south due to stronger currents. Droplines are generally used in deepwater areas such as waters adjacent to offshore drop-offs and submarine canyons. Fishers advise that between 3 and 20 lines are set and this is dependent on current speed and direction. Gear does not fish effectively at current speeds greater than 1.5 knots. Gear is set approximately 100 m apart and at varying depths. Gear can be set about 2-3 hours prior to sunrise with winching of gear commencing at sunrise.

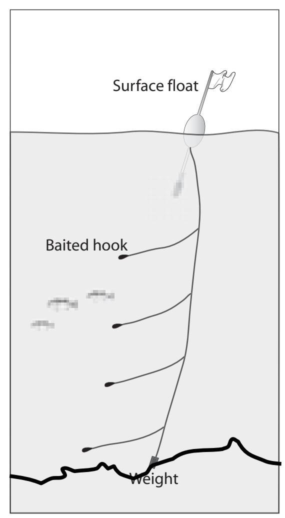


Figure B1.4 Diagram of a dropline used in the Ocean Trap and Line Fishery

Success of capture depends on bait loss, gear setting depth and current speed. Droplining is usually conducted in deep water areas beyond 100 fathoms (183 metres) in depth to target species such as blue-eye and hapuku. In Continental Shelf waters (<183 m), this method is used to target yellowtail kingfish, snapper, ocean and orange perch. The number of days fished can depend on offshore weather conditions, current speed and direction and area to be worked (inside or outside 3 nm). Barracouta, mackerel, pilchards, ribbonfish and squid are often used as bait.

Trolling

Trolling involves using a line to tow lures or baited hooks behind a vessel (Figure B1.5) to target pelagic fish such as mackerel, bonito, tuna and yellowtail kingfish. Fishers leadlining to target species such as kingfish may use up to around 5 lines with one hook per line, while fishers surface trolling for other species may use up to about 8 lines with one jig per line. The number of lines used may be limited by boat size.

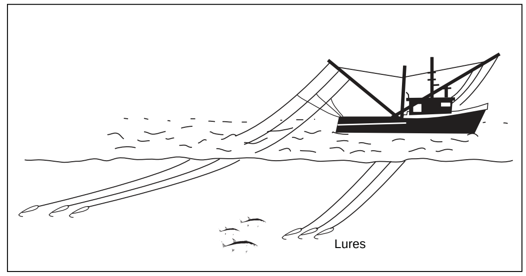


Figure B1.5 Diagram of trolling used in the Ocean Trap and Line Fishery

Jigging

Jigging is a line with large weighted lure that is jigged near the seabed or up through the water column whilst drifting or while anchored. Presently, the number of lines and hooks that may be used is unlimited. This method is used to catch species such as kingfish and bonito.

Poling

Poling is where bait or lures are attached to lines on the end of poles (Figure B1.6), which are lowered into a feeding school of fish and the hooked fish are then lifted into the boat. A poling operation consisting of about 3-4 crew would have about 3 poles with one hook per pole. Poling is used to catch species such as tuna and bonito, and poles of different lengths can be used depending on the species targeted.

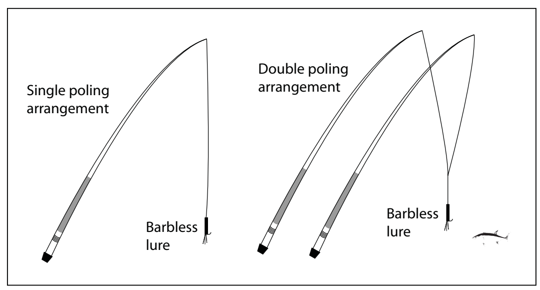


Figure B1.6 Diagram of poling used in the Ocean Trap and Line Fishery

B1.3.1.4 Identification (marking) of fishing gear

All gear types used in the OTLF (with the exception of hand held lines) must be marked. Demersal fish traps must be marked by a buoy which is positioned above the trap of no less than 150 mm in diameter that displays LFB number of the vessel followed by the letter F.

B1.3.2 Boats used in the fishery

Due the diverse nature of the OTLF, the composition of the fleet varies significantly depending on the methods used and the species targeted. Fishers who operate in near shore waters are able to use relatively small boats that require less capital investment. Fishers involved in fish trapping or deepwater lining operations generally use large ocean going vessels up to 20 metres in length, which require higher levels of capital investment. The average boat length is 6-8 m. A number of the boats used in the fishery are multi-purpose boats that are also used in the NSW Lobster Fishery and other commercial fisheries.

B1.4 Area of Operation

B1.4.1 Regions and zones

The OTLF extends from NSW coastal baselines seaward to the 4,000 metre isobath (approx. 60 to 80 nm offshore) (Figure B1.7). The ocean waters from the NSW coastal baseline to 3 nm offshore are State waters and fall under the jurisdiction of NSW. The waters from 3 nm to the 4,000 metre isobath are Commonwealth waters, however an Offshore Constitutional Settlement (OCS) was established in 1991 to allow NSW to manage some of the fishing activities in those waters.

Before 1991, the Commonwealth Government controlled all fishing in waters greater than 3 nm from shore. In January 1991 the Commonwealth and NSW Governments signed the OCS which gave jurisdiction of all ocean trap and line fishing activities within the 4,000 metre isobath (about 60 to 80 nm offshore) to NSW. The Commonwealth retained jurisdiction of the tuna and oceanic squid fisheries beyond 3 nm.

Resolution of the OCS meant that many fishers who previously held both NSW and Commonwealth licences needed only to renew their State licence each year, resulting in significant licence fee savings. Under OCS agreements, fishing boats that were previously licensed to fish outside 3 nm under Commonwealth jurisdiction were automatically issued an authority on their State boat licence (called an 'OG1') to continue to work in offshore waters. Since 1997/98 there have been approximately 300 fishing boats with an OG1 active in the OTLF.

There are six types of endorsements in the OTLF, the following five of which are based on a zoning system described below, and the fish trap endorsement, which is not subject to the following zoning or regions:

- line fishing (western zone) endorsement which authorises the holder to use a line to take fish for sale from ocean waters that are less than 183 metres (100 fathoms) in depth
- line fishing (eastern zone) endorsement which authorises the holder to use a line to take fish for sale from ocean waters that are not less than 183 metres (100 fathoms) in depth
- spanner crab (northern zone) endorsement which authorises the holder to use a spanner crab net to take spanner crab from ocean waters that are north of a line drawn due east from the southern breakwall at Yamba
- spanner crab (southern zone) endorsement which authorises the holder to use a spanner crab net to take spanner crab from ocean waters that are south of a line drawn due east from the southern breakwall at Yamba
- school and gummy shark endorsement that authorises the taking of school shark and gummy shark by line methods south of a line drawn east from the northern point of the entrance to the Moruya River

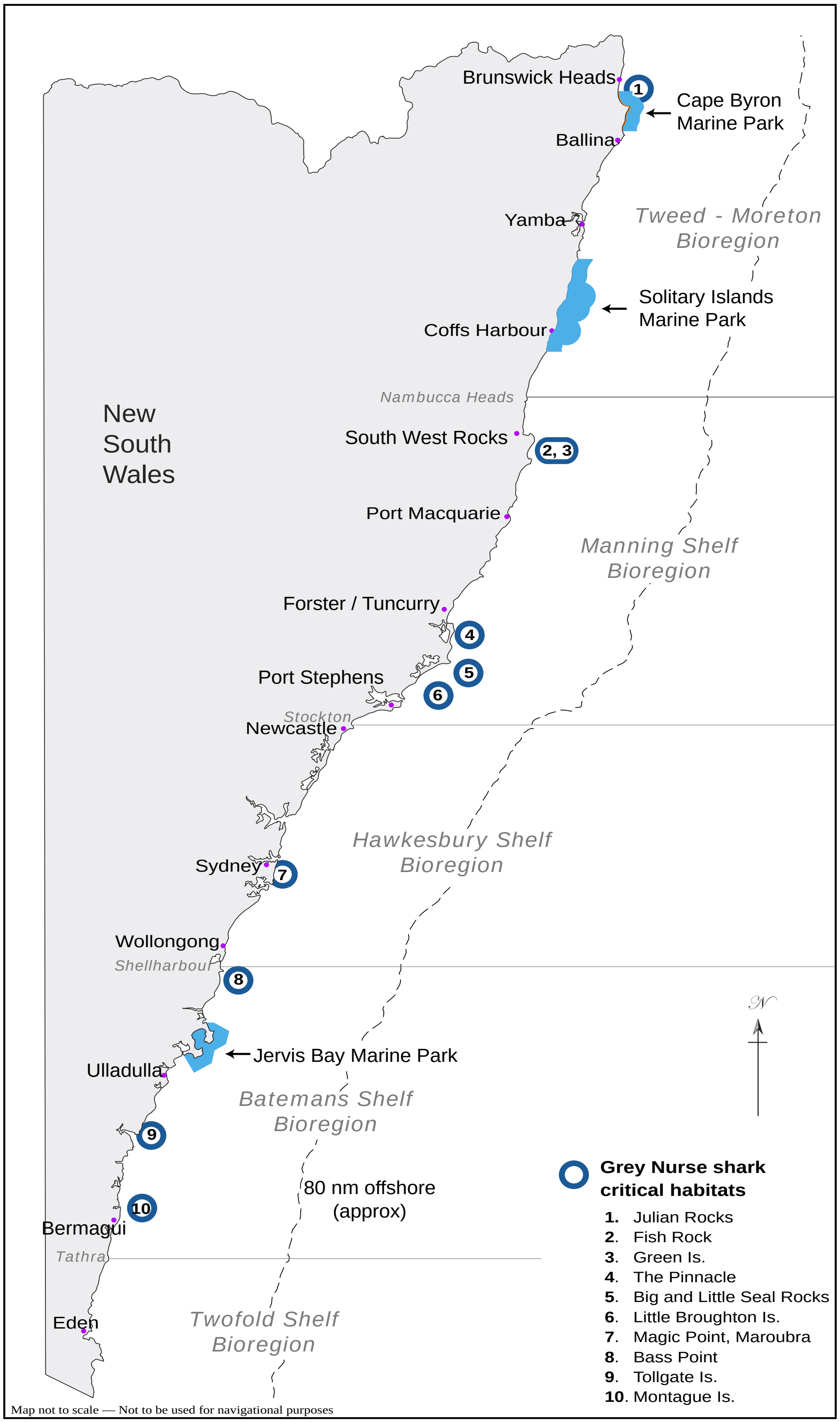


Figure B1.7 Map of the area of the Ocean Trap and Line Fishery including identification of major ports, marine parks, grey nurse shark critical habitats and marine bioregions where trap and line fishing is limited or is likely to be (Batemans Bay and Port Stephens / Great Lakes marine parks were declared in December 2005 and consultation was still occurring at the time of printing - see www.mpa.nsw.gov.au for more details)

B1.4.2 Major fishermen's co-operatives and associations

There are a number of fishermen's co-operatives in NSW that provide services for operators in this fishery. The major co-operatives are located at Ballina, Bermagui, Brunswick-Byron, Clarence River, Coffs Harbour, Crowdy Head, Hastings River, Newcastle, Laurieton, Macleay River, Twofold Bay, Ulladulla and Wallis Lake.

The co-operative system is important for many fishers for distributing catch and selling fish taken in the fishery, and provides a means for communication within industry, and between industry and other organisations including NSW DPI.

A number of other fisher-based organisations exist in NSW including the Northern Professional Fishermen's Association, Master Fish Merchants Association, Metropolitan Fishermen's Association, Australian Seafood Industry Council, NSW Seafood Industry Council and Ocean Watch.

B1.4.3 Closed areas

Some areas of ocean waters may be closed to the OTLF, or particular methods within the fishery, through the declaration of marine protected areas (such as marine parks, aquatic reserves, and marine components of national parks or nature reserves), critical habitats for endangered species, intertidal protected areas, habitat management plans, or fishery-specific closures.

The remainder of this section will focus on marine protected areas and critical habitats, as the other mechanisms have little or no impact on the fishery. Intertidal protected areas are temporary fishing closures and complement the marine protected area system by protecting rocky shore habitat and their associated intertidal invertebrates. Similarly, habitat management guidelines and plans have been and will continue to be prepared to prevent or minimise the impact of all types of activities on fish habitat. The Ocean Trap and Line MAC will provide advice and contribute to any reviews of DPI habitat management policy and guidelines or habitat protection plans, where they relate to areas fished by ocean trap and line fishers. To date, no areas have been closed to the fishery through this mechanism. The fishery-specific time and area closures are discussed in section B1.6.8.

The NSW Government is committed under international, national and state agreements to conserve marine biodiversity and manage the ecologically sustainable use of fish and marine vegetation. A key component of these agreements is to establish a system of marine protected areas that adequately represent the biodiversity found in the oceans and estuaries of Australia. Sixty-five marine bioregions and provinces have been identified in Australian waters (IMCRA, 1998), five of which are located in NSW waters, by scientists and conservation managers to assist in planning a National Representative System of Marine Protected Areas (MPA). National guidelines and criteria have been developed to identify and select MPA in each bioregion, in accordance with international, national and state strategies, and the NSW Government is using them to identify sites for marine protected areas and to prioritise new areas for marine biodiversity conservation in NSW waters.

Marine protected areas preserve many different types of marine environments, and the animals and plants that live in them. They allow areas for fish to breed and grow with minimal human interference, provide relatively unspoilt natural sites for people to visit, and offer representative areas for education and research. It is important to note that some marine protected areas allow for a range of activities to occur. The activities permitted depend on the zoning arrangements for the particular area and may include some forms of fishing.

B1.4.3.1 Marine Parks

Marine parks are the largest type of marine reserve in NSW. Marine parks are areas of coastal, estuarine or oceanic waters and adjoining lands permanently set aside to protect the organisms including plant life, fish species, birds and other animals that live in that environment. Marine parks are managed to effectively conserve biodiversity and associated natural and cultural resources, while still allowing for the sustainable use and enjoyment of these areas by the community. The community has a vital role in the management of marine parks. Community input is provided at two levels: (1) at the State-wide level through the Marine Parks Advisory Council, and (2) at the local level through advisory committees established for each park.

Marine parks aim to conserve biodiversity by protecting representative samples of the habitats in the five defined marine bioregions occurring in NSW (see Figure B1.7). Zoning and operational plans are used to guide the protection of conservation values and manage activities that occur within the marine park. Four zones are used in marine parks – sanctuary zones, habitat protection zones, general use zones, and special purpose zones. Sanctuary zones provide the highest level of protection, and include the prohibition of all forms of fishing. Some fishing methods can also be prohibited within habitat protection zones, and all forms of setlining, droplining and longlining are prohibited in NSW marine parks (the exception being setlining and droplining that are permitted in the general use zones in Jervis Bay MP).

Consultation occurs with the community prior to the declaration of marine parks. Information on the creation and zoning of marine parks in NSW waters is available on the Marine Parks Authority website: www.mpa.nsw.gov.au. Marine Parks have been declared in three of the five bioregions along coastal NSW, and another in the Lord Howe Province located approximately 320 nm (600 km) offshore. The Marine Parks Authority is currently reviewing assessments of the other bioregions to determine where additional parks may be required.

The six marine parks declared as of January 2006 include:

- Cape Byron (approx. 22,000 hectares) - Tweed-Moreton Bioregion - the final zoning plan was released in November 2005 and is anticipated to commence in April 2006. Under the zoning plan, Sanctuary Zones comprise 27.5% (6105 ha) of the park. The Sanctuary Zones are in nearshore waters between Brunswick Heads and Cape Byron (including waters around Julian Rocks), Cocked Hat Rocks to Jews Point, and parts of Lennox Head. Spanner crab netting, fish trapping and handlining are largely unaffected by the proposal beyond the Sanctuary Zones, and in the following Habitat Protection Zones: Mackerel Boulder (closed to all fishing 1 May - 31 December); Wilsons Reef - Bait Reef (surface fishing only); Lennox Head (line fishing only).
- Jervis Bay (approx. 21,450 hectares) - Batemans Shelf Bioregion - the waters of Jervis Bay west of a line drawn between Bowen Island to Point Perpendicular are closed to the fishery. In addition, there are also Sanctuary Zones located within the marine park between St Georges Head and Steamers Head, Point Perpendicular to Crocodile Head and on Warrain Beach. Spanner crab netting, fish trapping and handlining are largely unaffected by the park beyond the Sanctuary Zones, and setlining and droplining are also permitted in the general use zones.
- Lord Howe Island (approx. 48,000 hectares) - Lord Howe Island Province - Lord Howe Island is beyond the 80 nm (4,000 m isobath) range of the fishery.

- Solitary Islands (approx. 71,100 hectares) - Tweed-Moreton Bioregion - Sanctuary Zones comprise 12% (8,650 ha) of the park, and fish trapping is also prohibited in the following Habitat Protection Zones: Sandon Shoals, Chopper Rocks, Surgeons Reef and within 500 m of North Solitary Island, North West Rock, North West Solitary Island, South Solitary Island and Split Solitary Island.
- Port Stephens/Great Lakes (approx. 97,200 hectares) - Manning Shelf Bioregion - currently proposed to extend from Cape Hawke Surf Life Saving Club near Forster, south to Birubi Beach Life Saving Club at the northern end of Stockton Beach near Newcastle. At the time of this report, community consultation was underway.
- Batemans (approx. 85,000 hectares) - Batemans Shelf Bioregion - currently proposed to extend from Murramarang Beach to Wallaga Lake. At the time of this report, community consultation was underway.

B1.4.3.2 Aquatic Reserves

Aquatic reserves are administered by NSW DPI and play an important role in conserving biodiversity and protecting significant marine areas. Currently, there are 13 aquatic reserves that have been declared in NSW. Each aquatic reserve is unique, with the type of protection varying throughout the reserves. The 13 aquatic reserves (as of January 2006), and the degree to which they currently affect the OTLF, are:

- Cook Island off Tweed Heads (approx. 78 hectares) - fishing by all methods is prohibited for all waters from the mean high water mark on the island to a boundary defined by five marker buoys, generally located between 250-350 m from the island. In addition, setlining is prohibited within the entire aquatic reserve
- Fly Point in Port Stephens (approx. 70 hectares) - within the estuary of Port Stephens and thus closed to the OTLF
- Barrenjoey Head, near Palm Beach (approx. 29 hectares) - handlining permitted
- Narrabeen Head (approx. 5 hectares) - handlining permitted
- Long Reef, near Dee Why (approx. 76 hectares) - handlining permitted
- Cabbage Tree Bay, Manly (approx. 20 hectares) - fishing by all methods is prohibited
- North (Sydney) Harbour near Manly (approx. 260 hectares) - within the estuary of Sydney Harbour and thus closed to the OTLF
- Bronte-Coogee (approx. 43 hectares) - handlining permitted
- Cape Banks, La Perouse (approx. 22 hectares) - handlining permitted
- Boat Harbour, near Cronulla (approx. 72 hectares) - handlining permitted
- Towra Point in Botany Bay (approx. 1400 hectares) - Botany Bay is closed to commercial fishing
- Shiprock, in Port Hacking (approx. 2 hectares) - fishing by all methods is prohibited
- Bushrangers Bay south of Wollongong (approx. 4 hectares) - fishing by all methods is prohibited.

B1.4.3.3 Marine or estuarine extensions of National Parks or Nature Reserves

There are currently 28 National Parks and 16 Nature Reserves dedicated or reserved under the *National Parks and Wildlife Act 1974* that contain or adjoin marine or estuarine areas. The NPWS manages most of those areas to the low water mark, and thus have little or no impact on the OTLF. The only existing marine extension reserved as a national park occurs adjacent to Bouddi National Park and involves a co-operative management arrangement between the National Parks & Wildlife Service, DPI Agriculture and Fisheries Division, and the Waterways Authority.

Bouddi National Park includes a marine extension of 287.3 hectares offshore, between Gerrin Point and Third Point, a distance of approximately 3.8 km and encompassing Maitland Bay, Maitland Bombora, Bouddi Point and Caves Bay. The marine extension includes both the seabed and the waters beneath which it is submerged. There is currently a prohibition under section 8 of the FM Act, which prohibits the taking of fish including worms, nippers, shellfish and crustaceans of every description by all methods within the marine extension of the park.

B1.4.3.4 Critical habitats

Under the FM Act, the whole or any part of the habitat of an endangered species, population or ecological community that is critical to the survival of the species, population or ecological community is eligible to be declared as critical habitat. Further, habitat means any area occupied, or periodically or occasionally occupied, by fish or marine vegetation (or both), and includes any biotic or abiotic component. To date, the only species for which critical habitat has been declared under the FM Act is the grey nurse shark.

Grey nurse sharks roam over most of the NSW coast, but are known to gather to feed, mate and pup at a limited number of locations, generally referred to as aggregation sites. Some of these areas, such as North and South Solitary Islands, occur within existing Marine Parks, and others occur in Commonwealth waters, e.g. The Cod Grounds. In May 2002, a Draft Recovery Plan for the species was published, which proposed a range of protective measures for the species, including the declaration of critical habitats. In December 2002, ten of the then unprotected aggregation sites in NSW waters were recognised and declared as grey nurse shark critical habitat areas, with associated regulations to control fishing and diving activities. The 10 critical habitat sites as of January 2006 are:

- Magic Point at Maroubra
- Julian Rocks near Bryon Bay (rules apply only 1 May to 31 October inclusive)
- Green Island near South West Rocks
- Fish Rock near South West Rocks
- The Pinnacle near Forster
- Big Seal and Little Seal at Seal Rocks
- Little Broughton Island near Port Stephens
- Bass Point near Shellharbour
- The Tollgate Islands at Batemans Bay
- Montague Island near Narooma (rules apply only 1 November to 30 April inclusive).

Critical habitats were determined for most sites by a 200 m radius from the known aggregation site, with an additional buffer zone of 800 m extending from the edge of the critical habitat. Restrictions were introduced at these sites to limit the impacts on grey nurse sharks of both commercial and recreational line fishing and diving. Commercial line fishers are restricted to using recreational fishing gear in each critical habitat and buffer zone. There is also a ban on fishing with bait from anchored or moored vessels in critical habitat, and a ban on commercial drop, drift and setline fishing within both critical habitat and the adjacent buffer zone, i.e. within 1000 m of the aggregation site. The use of wire trace whilst anchored in critical habitat or buffer zones is also prohibited, although it is permitted whilst trolling or drifting. Trapping is not currently affected by the declaration of critical habitats.

Restrictions on scuba diving include no night diving in critical habitat sites as well as a ban on touching or harassing sharks, and on the use of underwater scooters and electronic shark repelling devices. NSW Fisheries is currently reviewing the protection of grey nurse sharks in critical habitat areas. In order to finalise the Recovery Plan, a discussion paper for increased grey nurse shark protection was released in July 2003. Options for increased protection outlined in the paper included enhancements that could be made to the current critical habitat and buffer zone provisions, and practical ways of providing increased protection for grey nurse sharks when they are foraging or travelling away from their critical habitat areas.

B1.5 Factors that Influence the Operation of the Fishery

Fishing is dependent on suitable weather and oceanographic conditions. Strong winds and heavy seas often restrict trap and line fishing in ocean waters. Strong ocean currents can also influence both fishing practices and the species composition of the catch.

Fishing for snapper is strongly associated with environmental conditions. There is some evidence for longer-term cycles in the landings of snapper. This may be associated with large scale environmental processes such as el Niño – la Niña. Oceanographic conditions strongly influence the efficiency of fish traps and strong currents can hold headgear (floats) underwater and can temporarily prevent the retrieval of set fishing gear.

The fishing techniques employed in the deepwater line fishery are strongly dependent on suitable oceanographic conditions. The fishery targets cool water temperate species, which are not highly catchable when strong warm currents flow from the north. The cycles in flow of the East Australian Current therefore play a significant role in determining the relative success of deepwater line fishers along the length of the NSW coast.

Market forces can also dictate which species are landed, as fishers are not going to receive a premium price for their product if there is already a lot of a particular species in the fish markets. Price can also be affected both seasonally and by imported product, in particular snapper imported from New Zealand has a significant effect on the fishery. Unlike snapper caught by the ocean trap and line fishers, the imported product does not have to meet the minimum legal length of 30 cm and the import market may be more capable of surviving a flooded market than the ocean trap and line fishers.

Besides restrictions placed on fishers by the DPI, fishers may also have restrictions imposed on them by other government departments including the Department of Environment and Conservation (such as changes to access of boat ramps), NSW Maritime Authority (such as vessel and crew requirements), NSW Food Authority (by the Food Production – Seafood Safety Scheme – Regulation 2001) and local councils.

B1.6 Existing Management Regime

B1.6.1 History and status of commercial fisheries management in NSW

Controls on commercial fishing in NSW date back as far as 1865 when the first fisheries legislation was introduced. Since that time, several Acts have been introduced to improve the ability to manage impacts of fishing. The *Fisheries & Oyster Farms Act 1935* provided a good set of management tools, such as licensing rules, gear controls and fishing closures, and was in force for some 60 years.

The OTLF has historically been managed by a series of licensing arrangements (e.g. boat replacement policy) and input controls (e.g. trap size, limit on hook numbers inside 3 nm) aimed at controlling effort in the fishery. Despite these controls, potential fishing effort has undoubtedly increased over the years with improvements in gear technology such as the introduction of colour sounders and satellite position fixing equipment. The quality and durability of materials used during the construction of fish traps and lines has also improved, making them more effective.

With the advent of new technology and ongoing increases in effective fishing capacity, more contemporary management regulations were needed. The *Fisheries Management Act 1994* replaced the *Fisheries & Oyster Farms Act 1935* and provided a more comprehensive instrument to manage fisheries. Table B1.6 below provides an insight into the historical development of fisheries management in NSW, as well as some of the major management decisions affecting the OTLF.

Table B1.6 Chronology of major fisheries management events in NSW relevant to the Ocean Trap and Line Fishery.

Year	Management event
Mid-1800s	Commercial fishing commenced in NSW estuaries
1865	*Fisheries Act 1865* commenced in response to concerns of overfishing, enabling the declaration of seasonal and area fishing closures
1881	*Fisheries Act 1881* commenced, allowing for the regulation of fishing gear, including controls over mesh sizes in nets, and the licensing of fishers and fishing boats
1935	*Fisheries and Oyster Farms Act 1935* introduced
1979	The use of bottom set mesh nets in ocean waters was banned within 3 nm
1984	Freeze on the issue of new fishing boat licences introduced
1987	Freeze on the issue of new fisher licences (“commercial fishing licences”) introduced
1990	Warning issued by Government against new investment and/or new diversification in commercial fishing activities
1991	Commonwealth and NSW governments sign the Offshore Constitutional Settlement (OCS)
1994	Licensing Policy introduced, commencing the process of catch validation
1995	Commencement of the *Fisheries Management Act 1994* which provided for the establishment of ‘share management fisheries’ and ‘restricted fisheries’. Ocean Hauling became a restricted fishery.
1996	1. 1994 Licensing policy revised and re-issued 2. Kingfish traps banned
1997	1. Restricted fisheries introduced for major marine commercial fisheries: Ocean Prawn Trawl, Ocean Fish Trawl, Ocean Trap & Line, Estuary Prawn Trawl, Estuary General. 2. Purse seining was incorporated into the Ocean Hauling Fishery. (NB. the Abalone and Rock Lobster fisheries were declared share management fisheries) 3. The *Marine Parks Act* commenced
2000	1. Commencement of share fishery management plans for the Abalone and Lobster Fisheries 2. Amendment to *Fisheries Management Act 1994* provides for the category 2 share management fisheries framework 3. Amendment to *Fisheries Management Act 1994* and *Environment Planning and Assessment Act 1979* to provide for the Environmental Assessment of fishing activities
2004	Category 1 share management fisheries introduced for major marine commercial fisheries: Ocean Trawl, Ocean Trap & Line, Estuary Prawn Trawl, Estuary General, Ocean Hauling.

The *Fisheries Management Act 1994* provides several broad frameworks for managing commercial fisheries including category 1 and category 2 share management fisheries and restricted fisheries. Each framework provides a different level of access rights along with different levels of cost and responsibility for industry. Table B1.7 provides a comparison between the three management frameworks.

Table B1.7 Comparison of the restricted fishery and share management fishery frameworks.

* exceptions apply in some fisheries where validated catch history is not required to hold the endorsement

	Restricted fishery	Category 1 share management fishery	Category 2 share management fishery
Right issued	Validated catch history which gives rise to an “entitlement”*	Shares	Shares (15 year term)
Access	Endorsement	Endorsement	Endorsement
Transferability	Subject to transfer policy	Subject to the management plan	Subject to the management plan
Statutory compensation payable?	No	Yes, if shares are cancelled	Yes, if shares are cancelled
Statutory management plan required?	No	Yes, 5 year plan	Yes, 5 year plan
Appeal mechanism	Statutory review panel	Statutory review panel	Statutory review panel
Cost recovery	Partial; moratorium on full cost recovery	Full cost recovery	Partial; full cost recovery after 8 years
Community contribution payable?	No	Yes, as determined by the NSW Treasurer from time to time	Small rental payment

B1.6.2 Controls on fishing activity

There are two broad types of fishery management controls, known as input controls and output controls. Input controls limit the amount of effort commercial fishers put into their fishing activities, indirectly controlling the amount of fish caught. They need to continually be modified in response to fishing technology. Input controls can include restrictions on the number of licences, the size and engine capacity of boats, the number of fishing lines and/or hooks used, the construction and number of traps, and the areas and times which can be worked. Output controls, on the other hand, directly limit the amount of fish that can be landed and are well suited for single species, high value fisheries using single gear types (Goulstone, 1996).

The OTLF in NSW is predominantly managed by input controls. The following section describes in broad terms the diverse range of controls that apply to activities in the fishery.

B1.6.3 Limited entry

Access to the OTLF has been limited to eligible fishers since the commencement of the restricted fishery regime on 1 March 1997. Prior to that date, nearly every NSW fisher with a general commercial fishing licence could operate methods now managed under the OTLF. The exception is the spanner crab fishery, which was managed through a limited access permit scheme between 1995 and 1997.

Initial entry to the OTLF under the restricted fishery regime for most methods was defined by having a minimum level of catch history showing that the methods sought in the application had been actively used over past years. An extensive statutory appeals process followed. For a full description of the initial allocation process for the Ocean Trap and Line Fishery, see Goulstone and McIlgorm (2001)

Following changes to the *Fisheries Management Act 1994* in December 2000, the OTLF, along with most other major commercial fisheries, was selected to become a category 2 share management fishery.

As of January 2004, the fishery has been operating under the restricted fishery regulations and will continue to so until a share management plan for the fishery has been made by regulation.

B1.6.4 Licensing arrangements

B1.6.4.1 Commercial fishing licences

A commercial fishing licence is required by an individual before they can take fish for sale or be in possession of commercial fishing gear in or adjacent to waters. The licence only authorises activities that are covered by the endorsements issued in respect of each part of fishery and specified on the licence.

Commercial fishing licences are currently available to persons who held a licence immediately prior to the commencement of the *Fisheries Management Act 1994*, owners of a recognised fishing operation (RFO), or the nominated fisher of an RFO (see section B1.6.5.3 for further details on the nomination policy). An RFO is a fishing business with a minimum level of validated catch history. The RFO policy was introduced via the Licensing Policy issued by NSW DPI (then known as NSW Fisheries) in June 1994.

The common objectives of the 1994 Licensing Policy and its replacement in 1996 were to:

- provide transitional arrangements which do not pre-empt future management whilst longer term management arrangements are being introduced
- provide a mechanism which allows existing fishers with catch history to identify and subsequently dispose of their fishing business
- allow new entrants into the industry in a manner which ensures that active fishing effort only is being replaced (see section B1.6.7.2 for further details on the transfer of fishing business entitlements to new entrants)
- provide a mechanism for the consolidation of smaller fishing businesses.

The RFO policy has been effective at restructuring and consolidating fishing businesses at the lower end of the income range and has been delivering on the objective of promoting a viable commercial fishing industry (Murphy, 1999).

B1.6.4.2 Fishing endorsements

It is important to identify the difference between endorsements and entitlements in the fishery and how they relate to commercial fishing licences.

Entitlements in the fishery are associated with fishing businesses, while endorsements appear on commercial fishing licences of individuals and authorise the use of specific gear or taking of specific species. Some fishing businesses can be owned and held in the names of more than one individual (including company or partnership names) and therefore, an entitlement associated with a business may entitle more than one person's licence to be endorsed to operate in the fishery.

Further information on entitlements and endorsements is provided in section B1.6.5.

The OTLF is categorised into six endorsement types that determine the type of fishing that may take place. Table B1.8 lists the endorsement types available in the fishery and details the activity that is authorised by each endorsement (as at July 2005). For example, only fishers with a demersal fish trap endorsement on their fishing licence are permitted to use fish traps.

Conditions may be placed on endorsements to further restrict or manage the activities of fishers. For example, fishers holding a line fishing (western zone) endorsement are subject to an endorsement condition that prevents them from landing certain deepwater species unless they also hold a line fishing (eastern zone) endorsement.

Table B1.8 Entitlements and endorsements in the Ocean Trap and Line Fishery (at July 2005)

Endorsement type	Endorsement description	Number of entitlements
Spanner crab (northern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are north of a line drawn east from the southern breakwall at Yamba.	55
Spanner crab (southern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are south of a line drawn east from the southern breakwall at Yamba	9
Line fishing (western zone)	Authorises use of line methods to take fish from ocean waters that are west of the 100 fathom (183 metres) depth contour. This endorsement does not authorise the holder to take school or gummy shark from waters that are south of a line drawn east from the northern point of the entrance to Moruya River. The endorsement does not authorise the taking of the deeper water species blue eye trevalla, ling, gemfish, hapuku and bass groper.	474
Line fishing (eastern zone)	Authorises use of line methods to take fish from ocean waters that are east of the 100 fathom (183 metres) depth contour. This endorsement does not authorise the holder to take school or gummy shark from waters that are south of a line drawn east from the northern point of the entrance to Moruya River.	111
Demersal fish trap	Authorises the taking of fish for sale from ocean waters by bottom set fish traps.	277
School and gummy shark	Authorises the taking of school shark and gummy shark by line methods south of a line drawn east from the northern point of the entrance to the Moruya River	30

Note: fishers may hold more than one endorsement. Additionally, any vessels operating outside 3 nm must have an OG1 authorisation.

B1.6.5 Fishing boat licensing

In addition to each fisher having to be licensed, every fishing boat used in connection with the OTLF must also be licensed. There has been a cap on the total number of boat licences since 1984 (includes boats used in all fisheries).

To prevent any increase in size and therefore efficiency of vessels in the fishery, a strict boat replacement policy applies[1]. Boats 5.8 m in length or less may be replaced with boats up to 5.8 m. Boats that are greater than 5.8 m in length may only be replaced with boats that are no more than 10% or one metre greater in length, whichever is lesser. The 10% tolerance continues to relate to the original boat length to avoid a progressive increase in boat length over time.

In addition, the former Minister for Fisheries approved a new provision allowing fishers to temporarily replace their fishing boats with smaller boats for up to two years. During this time, a permanent boat replacement must be made with respect to the original boat.

B1.6.5.1 Renewal of licences

Commercial fishing licences and fishing boat licences must currently be renewed annually. Fishers are sent renewal application forms approximately one month before the expiry date on the licence. If a commercial fishing licence is not renewed within 60 days of the expiry date on the licence, the renewal application is taken to be an application for a new licence. Additional fees apply to late renewal applications.

Abeyance period for fishing boat licences

Fishing boat licences can be held in abeyance for a period of up to two years from the date of expiry of the licence or when advised in writing by the owner. Fishing boat licence fees are not payable during the period of abeyance, but the full amount due is payable if the licence is reinstated within the two years specified.

B1.6.5.2 Appeals mechanisms

Fishers may lodge an appeal to the Administrative Decisions Tribunal (ADT) against a decision to refuse to issue or renew, suspend, cancel or place conditions on a commercial fishing licence (or an endorsement on that licence) or a fishing boat licence.

The main role of the ADT is to review administrative decisions of New South Wales government agencies. To lodge an appeal with the ADT, a request must first be made to NSW DPI for an internal review of the decision, then a written application should be lodged with the ADT no more than 28 days after the internal review was finalised.

The ADT can make various orders concerning an appeal application including:

- upholding the original decision
- reversing the decision completely or in part
- substituting a new decision for the original decision
- ordering the agency to reconsider the decision in light of the ruling.

[1] This policy has been in place since the introduction of the June 1994 Licensing Policy, and several variations to the policy apply prior to that.

For further information, refer to the *Administrative Decisions Tribunal Act 1997* or the following website: http://www.lawlink.nsw.gov.au.

B1.6.5.3 Nomination policy

Part of the introduction of the restricted fishery regime was the creation of rules to allow the endorsements of a fishing business to be nominated to a person. This was necessary due to fishing businesses being held in company or partnership names and because fishing licences can only be issued to natural persons.

B1.6.5.4 Training licences

Licences are available to eligible persons for the purposes of training a new entrant to the commercial fishing industry. There are two types of training licences currently available:

1) trainer's licence: the seller may apply to continue to hold his/her fishing licence for up to one year from the next fishing renewal date, to work with the purchaser of the fishing business for training purposes (but the business must qualify as a RFO), subject to the entitlements of the fishing business, on the understanding that the licence is surrendered at the end of the one year period unless a further RFO is acquired which is not the original business.

2) trainee licence: within six months of acquiring a RFO a new entrant may request that the RFO be placed into abeyance whilst the owner works with an experienced fisher to gain the necessary skills. This arrangement may apply for a period of up to two years. Fishing methods that the new entrant can use are restricted to the entitlements held by his or her fishing business. Areas that can be worked by the new entrant are limited to areas included in the purchased RFO and areas of historic operation of the experienced fisher.

B1.6.6 Fishing gear registration

There is no requirement to register nets, traps or lines used in the OTLF.

B1.6.7 Transfer policies

B1.6.7.1 Transfer of licensed fishing boats

In most cases, boat licenses can be transferred from one person or company to another. Transferred licenses remain subject to any conditions applying to the license or general policy. Licensed fishing boats used in the OTLF operate under "general purpose" or "boat history" licenses.

The license of a general purpose boat may be transferred separately from any fishing business and has no associated catch history. General purpose boats are generally operated in fisheries where the fisher, rather than the boat, is the principal unit of effort. The majority of licensed fishing boats used in the OTLF operate with "boat history" licenses. The license of a boat history boat, and any associated endorsements, can only be transferred as part of the associated fishing business. The Licensing Branch can advise a fishing boat owner whether a boat has a boat history or general purpose license. Any transfer of a fishing boat license must be approved by the Director-General, NSW DPI.

B1.6.7.2 Transfer of fishing business entitlements

Commercial fishing licences and endorsements to participate in a fishery are not freely transferable. Currently, commercial fishing licences and endorsements only become available to a new entrant if a fishing business with the required level of validated catch history is acquired (i.e. an RFO). A transfer policy came into force in the ocean trap and line restricted fishery on 15 December 2000. The policy is based upon the requirement that a minimum level of catch history be transferred with the fishing business for the ocean trap and line endorsement(s) to be activated by a new owner.

Under this policy all ocean trap and line endorsements are issued to the new owner provided the validated catch history of the fishing business is equal to, or greater than, $20,000 in value per year in two of the years 1986 to 1990 and one of the years 1991 to 1993. If the value of the fishing business is less than $20,000, then the new owner may amalgamate other suitable fishing businesses to reach to the required level. A restrictive transfer policy was necessary to prevent endorsements, which were granted under extremely low entry criteria, from being issued to new owners of fishing businesses and utilised at much higher levels.

Under the current Licensing Policy, fishing businesses must be sold as an entire package (i.e. the catch history, boat history vessel licenses and/or endorsements associated with boats cannot be split). Proposals regarded as licence splitting, or contrary to the intention of the Licensing Policy are not approved.

B1.6.7.3 Licence splitting policy

Under the NSW DPI Commercial Licensing Policy 2003, fishing entitlements granted by one or more Australian Governments to a single owner or vessel may not be split. This is supported by a fishing closure implemented under the *Fisheries Management Act 1994*. This policy is in place to prevent the increase in effort that would occur if entitlements held by a fishing business were split into two (or more) entitlements and allowed to operate separately at full capacity.

NSW DPI allow transferral of fishing businesses to new owners with the condition that all entitlements must be transferred; any that are not transferred must be surrendered to the issuing authority. Licence-splitting proposals will only be considered where a decrease in effort in State fisheries has been demonstrated through the surrender of entitlements or vessel licenses.

B1.6.8 Time and area closures

The *Fisheries Management Act 1994* provides for the use of fishing closures in the OTLF to, among other things:

- protect and conserve areas of key habitat
- manage the amount of fishing effort in an area/region
- manage conflicts between stakeholders over the use of the resource and to ensure it is equitably shared
- minimise bycatch and the impacts of the fishery on threatened and protected species.

Fishing closures can be established on a seasonal, time, area, operator or gear specific basis. Closures may also be absolute, as in a complete prohibition applying to a method or activity, or be conditional where the closure controls an activity without creating a full prohibition. There are several fishing closures in place in NSW, which limits fishing in the OTLF.

Fishing closures are required to be published in the NSW Government Gazette, however, if the Minister for Primary Industries considers that a fishing closure is required urgently, the Minister may introduce the closure and advise the public through media outlets and by displaying prominent signs in areas adjacent to the waters affected. In the case of an urgent closure, the Minister is to publish the closure in the Government Gazette as soon as practicable.

There are a number of species related fishing closures that affect the operation of the fishery, for example a seasonal closure applied to spanner crabs (Table B1.9).

Table B1.9 Closure example relating to spanner crabs

Gender	Period in which fishing is prohibited
Male	From 20 November to 20 December (inclusive) in each of the years 2001 to 2005.
Female	From 20 October in each of the years 2001 to 2005, until 20 January in each succeeding year (inclusive)

Details on up-to-date fishing closures that apply to the OTLF can be found on the NSW DPI' website at: www.dpi.nsw.gov.au

B1.6.9 Permits

Section 37 of the *Fisheries Management Act 1994* allows for permits to be issued for research or other authorised purposes. These permits provide a legal framework for activities that fall outside normal operating rules set out in the Act or its Regulation. Each permit sets out a number of conditions, which vary depending on the purpose of the permit. These conditions ensure that permits are used only for the purpose intended by their issuing and are often used to limit the extent of the permitted activity. The permits that may be issued in relation to the OTLF are outlined in Table B1.10.

Permits are valid for the period specified in the permit, and may be suspended or cancelled at any time by the Minister. Permits are not transferable and are valid only insofar as they do not conflict with approved determinations of native title made under the Commonwealth *Native Title Act 1993*.

Table B1.10 Permits currently issued in the OTLF.

Permit type	Description
Research	Permits are issued to research scientists (including NSW DPI staff, universities and other research organisations) and commercial fishers assisting in undertaking research programs. The permits generally authorise the retention of prohibited size fish, fish in excess of the possession or bag limits or use of gear not prescribed by the Regulation
Retirement of existing fishing gear	These permits provide a legal framework for the possible development of more selective or passive fishing methods. Permits are often required to trial types of fishing gear with dimensions or configurations not prescribed by the Regulation. Permits may be issued to facilitate industry in developing alternate fishing practices in line with the goals of the Act and existing policy

B1.6.10 Catch limits

A commercial daily catch limit (or trip limit) applies to a range of species taken from NSW waters as part of the OTLF (see Table B1.11). These daily catch limits are intended to complement the quota system administered by the Commonwealth Government that limits the harvest levels of these species by Commonwealth endorsed boats, and to achieve a level of consistency on the fishing controls that exist in State waters.

Trip limits apply to some species that are managed by way of Total Allowable Catch Quotas in the Commonwealth South East Fishery. These trip limits were introduced in the mid 1990s to discourage the misreporting of SEF catches in NSW waters (and thereby avoiding having the catches decremented against the vessel's available quota for that species). The trip limits currently applying to species taken by trap and line fishers in NSW ocean waters are listed in Table B1.11.

Table B1.11 Daily commercial fishing trip limits for a range of species landed in the OTLF

Species	Period	Method	Waters	Trip limit
Gemfish (*Rexea solandri*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters other than those waters listed below	No more than 50 kg whole weight, or where the vessel is not a commercial fishing vessel 10 whole fish, in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters south of Barrenjoey Headland, and west of a line drawn 3 nm from the coastal baseline	0 kg
Orange roughy (*Hoplostethus atlanticus*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters including those waters subject to an OCS agreement between the State and the Commonwealth	0 kg
Pink ling (*Genypterus blacodes*) Mirror dory (*Zenopsis nebulosis*) Blue-eye trevalla (*Hyperoglyphe antarctica*) Blue grenadier (*Macruronus noveazelandiae*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters west of a line drawn 3 nm east of the coastal baseline	0 kg
Blue warehou (*Seriolella brama*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 100 kg whole weight in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
Spotted warehou (*Seriolella punctata*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 50 kg whole weight in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)

Table B1.11 cont.

Species	Period	Method	Waters	Trip limit
Jackass morwong (*Nemadactylus macropterus*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters north of Barrenjoey Headland including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 50 kg whole weight in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters south of Barrenjoey Headland including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 350 kg whole weight in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
Ocean perch (*Helicolenus percoides*)	From 1 January to 31 March of each year, all dates inclusive	By all methods	All NSW ocean waters north of Barrenjoey Headland including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 500 kg whole weight in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
	From 1 April to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters north of Barrenjoey Headland including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 1000 kg whole weight of each fish species in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters south of Barrenjoey Headland including those waters subject to an OCS agreement between the State and the Commonwealth	No more than 300 kg whole weight of each fish species in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)
Tiger flathead (*Neoplatycephalus richardsoni*) Sand flathead (*Platycephalus bassensis*)	From 1 January to 31 December of each year, all dates inclusive	By all methods	All NSW ocean waters south of Barrenjoey Headland including waters 3 nm east of the coastal baselines	No more than 200 kg whole weight of all flathead species combined in possession on board the fishing vessel once each day or from the time of departure to the time of return to port (when longer than a day)

B1.6.11 Seafood safety programs

Food safety programs which relate to the OTLF are administered by the NSW Food Authority under the *Food Act 1989*. Food safety programs for all commercial fisheries are currently being prepared by the NSW Food Authority.

B1.6.12 Fees

A number of fees are payable in the OTLF. An outline of the cost recovery policy and a summary of the fees follows. (Note: fees change periodically in response to the CPI and other factors).

B1.6.12.1 Commercial fishing licences

The following fees are payable on application for issue or renewal of a licence (January 2004):

New licence application	
Fee	$443
Contribution to industry costs	$221
FRDC research levy	$122
Unlicensed crew application	
Fee per crew member	$56
Licence renewal received within 30 days of expiry	
Fee	$221
Contribution to industry costs	$221
FRDC research levy	$122
Unlicensed crew (class C and D only)	$56
Licence renewal received more than 30 days after expiry	
Fee	$332
Contribution to industry costs	$221
FRDC research levy	$122

Fishing boat licences

The following fees are payable on application for renewal of a fishing boat licence:

Renewal application lodged within 30 days after licence expiry:

Boats not greater than 3 metres in length $44

Boats in excess of 3 metres in length according to the scale hereunder:

Boats over 3 metres but not over 4 metres.................$67

Boats over 4 metres but not over 5 metres.................$90

Boats over 5 metres but not over 6 metres...............$113

Boats over 6 metres but not over 7 metres...............$136

Boats over 7 metres but not over 8 metres...............$159

Boats over 8 metres but not over 9 metres...............$182

etc… for each additional metre, or part thereof, add an additional $23

Renewal application received over 30 days after licence expiry:

Boats not greater than 3 metres in length $155

Boats in excess of 3 metres in length according to the scale hereunder:

Boats over 3 metres but not over 4 metres...............$178

Boats over 4 metres but not over 5 metres...............$201

Boats over 5 metres but not over 6 metres...............$224

Boats over 6 metres but not over 7 metres...............$247

Boats over 7 metres but not over 8 metres..............$270

Boats over 8 metres but not over 9 metres..............$298

etc… for each additional metre or part thereof, add an additional $23

The fee to replace an existing licensed boat with a new boat is approximately $111, plus the cost of the new boat licence fee, which depends on the length of the boat.

Share management fishery rental charge

The *Fisheries Management Act 1994* provides that a rental charge of $107 applies to shareholders in a category 2 share management fishery (irrespective of the number or type of shares held). This charge has applied from the date of commencement of category 2 share management fisheries on 23 March 2001, and is adjusted annually according to the Consumer Price Index. This rental charge will initially become the community contribution under the share management plan for new category 1 share management fisheries. An independent economic review of the new category 1 fisheries will occur within three years, with future community contributions based on the outcome of that review.

Environmental impact assessment charges

Arrangements have been made under Part 5 of the *Environmental Planning and Assessment Act 1979* for recovery of the costs associated with the preparation of the Environmental Impact Statement (EIS). The EIS charge for 2003-06, for each fishery in which the person is eligible to hold shares there is a charge of $244 for the first fishery, $159 for the second fishery, then $107 for each fishery thereafter (subject to CPI changes).

Fishers have the option of paying these charges and the share management fishery rental charge in one or in four instalments over the course of each year.

Research levy

An annual fee of $122 is collected upon commercial fishing licence renewal and paid directly to the Fisheries Research and Development Corporation (FRDC) to support funding of fisheries related research programs around Australia. The FRDC funds a number of research programs with a flow of benefits to the OTLF in NSW.

Endorsement application fees

There is an endorsement application fee of $32 for commercial fishers in the OTLF.

Other transaction fees

There are several other fees payable in the fishery to cover the costs of individual licensing transactions, however, these only apply to the persons utilising these services. An example of this type of fee is the $277 fee payable for the transfer of a fishing boat licence.

B1.6.12.2 Cost recovery policy

NSW DPI recoups some of the costs that are attributable to industry through a cost recovery policy. The cost recovery policy applies to existing services traditionally provided by NSW DPI in administering and regulating commercial fishing.

In November 2000, the Government announced a new cost recovery policy. The Government will develop and implement a cost recovery framework for the new category 1 share management fisheries. The framework will be subject to extensive industry consultation. During this period, the total amount of money collected for NSW DPI, for its existing management services, will not increase without the support of the relevant management advisory committee. After five years, the costs that have been identified as attributable to the industry will be progressively introduced over a further three-year period.

B1.6.13 Size limits

Size limits apply to a number of species taken in the OTLF and are prescribed in the Regulation and apply to both commercial and recreational fishers. Table B1.12 lists the minimum legal lengths (MLL) that apply to the species permitted to be taken in the fishery.

Table B1.12 Minimum legal lengths on ocean trap and line species (at January 2006).

Species	**Size limit -Total length (cm)**
Bream, yellowfin or black	25
Eels, short and long finned	30
Flathead, sand	33
Jackass and rubberlip morwong	28
Mulloway	45
Red morwong or sea carp	25
School shark	91
Snapper	30
Spanner crab	9.3*
Tailor	30
Tarwhine	20
Teraglin	38
Yellowtail kingfish	60

* measured along the body from the base of the orbital notch to the centre of the posterior margin of the carapace

B1.6.14 Threatened and/or protected fish

One of the ways that the FM Act (Part 7A) aims to conserve biological diversity is by listing threatened species, populations and ecological communities and their habitats. Table B1.13 lists those species, populations and communities, some species of which are also referred to as protected species under the FM Act. Protected species generally encompass most of those listed as threatened, but is designed to protect fish from all forms of fishing (section 19) or from commercial fishing (section 20). Unlike threatened species, protected species can be listed for reasons other than stock survival (e.g. for iconic purposes). Protected species that are not also threatened species are listed in Table B1.14.

A range of threatened species, other than fish, are protected by other legislation including the NSW *Threatened Species Conservation Act 1995*, the NSW *National Parks and Wildlife Act 1974*, and the Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999*. Those other animals, and the fish from Tables B1.13 and B1.14 that could be encountered by the fishery, will be discussed in detail in the risk assessment in section B2.

Table B1.13 Threatened species, populations and ecological communities.

Common Name	Scientific Name
Endangered species	
Eastern freshwater cod P19	*Maccullochella ikei*
Green sawfish*	*Pristis zijsron*
Grey nurse shark * P19	*Carcharius taurus*
Murray hardyhead	*Craterocephalus fluviatilis*
Oxleyan pygmy perch	*Nannoperca oxleyana*
River snail	*Notopala sublineata*
Trout cod P19	*Maccullochella macquariensis*
Endangered populations	
Western population of olive perchlet	*Ambassis agassizii*
Western population of purple spotted gudgeon	*Mogurnda adspersa*
Endangered ecological communities	
Aquatic ecological community in the natural drainage system of the lower Murray River catchment	
Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River	
Species presumed extinct	
Bennetts seaweed	*Vanvoorstia bennettiana*
Vulnerable species	
Adams emerald dragonfly	*Archaeophya adamsi*
Black rock cod * P19	*Epinephelus daemelii*
Buchanans fairy shrimp	*Branchinella buchananensis*
Great white shark * P19	*Carcharodon carcharias*
Macquarie perch P19	*Macquaria australasica*
Silver perch P20	*Bidyanus bidyanus*
Southern pygmy perch	*Nannoperca australis*

An asterisk denotes species that could be encountered by the fishery; and P19 and P20 denotes species protected under sections 19 or 20 of the FM Act, respectively.

Table B1.14 Protected species of fish (other than those that are also threatened species).

Protected from Fishing (Section 19)	
Common name	**Scientific name**
Australian grayling	*Prototroctes maraena*
Ballina angelfish *	*Chaetodontoplus ballinae*
Eastern blue devil fish *	*Paraplesiops bleekeri*
Elegant wrasse *	*Anampses elegans*
Estuary cod *	*Epinephelus coioides*
Giant Queensland groper *	*Epinephelus lanceolatus*
Herbst nurse shark *	*Odontaspis ferox*
All Syngnathids, Solenostomids & Pegasids *	Various
Protected from Commercial Fishing (Section 20)	
Atlantic salmon	*Salmo salar*
Australian bass *	*Macquaria novemaculeata*
Black marlin *	*Makaira indica*
Blue groper *	*Achoerodus viridis*

Table B1.14 cont.

Protected from Commercial Fishing (Section 20) cont.	
Blue marlin *	*Makaira nigricans*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Eel-tailed catfish	*Tandanus tandanus*
Estuary perch *	*Macquaria colonorum*
Freshwater crayfish	*Euastacus* & *Cherax* spp. (except *C. destructor*)
Rainbow trout	*Oncorhynchus mykiss*
Striped marlin *	*Tetrapturus audax*

*denotes species that could be encountered by the fishery.

B1.6.15 Research

The species within the OTLF for which a comprehensive stock assessment is available are gemfish and spanner crabs, although detailed research data are available for snapper, yellowtail kingfish, bream and blue-eye trevalla. Information on growth and the general biology of other species important in the OTLF is also available.

Snapper was studied in detail during a three year research project from 1993 to 1996, and snapper landings from the OTLF have been closely monitored since this study.

Research reports have recently been completed on the ageing of yellowtail kingfish, silver trevally and spanner crabs. A study has also been completed on mesh selectivity in the demersal fish trap fishery.

Table B1.15 provides a brief description of the relevant and recent primary research programs conducted by NSW DPI that relates to the OTLF. This is not a comprehensive list of all research relevant to the fishery, as a range of other research groups and institutions conduct programs that provide valuable information for use in fisheries management.

Table B1.15 Research programs recently completed or underway by NSW DPI relating to the OTLF.

Project title/Funding	Researchers	Status	Project Objectives
Assessment of the fishery for snapper (*Pagrus auratus*) in Queensland and New South Wales. FRDC 93/074 Funding source: FRDC Queensland DPI and NSW Fisheries	D. Ferrell and W. Sumpton	Completed 1997	To estimate the recreational snapper catch in the Moreton Bay region and evaluate methodologies for estimating offshore recreational effort. To provide fishery managers with models for assessing the impact on yield of proposed changes to the legislated minimum legal size of snapper To provide fisheries managers with information on the genetic relationship between snapper populations in south Queensland, Northern New South Wales and east of the Swains Reefs (Southern Great Barrier Reef). To develop methods of estimating relative abundance and year class strength of juvenile snapper.
Description of the biology and an assessment of the fishery for Silver Trevally *Pseudocaranx dentex* off New South Wales. FRDC 97/125 Funding source: FRDC and NSW Fisheries	K.R. Rowling and L.P. Raines	Completed 2000	To describe the size and age composition of the catch of silver trevally taken by each of the sectors utilising the resource in NSW waters. To investigate the reproductive biology of silver trevally, including determination of the size at first maturity, spawning period and fecundity. To refine techniques to age silver trevally and apply these to samples from commercial and recreational catches, and to develop a growth rate model for this species in NSW. To incorporate all relevant data in an initial stock assessment, describing the relative impact on the silver trevally stock of the various fishery sectors. To provide advice on the status of the silver trevally stock, and the appropriateness or otherwise of establishing a minimum legal size for silver trevally.
Assessment of length and age composition of commercial kingfish landings. FRDC 97/126 Funding source: FRDC and NSW Fisheries	J. Stewart, D. Ferrell, B. van der Walt, D. Johnson, M. Lowry	Completed 2001	To accurately document the size and age composition of kingfish landed by commercial fishers in NSW. To refine existing estimates of kingfish growth with new information on size at age, with a focus on large fish. To examine the suitability of the current minimum legal length with yield models, utilizing the improved information on kingfish growth and information on kingfish size and age composition. To examine the possibility of using age-structured modelling in future assessments of yellowtail kingfish.
Mesh selectivity in the NSW demersal trap fishery FRDC 98/138 Funding source: FRDC and NSW Fisheries	J. Stewart and D. Ferrell	Completed 2001	Document throughout NSW, the current usage patterns of the various mesh types used in demersal fish traps. Describe the size composition of retained and returned catch for species common in the NSW trap fishery for all mesh types as they are currently used. Describe the size composition of retained and returned catch for commercially available mesh and wire products in areas where they are not currently fished. Determine the likely utility of possible mesh configurations not currently in use.
Stock assessment of snapper (FSC2000/027) Funding source: NSW DPI	J. Scandol	Active. Ongoing	Complete the annual time and location-stratified estimate of the size composition of commercial snapper landings in NSW. Estimate the annual age composition of commercial snapper landings in NSW. Complete annual analysis of catch data from the commercial fishery. Assemble all available information into a stock assessment model.

Table B1.15 cont.

Project title/Funding	Researchers	Status	Project Objectives
Biological information for appropriate management of endemic fish species at Lord Howe Island (FSC2000/051) Funding source: NSW DPI, the Natural Heritage Trust Fishcare fund and the Lord Howe Island Management Board	D. Ferrell	Completed 2005	Provide estimates of growth and age composition of double-header wrasse and bluefish caught at Lord Howe Is. Inform the fishing community at Lord Howe Is. about the growth and longevity of these species and promote community involvement and discussion of appropriate sustainable management. Ensure appropriate and sustainable management of double-header wrasse and bluefish through informed community response and understanding of the biology of these species. Engender support from the Lord Howe Is. community for appropriate fisheries management through involvement in data collection, dissemination of information and integration into management regimes. Improve understanding of silver trevally, rosy jobfish and redfish by gathering information and biological material from the limited fisheries for these species at Lord Howe Is. over a long period.
Age validation of silver sweep (*Scorpis lineolatus*) (FSC2002/108) Funding source: NSW DPI	J. Stewart	Completed 2005	Develop a validated ageing method for sweep.
Arresting the decline of the commercial and recreational fisheries for mulloway (*Argyrosomus japonicus*) (FSC2001/092) Funding source: FRDC and NSW DPI	C. Gray and V. Silberschneider	Completed 2005	Synthesize and publish a review of the biology and fisheries of mulloway (and other relevant sciaenid species) in an international scientific journal and provide a layman's summary that can be given to stakeholders. Re-analyse all existing tagging information on mulloway. Describe the growth, age and reproductive biology of mulloway in NSW and do yield-per-recruit analyses. Determine the length, sex and age compositions of commercial catches of mulloway and assess how these vary between different gear types, industry sectors (e.g. estuary v ocean) and regionally. Advise the commercial and recreational fishing communities and other interest groups on the biology of mulloway and provide recommendations on ways to stop the apparent decline in populations and future management and assessment strategies for the species.
Reducing uncertainty in the assessment of the Australian spanner crab fishery (FSC 2003/139) Funding source: FRDC, NSW DPI, DPI QLD, Industry	J. Scandol	Active	Determine the age at which spanner crabs recruit to the fishery Develop a common methodology for monitoring and assessing the Australian spanner crab stock Exploratory investigation of sources of variability in apparent population density
Determining appropriate sizes at harvest for species shared by the commercial trap and recreational fisheries in NSW (FSC 2003/126) Funding source: NSW DPI, FRDC, Recreational Fishing (Saltwater) Trust, Industry	J. Stewart	Active	Develop a framework based on biological, economic and social information by which appropriate harvest sizes can be determined. Recommend appropriate sizes at harvest for primary species shared by the commercial trap and recreational fisheries in NSW. Where appropriate, recommend minimum legal lengths for species across all fisheries

NSW DPI is preparing a strategic research plan for fisheries, aquaculture and aquatic conservation following consultation with a broad range of stakeholder groups over the development of research priorities relating to the States fisheries resources, including the OTLF. Listed below in Table B1.16 are the priorities identified by the Ocean Trap and Line MAC and NSW DPI (then NSW Fisheries) in August 2002.

Table B1.16 Priority areas for research identified by the Ocean Trap and Line MAC and NSW DPI (then NSW Fisheries) in August 2002.

Research Area	Identified by:
Mapping of reef areas along the NSW coast	NSW Fisheries & MAC
Description of by-catch	NSW Fisheries & MAC
Impact of trawling and hauling on other fisheries, biodiversity, ecosystems and habitats	NSW Fisheries & MAC
Determine and reduce the impacts of flood mitigation, invasive species, blue green algae, flood events and land management practices on water quality, fish habitats and ecosystems	NSW Fisheries & MAC
Effects on wild populations from aquaculture fish, pond run-off or artificial feeds escaping or being released	NSW Fisheries & MAC
Wobbegong population studies	NSW Fisheries & MAC
Evaluating marine protected areas	NSW Fisheries & MAC
Stock assessment of commercially caught sharks	NSW Fisheries
Stock assessments for all primary and key secondary species	NSW Fisheries
Estimates of size at maturity, age and growth for all primary and key secondary species	NSW Fisheries

B1.6.16 Catch monitoring

Records of commercial catch have been collected in NSW for over 50 years. The forms used by fishers to record catches have changed several times over the years (Pease and Grinberg, 1995), the most recent major overhaul occurring in July 1997. Since that time there have also been some minor amendments, particularly with regards to threatened species. The information collected on commercial landings assists in the ongoing monitoring and assessment of the status of fish stocks.

Fishers in the OTLF are required to submit records on a monthly basis detailing their catch and fishing effort. The information includes catch for each species, the effort expended (for each method) to take the catch (i.e. days fished), and the area/s fished. This information is entered onto a database by NSW DPI and allows for analysis of fishing activity, catch levels and effort levels. The entry of catch return information onto the database is subject to stringent control procedures including a three month timeframe for data entry following the receipt of a catch return by NSW DPI. A policy is being developed to manage the timely receipt and entry of commercial catch return data into the commercial catch records database.

The accuracy of the data provided on catch returns, particularly with respect to fishing effort data, is variable. To maximise the accuracy of the data collected on monthly catch returns a range of quality control procedures are currently in place or scheduled for implementation in the near future. A brief synopsis of these quality control procedures is provided here:

- every return is scanned for errors when received by the “Commercial Catch Records” section in NSW DPI, and suspected omissions or errors are queried with fishers (by phone and/or written correspondence) and corrected if necessary
- logical checks of data accuracy (range, consistency and validity checks) are performed automatically by computer during data-entry. Likely errors are queried with fishers (by phone and/or written correspondence) and corrected if necessary
- data from the commercial catch statistic database “FINS” is regularly downloaded to a database “COMCATCH”, which can be accessed or queried by biologists and managers responsible for individual fisheries. Subsequently, any problems with data identified by the relevant biologists or managers are queried and may be corrected by the commercial catch records section after consulting fishers where necessary
- a previous pilot survey was undertaken to assess the accuracy of data entry with respect to the catch records. The results showed that data-entry errors by staff were of minimal significance. Errors were rare and generally concerned minor species. It is planned to repeat this survey to provide ongoing monitoring of the quality and accuracy of data entry
- following implementation of routine reporting of the quantities of fish handled by registered fish receivers in NSW, it will be possible to compare the quantity of catch (by species) reported by fishers on catch returns with the quantity handled by fish receivers in NSW. This will provide a cross-validation of weights of individual species caught and handled in NSW
- the information collected on catch returns is reviewed annually by the “Catch and Effort Working Group” (which comprises industry representatives from each fishery), and options for improving the catch return forms (and increasing the reliability of data) is reviewed periodically by the management advisory councils.

The existing procedures aim to maximise data quality. It is, however, inevitable that the accuracy of data supplied by fishers cannot be directly assessed and can sometimes be variable, particularly with respect to fishing effort data. Consequently, the commercial catch statistics supplied by fishers and maintained in the commercial catch records database is most accurately described as representing “reported landed catch”.

B1.6.17 Compliance

NSW DPI has approximately 100 fisheries officers responsible for coordinating and implementing compliance strategies in NSW. These strategies include:

- maximising voluntary compliance
- providing effective deterrence for offences
- providing effective support services.

Approximately 75 of these fisheries officers are located in areas along the NSW coast where the OTLF occurs. Their general duties include conducting patrols, inspecting commercial fishers and fishing gear, and recording rates of compliance.

Effective implementation of any fisheries management regime requires a compliance framework that leads to optimal levels of compliance within that management regime. According to the Strategic Direction for Australian Fisheries Compliance and Framework for Fisheries Agencies developed by fisheries agencies throughout Australia in 1999, an optimal level of compliance is defined as;

> *'that which holds the level of non-compliance at an acceptable level, which can be maintained at a reasonable cost for enforcement services while not compromising the integrity and sustainability of the resource.'*

NSW DPI manages compliance service delivery for each significant fishing or target program through a district compliance planning process. Each district fisheries office is responsible for compliance service delivery within a geographical area, and develops a district plan based on the particular priorities associated with that area. These priorities vary throughout the state, and may be determined by a focus of certain fishing activities in that area, and may also be driven by the existence of areas of importance, or sensitive habitat within that area.

The district plan for the location sets out the percentage of available time officers from that office will spend on particular compliance duties. All coastal fisheries offices in NSW focus a set number of resources toward achieving optimal levels of compliance in the OTLF through their business plans. Other target service areas including the recreational fishery, related commercial fisheries and the patrolling of fishing closures whilst carrying out routine duties, all provide indirect compliance benefits for the fishery.

The *Fisheries Management Act 1994* and the *Fisheries Management (General) Regulation 2002* provide a number of offences relating to fishing activities that encompass the methods used, and species taken in the OTLF. These offences and their maximum penalties are summarised in Table B1.17. The table is not a comprehensive list of offences under the Act or its regulations, but highlights the offences that are most relevant in the OTLF.

The Regulation lists a number of forfeiture offences for the seizure of boats and motor vehicles. A court may order the forfeiture of these items if it is satisfied that they were used to commit a forfeiture offence.

Sections within the Regulation that detail forfeiture offences include:

- Offences under the Fisheries Management Act 1994:

  Section 8 Waters closed to fishing

  Section 17 Bag limits – taking of fish – (recreational fishers)

  Section 18 Bag limits – possession of fish – (recreational fishers)

  Section 24 Lawful use of nets or traps

  Section 25 Possession of illegal fishing gear

  Section 247 Obstructing / impersonating a fisheries officer

- Offences under the Fisheries Management (General) Regulation 2002:

  Clause 112 Use of explosive substances

  Clause 114 Use of electrical devices

- An offence against the Fisheries Management (Aquatic Reserves) Regulations 1995.

Table B1.17 Current offences under the *Fisheries Management Act 1994* specifically relevant to the OTLF.

Note that these offences and penalties are the current offences and penalties under the *Fisheries Management Act 1994* and its Regulation (as at April 2001), and apply to both commercial and recreational fishers

Section	Short title	Maximum penalty
14(1)	Take fish contrary to fishing closure	$22,000 and/or 6 months imprisonment
14(2)	Possess fish taken contrary to fishing closure	$11,000 and/or 3 months imprisonment
16(1)	Possess prohibited size fish	$11,000 and/or 3 months imprisonment
16(2)	Sell prohibited size fish	$11,000 and/or 3 months imprisonment
19(2)	Take protected fish	$11,000 and/or 3 months imprisonment
19(3)	Possess protected fish	$11,000 and/or 3 months imprisonment
20(2)	Take commercially protected fish for sale	$11,000 and/or 3 months imprisonment
20(3)	Sell commercially protected fish	$11,000 and/or 3 months imprisonment
24(1)	Unlawful use of net or trap	$22,000 and/or 6 months imprisonment
25(1)	Possess fishing gear in / on / adjacent to closed waters when use of that gear or taking of fish is prohibited	$22,000 and/or 6 months imprisonment
35(1)	Possess fish illegally taken	$11,000 and/or 3 months imprisonment
102(1)	Take fish for sale when unlicensed	$11,000
104(7)	Contravene condition of a commercial fishing licence	$11,000
107(1)	Use unlicensed boat to take fish / land fish for sale	$11,000
108(7)	Contravene condition of boat licence	$11,000
110(9)	Carry unregistered crew	$5,500
121	Fail to make catch record	$22,000
122	Fail to send catch record to Director	$1,100
247(1)	Resist or obstruct a fisheries officer	$22,000 and/or 6 months imprisonment
248(4)	Fail to assist in boarding and search of boat	$5,500
249(3)	Fail to comply with requirement to remove gear from water	$5,500
256(4)	Fail to comply with requirement to produce records or answer questions	$5,500
257(4)	Fail to comply with requirement to produce authority	$2,750

The NSW Parliament recently passed a number of amendments to the FM Act which will strengthen compliance when enacted. Additionally, the NSW Government is currently consulting stakeholders over the findings of an independent report into illegal commercial fishing in NSW (see Palmer 2004). The report contains numerous recommendations for additional compliance measures.

B1.6.18 Consultation

A range of consultative bodies are established in NSW to assist and advise the Minister and NSW DPI on fisheries issues. There are committees that are established to provide advice on specific issues as well as bodies that advise on matters that cut across different fisheries or sectors.

B1.6.18.1 The Management Advisory Committee

Share management and major restricted fisheries in NSW each have a Management Advisory Committee (MAC) that provides advice to the Minister for Primary Industries on:

- the preparation of any management plan or regulations for the fishery
- monitoring whether the objectives of the management plan, strategy or those regulations are being attained
- reviews in connection with any new management plan, strategy or regulation
- any other matter relating to the fishery.

Table B1.18 details the membership on the Ocean Trap and Line MAC. The industry members of the MAC comprise representatives that are elected by endorsement holders in the fishery. There is an industry representative from each section in the fishery. The members hold office for a term of three years, however, the terms of office are staggered and the terms of half of the industry members expire every 18 months. The non-industry members on the MAC are appointed by the Minister for Primary Industries and also hold terms of office for up to three years. To ensure that all issues discussed by the committee are fairly represented, the MAC is chaired by a person who is not engaged in the administration of the FM Act and is not engaged in commercial fishing.

The MAC receives advice from NSW DPI observers on research, compliance and administrative issues relating to the fishery. However, only members of the MAC have voting rights on the decisions of the MAC. The actual composition and role of the MAC is set by the FM Act and its regulations and may be altered from time to time.

Table B1.18 Membership on the Ocean Trap and Line MAC.

Position
Independent chairperson
Spanner crab representative
Line fishing (eastern zone) – north representative
Line fishing (eastern zone) – south representative
Demersal fish trap – north representative
Demersal fish trap – south representative
Line fishing (western zone) – north representative
Line fishing (western zone) – south representative
Recreational fishing representative
Conservation representative
Representative of the D-G, NSW DPI

B1.6.18.2 Ministerial advisory councils

Two Ministerial advisory councils are currently established under the *Fisheries Management Act 1994*. The Councils provide advice on matters referred to them by the Minister for Primary

Industries, or on any other matters the Councils consider relevant. They report directly to the Minister for Primary Industries.

The Ministerial advisory councils currently established (at January 2006) are:

- Seafood Industry Advisory Council (SIAC)
- Advisory Council on Recreational Fishing (ACoRF)

The OTLF and each of the other share management fisheries have representatives on the SIAC. These representatives are nominated by each of the respective management advisory committees and appointed by the Minister for Primary Industries.

The name and composition of Ministerial advisory councils are determined by regulations under the FM Act, and may be altered from time to time.

B1.7 Interactions with Other Fisheries

The fisheries of NSW are intrinsically complex due to the large diversity of species caught, the wide range of areas fished and gear types used. Many species taken in the OTLF are also taken in other NSW commercial fisheries, by recreational fishers, by indigenous fishers and by fisheries managed under the jurisdiction of the Commonwealth or other States.

Ocean waters off NSW contain a large number of fish and invertebrate species due to the overlap of sub-tropical and temperate ecosystems, and the relatively narrow continental shelf. Of the primary and key secondary species taken by trap and line fishing in NSW ocean waters, most are also significant in the catch taken by one or more commercial or recreational fisheries, either in NSW or in adjoining jurisdictions. Species such as yellowfin bream, mulloway, and silver trevally are targeted and constitute a large percentage of the overall landings in other commercial fisheries.

B1.7.1 Other NSW commercial fisheries

Apart from interaction by way of the species taken, trap and line fishing in ocean waters overlaps with the other ocean fisheries in regard to areas fished. There have been interactions between trap and line fishers, trawl fishers and lobster fishers, mainly involving interaction between the two types of fishing gear being fished on the same grounds. Many businesses endorsed in the OTLF also hold endorsements in other NSW commercial fisheries, such as the lobster, estuary general, ocean trawl or ocean hauling fisheries.

The largest interaction with the OTLF based on area fished and species taken occurs with the Ocean Trawl Fishery. The Ocean Trawl Fishery operates between the NSW coastal baseline and the 4000 metre isobath in ocean waters between Barrenjoey Headland and Smoky Cape (and the same trawlers operate in the Commonwealth's South East Trawl Fishery outside 3 nm), and between the NSW coastal baseline and 3 nm to sea south of Barrenjoey Headland. In addition to the overlap in areas fished, there is a significant overlap in the species landed in these fisheries.

There is a reasonable interaction between operators in the ocean trap and line and lobster fisheries, with a number of fishers being endorsed in both fisheries. This is most likely due to the historic fishing patterns, which saw the use of traps to target both fin fish and lobsters until access to the Lobster Fishery was restricted in 1993.

Although there is some conflict between commercial fishing sectors in NSW, the interaction of fishers participating in more than one fishery possibly reduces the level of conflict that may be expected if each fisher participated in one fishery only. The diverse nature of commercial fishers in NSW means that most fishers have an understanding of the issues affecting each other and the industry as a whole.

B1.7.2 Recreational fishery

To obtain reliable estimates of non-commercial fishing patterns and levels of harvest, a National Recreational and Indigenous Fishing Survey (Henry and Lyle, 2003) was completed in 2002 based on fisher activity from May 2000 - April 2001. Data from the national survey, and a survey from September 1993 - August 1995 (Steffe *et al*., 1996) of NSW offshore recreational fishers shows considerable interaction between recreational fishing and the OTLF, as almost all of the target species within the fishery are also heavily targeted by recreational anglers and/or charter boat operators. The surveys also indicate that the recreational catch of some species, such as black-spot pigfish, dolphinfish, bream, kingfish, mulloway, pearl perch and teraglin are comparable and in some cases larger than the OTLF catch.

The marine and estuarine charter fishing industry was restricted in 2000 when eligible vessels became licensed under the FM Act. Since licensing arrangements commenced, operators have been required to enter logbook returns, detailing the catch taken on board the vessel during charter activities, as part of a compulsory monitoring program. There is potential for greater competition between the commercial deepwater dropline fishers and charter fishing industry because of the increasing recreational effort directed at deepwater species such as blue-eye, gemfish and bar cod.

B1.7.3 Indigenous fishing

A number of species taken by the OTLF are also targeted by Indigenous fishers, including leatherjackets, snapper, yellowtail kingfish and silver trevally (Schnierer and Faulkner, 2002). However, as most indigenous fishing occurs in estuarine and near shore ocean waters, the level of direct interaction between the OTLF and the Indigenous Fishery is thought to be low. In 1997, NSW DPI (then NSW Fisheries) conducted a small survey on Aboriginal coastal fishing. The survey showed that Indigenous people fished regularly and that they often fished to feed large or extended families. When certain circumstances exist, the Minister for Primary Industries may issue a permit under the *Fisheries Management Act 1994* that authorises Indigenous people to meet specific cultural obligations with respect to traditional fishing.

The exact number of Aboriginal people directly involved in this fishery is not presently known. While there is provision for Indigenous representation on the Ocean Trap and Line MAC, to date no Indigenous representative has been nominated.

The NSW government released an Indigenous Fisheries Strategy and Implementation Plan in December 2002. The strategy provides for the development of a range of initiatives and programs to facilitate Indigenous fishing in NSW. The NSW Indigenous Fisheries Strategy will:

- encourage a broad community understanding of Indigenous traditional cultural fishing issues in NSW
- ensure that the importance of traditional cultural fishing is acknowledged in fisheries policy and practices, and during discussions on fisheries resource management issues
- encourage and support the involvement of Indigenous communities in the management of the state's fisheries resources
- encourage and support the involvement of Indigenous communities in commercial fishing, fishing based ecotourism, and the emerging aquaculture industry.

Further information on the interaction of the OTLF with Indigenous fishing can be found in the detailed study completed as part of this EIS (see Volume 3 Appendix B4)

B1.7.4 Commercial fisheries in adjacent jurisdictions

Interactions between fisheries managed in adjacent jurisdictions and the OTLF are based around area fished and species harvested. Listed below is information about fisheries in adjacent jurisdictions that have a reasonable level of interaction with the OTLF.

B1.7.4.1 Commonwealth South East Trawl Fishery (SEF)

The SEF harvests species taken in the OTLF, including blue-eye, hapuku, gemfish, silver trevally, rubberlip morwong, leatherjackets and snapper, with some of these species managed by quota. It is likely that for the majority of species, trawled fish come from the same stock utilised by ocean trap and line fishers. Methods used include mid-water trawl, demersal otter trawl, Danish seine trawl and pair trawl. A minimum of 90 mm mesh is to be used for demersal trawling, 38 mm for Danish seining, and between 40 – 60 mm for royal red prawn gear. The SEF covers the areas of the Australian Fishing zone extending southward from Barrenjoey Headland (north of Sydney) around the NSW, Victorian and Tasmanian coastlines to Cape Jervis in South Australia.

B1.7.4.2 Commonwealth Skipjack Tuna Fishery

The skipjack tuna fishery targets only skipjack tuna (*Katsuwonus pelamis*). Methods include purse seine, pole, minor line and longline, with the majority of catch coming from purse seine netting. Of the 19 operators authorised to use the purse seine method in the Eastern Tuna and Billfish Fishery (ETBF), an average of only 5 vessels per year recorded skipjack tuna in the ETBF from 1990 to 2001. The waters off the NSW coast (beyond 3 nm) south of Ulladulla to near Gabo Island produce the majority of catch taken in the Skipjack Tuna Fishery.

B1.7.4.3 Commonwealth Eastern Tuna and Billfish Fishery

The eastern tuna and billfish fishery uses longline and minor line methods to catch yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*) and broadbill swordfish (*Xiphius gladius*). All permit holders in the ETBF may land skipjack tuna (*Katsuwonus pelamis*).

Fishers in the eastern tuna and billfish fishery use lines that can be many kilometres long and are set for periods of up to 10-12 hours. During this time the longlines may become entangled with gear used by other fishers, including NSW ocean trap and line fishers, as the lines drift with prevailing currents. There have been reports of longline fishers cutting the headgear from fish traps to release (or untangle) their longline.

B1.7.4.4 Commonwealth Small Pelagic Fishery

The small pelagic fishery (SPF) includes the use of purse seine and mid-water trawl nets in Commonwealth waters. Target species for the SPF are limited to greenback jack mackerel (*Trachurus declivis*), Peruvian jack mackerel (*T. symmetricus*), yellowtail scad (*T. novaezelandiae*), blue or slimy mackerel (*Scomber australasicus*) and redbait (*Emmelichthys nitidus*).

B1.7.4.5 Commonwealth Gillnet, Hook and Trap Fishery

The two separately managed South East Non-Trawl and Southern Shark Fisheries have been merged to form a single fishery, the gillnet, hook and trap fishery (GHATF). The GHATF covers the taking of Commonwealth managed species of demersal scalefish including blue-eye trevalla, pink ling and blue warehou and demersal shark species including gummy shark and school shark. Gillnet, hook and trap fishers use a variety of methods including demersal gillnets, drop lines, demersal and automatic longlines, and traps. Hook operators use a range of hook and line methods to target scalefish, in particular blue warehou, ling and blue eye trevalla.

The management arrangements for the gillnet, hook and trap fishery are a combination of individual transferable quotas, limited entry, area restrictions and some gear restrictions.

B1.7.4.6 Queensland Spanner Crab Fishery

This fishery targets the same species as the NSW OTLF, and indeed it is thought to be a single stock that straddles the state border. Most of the catch is exported as live product to east Asia.

The spanner crab component of the OTLF interacts with the Queensland spanner crab fishery, as fishers in these fisheries target the same stock. The Queensland spanner crab fishery is much larger than the NSW fishery (in excess of 2,000 t in QLD compared to approximately 200 t in NSW), and is managed under total allowable commercial catch (TACC). The total allowable commercial catch in 2000/01 was 2,800 t and was reduced to 2,208 t in 2001/02 due to recent apparent decreases in stock size. Spanner crabs in NSW are managed by a range of input controls, such as limited access, time and gender closures, dilly limits, gear design and size limits, though there have been previous discussions and consultations about moving to a quota scheme and previous surveys of endorsements holders have resulted in majority support for quota management.

B1.7.5 Aquaculture (marine fish farming)

Farming in marine waters is a relatively new but increasingly valuable aquaculture industry in NSW. Aquaculture production from marine waters (offshore sites) primarily comes from sea cage fin fish farming (including snapper and mulloway), and bivalve farming (i.e. blue mussels). Snapper farming was worth approximately $220,000 in 2001/02 and worth approximately $135,000 in 2002/03, most of which was produced in marine sea cage farms.

Sea cage farming involves the deployment of cages moored onto the ocean floor. Fingerlings are raised in land-based hatcheries and stocked into cages, where they are fed, graded and raised to a market size. The technology used for farming is similar to that used for Atlantic salmon in Tasmania and tuna in South Australia. Potential environmental impacts are monitored regularly by farmers in line with strict license conditions. Local broodstock are used for fingerling production to ensure escapees do not affect the genetic integrity of wild stocks. Marine water farms can often act as fish attracting devices, and at certain times of the year bait and pelagic species will gather near the farming structures.

It is expected that the growth of marine waters aquaculture in NSW will be limited, due to the lack of good sheltered deep water sites. However, the expansion to commercial production of a number of existing farms will ensure this industry remains a valuable component of aquaculture production in NSW. Species that are being considered for culture in offshore sites in the future include scallops, pearl oysters, abalone, kingfish and tuna. One of the key interactions between marine aquaculture and the OTLF is competition in the market place for shared species, as price is responsive to supply.

B2 Ecological Issues

The aim of this section of the EIS is to describe and evaluate the potential environmental impacts arising from the current operation of the OTLF. The collective term OTLF will be used throughout this document to refer to three distinct activities: (a) demersal fish traps; (b) active and passive line fishing methods; and (c) crab tangle nets or dilly nets for spanner crabs, hereafter referred to as spanner crab nets. A risk analysis, considering all components of the ecosystem and large-scale ecological processes, will be used to identify those aspects of the existing operation of the OTLF (described in Chapter B1) that could impact the environment. Those aspects of the current fishery that are assessed as posing the greatest threat to the ecological sustainability of the environment and/or the fishery will be identified and may be modified or changed through the draft FMS (Chapter D). Those aspects assessed as posing little or negligible risk will receive little, if any, modification in the draft FMS.

This section will begin with an introduction to the process of risk analysis and to the framework used to determine the risks associated with the current operation of the OTLF. It will then define the terms used throughout the methodology and within this chapter, and will outline some of the problems or issues associated with applying risk assessment frameworks to marine ecosystems in which the fishery operates. Having broadly described the process and framework, the methods used to actually do the analyses will be presented.

Section B2.2 will describe the results of a preliminary risk analysis. The preliminary analysis is a very broad scale (i.e. ecosystem level), rapid assessment that compares the components of marine ecosystems against the activities of the fishery that are thought to be the sources of risk. At that point, a decision is made as to which ecosystem components and/or fishery activities will be reviewed in more detail as they are thought to be at risk/posing the greatest risk, yet cannot be sufficiently well understood at the broad ecosystem level. The ecosystem components and the activities of the fishery that affect them will then be assessed in more detail in sections B2.3 to B2.7. Those components that can be rapidly dismissed as at little or negligible risk due to the fishery will not be further considered, and a justification for that decision will be provided (section B2.2).

As an overview:

- this section (B2) will highlight the risks and sources of risk associated with the current fishery
- Chapter C will provide some alternative management regimes to those of the current fishery
- Chapter D will present the draft fishery management strategy that includes the measures proposed to address the risks discussed in this section (B2) and
- Chapter E will assess the proposed management strategy to determine whether its management measures can effectively reduce the risks to the environment that were highlighted in this section (B2) to ensure that the activity is conducted in an ecologically sustainable manner.

B2.1 Outline of the Risk Analysis Process

B2.1.1 Introduction

A broad range of risk analysis, risk assessment and risk management information and literature was reviewed in order to determine the most appropriate method for determining the ecological risks associated with the fishery. This information and literature covered generic principles of risk analysis (Standards Australia/Standards New Zealand, 1999), generic principles of environmental risk analysis (Standards Australia/Standards New Zealand, 2000), a risk analysis and reporting framework for ecologically sustainable development in fisheries (Fletcher *et al.*, 2002), a comprehensive review of risk assessment terminology for the fields of chemistry and toxicology (Duffus, 2001), the risk analysis terminology provided by the Food and Agriculture Organisation of the United Nations (FAO) in their online glossary of fisheries terms and definitions (http://www.fao.org/fi/glossary), and relevant publications in the aquatic sciences dealing with quantitative and qualitative risk analyses and assessments (Francis, 1992; Francis and Shotton, 1997; Lane and Stephenson, 1998).

The practical application of the risk analysis process for assessing and managing risks in the OTLF was made difficult because of the:

a) different risk analysis methods and frameworks that are used among and within different fields of research and management

b) inconsistent usage of risk analysis terminology throughout the literature (Hayes, 1997; Duffus 2001)

c) complex relationships that exist between assemblages of species, habitats and ecological processes in the marine environment (Dayton *et al.*, 1995; Hall, 1999; Jennings *et al.*, 2001, Polunin and Pinnegar, 2002) and

d) lack of detailed biological and ecological data for many species and habitats.

These difficult issues were resolved by modifying the risk analysis framework outlined in the ASNZ Standards (1999 and 2000). Thus, the risk analysis framework used in the assessment of the OTLF was improved because it integrated the general concepts and principles that had been used previously across many different areas of risk analysis in a way that suited issues arising from a marine multi-species fishery. A description of this risk analysis framework (Figure B2.1), its relationship to the broader framework under which this EIS was written (i.e. chapters in the former Department of Planning's guidelines - Appendix A2), and the definitions of the terms used are provided below.

B2.1.2 Risk analysis framework and terminology

Risk analysis is the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects (AS/NZS 4360). It is an iterative process that has three main steps: risk assessment, risk management and risk communication (see Figure B2.1). The risk analysis process is intended to provide insights about sources of risk and their potential impacts, which then enables managers to take mitigative action against undesirable outcomes.

RISK ANALYSIS (EIS)

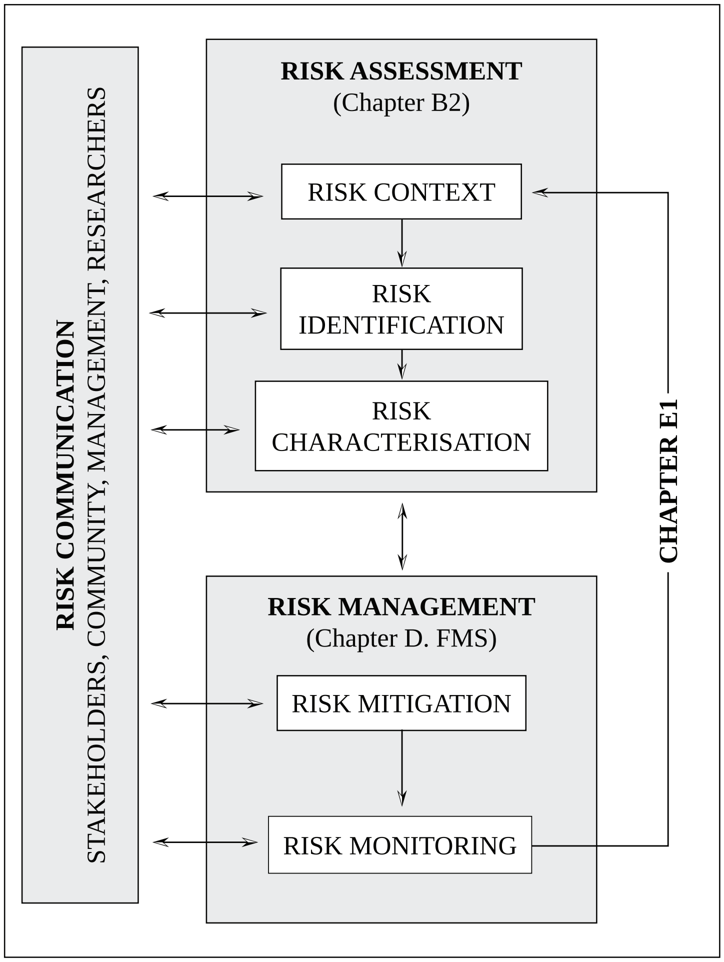


Figure B2.1 Framework of the risk analysis used for the OTLF.

Risk is the probability or likelihood of an undesirable event happening. This broad definition of risk reflects common usage in fisheries science (Francis and Shotton, 1997; FAO, http://www.fao.org/fi/glossary). This definition requires that an *a priori* definition of consequence be given for the undesirable event that is being analysed. In this way, the definition of risk combines the consequence and likelihood of an undesirable event happening.

Consequence is the outcome of an event expressed either quantitatively or qualitatively. In qualitative risk analysis an *a priori* definition of the consequence of an event can be used to provide the context or scope of the risk analysis.

Likelihood is a qualitative description or estimate of probability. This means that likelihood is a qualitative measure or estimate of risk for any event whenever an *a priori* definition of consequence has been provided.

Risk assessment is the first main step in the risk analysis process. Risk assessment contains three parts: risk context, risk identification, and risk characterisation (see Figure B2.1).

Risk context must be the first part of any risk assessment, as it establishes the structure of the analysis and the criteria against which risk will be assessed. It also identifies stakeholders and defines the communication and consultation policies. The scope or context of the risk analysis can be clearly defined by specifying three main elements: (1) the risk that is to be analysed (e.g. in a qualitative risk analysis the risk should be defined explicitly by: (a) describing the undesirable event that is to be avoided; and (b) stating the consequence of the undesirable event); (2) the relevant temporal extent of the risk analysis (e.g. this may be the life of a management plan or some relevant biological timeframe); and (3) the spatial extent of the risk analysis (e.g. this could include the entire known distribution of a target species or be restricted to a single jurisdiction).

The broad context for this assessment has been established by the Guidelines for the Environmental Impact Assessment of the Draft Fishery Management Strategy for the Ocean Trap and Line Fishery (Appendix A2) issued by the Department of Planning (DP - formerly PlanningNSW), which includes criteria under the FM Act and EP&A Act. The criteria against which risk must be assessed are thus largely legislative, e.g. preventing the recovery of a threatened species listed under the TSC Act or FM Act, but must also use broader guiding principles such as Ecologically Sustainable Development when determining the impact on other components.

Risk identification is the second part of risk assessment. The aim is to generate a comprehensive list of sources of risk. This can be done using a variety of methods that include: literature reviews, examination of historical records, expert panels, brainstorming, and meetings to discover stakeholder opinions and perceptions. The results of this risk identification step are often presented as lists, tables or as component trees (see Fletcher *et al*., 2002).

Risk characterisation is the third part of risk assessment. The aim of risk characterisation is to estimate the probability or likelihood that the various sources of risk (identified in the previous step) will indirectly or directly cause the undesirable event that has been defined. Risk characterisation is an iterative process that involves: (a) the integration of qualitative and/or quantitative information, including the associated uncertainties, about the sources of risk; (b) the separation of the sources of risk into categories according to their estimated probability or likelihood of causing the previously specified undesirable event; (c) the acceptance of negligible or low risks with a justification supporting the conclusion reached (these sources of lower risks are eliminated from the subsequent risk analysis); and (d) the rejection of the remaining sources of risk that have been estimated to be above the threshold of low risk, followed by an iterative re-analysis of relevant factors at a finer scale of resolution within each major source of risk.

In a qualitative risk analysis it is acceptable to use categories such as low, intermediate and high to describe risk. There is no restriction to the number of categories that can be used but it is implied that each category has an equal weighting of risk (e.g. the use of five categories – low, low-intermediate, intermediate, intermediate-high and high – implies each category accounts for one fifth of the total risk). There are no rules as to which method to use to determine risk, and a variety of methods will be used as appropriate for different ecosystem components (see B2.1.4). The re-analysis of major risk sources then involves a detailed investigation of all lower level factors that may influence the probability or likelihood of that source of risk causing the undesired event. This approach is useful when risk characterisation is done iteratively by stepping down through a series of hierarchical levels. For example, risk characterisation can be done initially at the broad ecosystem level to examine large-scale ecological processes and biodiversity issues, and then at a finer resolution for individual taxa (or other ecological component) impacted by the fishery.

Risk management is the second step in the risk analysis process. Risk management contains two main components: (a) risk mitigation; and (b) risk monitoring (see Figure B2.1)

> **Risk mitigation** is the first part of risk management. The aim of risk mitigation is to minimise the risk of the undesirable event that has been defined in the risk context. This is done by evaluation and implementation of regulatory and/or non-regulatory (e.g. code of practice) management responses. The draft FMS document provides a detailed overview of the proposed management initiatives that have been designed to mitigate the risk of the undesirable event that was specified in the risk context section of the risk analysis. It is assumed that management initiatives outlined in the draft FMS will be effective for mitigating risk. Consequently, the risk analysis done on the proposed FMS for the OTLF should be regarded as a "best outcome" because the effectiveness of the management initiatives are unproven.
>
> **Risk monitoring** is the second part of risk management. The aim of risk monitoring is to collect information to determine whether the management initiatives that were implemented previously were effective in minimising the risk of the undesirable event. Quite simply, risk monitoring is useful for: (a) validating management actions when they have been effective; and (b) highlighting areas that need further management response when previous initiatives have been shown to be ineffective. Risk monitoring should be regarded as a practical appraisal of management initiatives and an opportunity to modify management plans in a timely manner.

Risk communication is an important step in the risk analysis process because it provides the basis for information flow among stakeholders, fisheries managers, scientists and consultative committees. Risk communication should occur continuously during the risk analysis process in order to achieve a better outcome. The preparation of this EIS has involved extensive and ongoing consultation and communication with a variety of stakeholders, including: the DP to develop the guidelines upon which this EIS is based; the Ocean Trap and Line Management Advisory Committee; Ministerial advisory councils on Recreational Fishing (ACoRF) and for the Seafood Industry (SIAC); and the Natural Resource Assessment Council (NRAC) to assist in the formulation of the draft FMS and EIS; meetings at fishing ports to discuss the content and development of the draft FMS; surveys of fishers to gather socio-economic data; liaising with peak Aboriginal organisations; and peer review and public exhibition of this EIS. Consultation will also continue with the OTL MAC during the refinement of the FMS until its approval.

B2.1.3 Issues in applying the risk analysis framework

B2.1.3.1 Components of marine ecosystems and ecological processes

The **marine ecosystem** encompasses all ecological, physical and other processes that affect or are influenced by finfish, shellfish and the operation of all commercial and recreational fisheries. The relevant processes that may affect the ecology of finfish, shellfish and the environment in which they live include hydrological, geomorphological and biological factors, such as oceanographic circulation patterns, climate change, food-webs, interactions among species, interactions of species with habitats, spawning migrations and behaviour, dispersal and recruitment, and natural variability in population abundance (Underwood and Chapman, 1995; Underwood, 2000; Brodziak and Link, 2002; Heino and Godo, 2002). Great emphasis has been recently directed towards assessing the impacts of fisheries on the whole ecosystem (Dayton *et al.*, 1995; Trites *et al.*, 1999; Murawski, 2000; Reynolds *et al.*, 2002; Sinclair *et al.*, 2002). However, the assessment of fishery-related impacts is difficult because relationships between assemblages of species, habitats and ecological processes in the marine environment are inter-related and very complex (Hall, 1999; Trites, 2002). Figure B2.2 provides a simplistic model of the complex web of links between ecological processes, habitats and the marine biota. This simple model shows the importance of ecological processes within a marine ecosystem and it is evident from this model that the sustained viability of habitats and biota are dependent on the long-term integrity of these ecological processes.

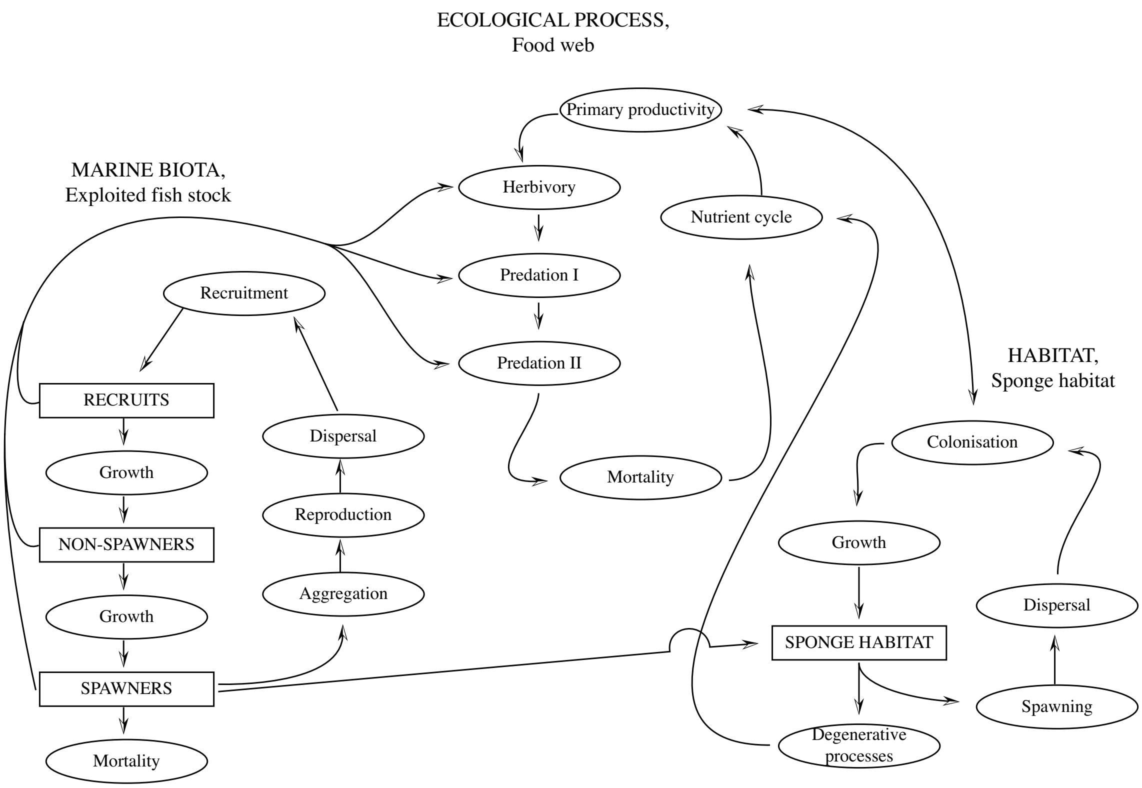


Figure B2.2 Example of the links between ecological processes within marine ecosystems.

Note: Mortality is assumed to occur at all stages but is only indicated at some points to simplify the example.

A fishery can impact a marine ecosystem directly or indirectly in three main areas – marine biota (fauna and flora), habitats (biophysical habitats and physical habitats) and ecological processes (trophic cascades, primary productivity, spawning and recruitment processes). Each of these main areas can be divided into smaller ecosystem components. These **ecosystem components** are the different aspects of the environment relevant to the fishery being examined by the risk analysis. They include retained species, non-retained species including bycatch species, bait sources, protected and threatened species, species diversity, ecological processes and relationships, habitats and biophysical properties of the environment. Systematically dividing the ecosystem into smaller manageable components ensures that all relevant sources of risk are examined (Fletcher *et al.*, 2002).

B2.1.3.2 Qualitative versus quantitative ecological risk analysis

Ecological risk analysis of potential impacts on aquatic environments and their associated flora and fauna are limited by the quality and quantity of information that is available for use in the risk analysis process. Recent audits of the state of the Australian marine environment have concluded that our knowledge of the marine environment remains limited (Zann, 1995; Australian State of the Environment Committee, 2001). There is also a paucity of quantitative data for most of the important species harvested in the oceanic commercial fisheries in NSW (NSW Fisheries, 2001a). For example, stock-recruitment relationships have not been described for most of the retained species in these oceanic fisheries (NSW Fisheries, 2001a) and many aspects of the basic biology and ecology for some of these species remain poorly understood (NSW Fisheries, 2001b & c). There is even less information for the other ecosystem components that are not targeted by the fishery, such as threatened species or ecological processes, but interact with it in some way.

Ideally, a quantitative model of the fishery should be used as an aid in the ecological risk analysis process (Francis, 1992) but this is only possible in “data-rich” fisheries (i.e. those high value fisheries that can support the economic cost of long-term, intensive monitoring programs) (e.g. Hutchings, 1999; Hilborn *et al.*, 2001). Ecological risk assessment models for many “data-rich” northern hemisphere fisheries make use of information which describes stock-recruitment relationships and estimates of fishing mortality and spawning biomass (Linder *et al.*, 1987; Hilborn *et al.*, 1993; Rosenberg and Restrepo, 1994). These quantitative models are used to assess the potential impacts of different harvest levels and changes to management regimes (e.g. Hall *et al.*, 1988). However, it should be noted that the use of stock assessments based on sophisticated quantitative modelling techniques alone does not guarantee a sustainable fishery. The catastrophic stock collapse of the “data-rich” northern cod fishery in Canada (Hutchings and Myers, 1994; Myers and Cadigan, 1995;) was not prevented despite the vast amounts of resources devoted to quantitative stock assessments in this fishery (Walters and Maguire, 1996; Myers *et al.*, 1997).

The oceanic commercial fisheries in NSW are “data-poor” when compared to the larger more valuable fisheries of the northern hemisphere. This lack of quantitative information means that the ecological risk analysis for the commercial oceanic fisheries in NSW must incorporate a qualitative approach. The paucity of biological information for many species, particularly secondary species, that are taken in the multi-species OTLF makes it difficult to analyse the risk of fishing-related impacts.

Two potential solutions exist for overcoming these knowledge gaps and completing a risk analysis for the fishery. The first solution is to apply the Precautionary Principle whenever biological information for a species is unknown. The application of this “precautionary-at-all-times” approach would mean that all species for which biological knowledge gaps exist (which would apply to most species of economic importance in NSW) would be assessed as having a high level of risk. The outcome of a “precautionary-at-all-times” approach in a multi-species fishery like the OTLF would inevitably lead to the unworkable situation where most key secondary and secondary species, as well as many primary species in the fishery would be assessed as having a high level of risk. Consequently, limited management resources would then be disproportionately allocated to mitigate risk levels that have been artificially increased for many species. Further, such an outcome would fail to highlight those species most in need of, and the appropriate level of management and/or research resources.

A second solution is to consider the available biological information at a coarser taxonomic resolution (i.e. generic or family level as opposed to species level). This “best available knowledge” approach is particularly useful when examining general biological traits or characteristics such as reproductive modes and strategies in fishes. In this way, biological inferences can be made for most species for which biological knowledge gaps exist by using the best available information, and not necessarily based on related species from within NSW or even Australian waters. It also allows the species assessments to adopt a “precautionary where necessary” approach, as opposed to trying to strictly apply the Precautionary Principle. The difference is that in the former, where there are deemed to be knowledge gaps or that family level information is inadequate for a particular trait or traits, that trait or knowledge gap is considered to be increasing the risk to a species, not automatically making it high risk as in the latter.

B2.1.3.3 Accounting for scientific uncertainty in risk assessment

The term "scientific uncertainty" includes two components: (a) ecological uncertainty, and (b) statistical uncertainty. Ecological uncertainty refers to the levels of natural variability that are inherent in ecological processes and in the intrinsic biological characteristics expressed by populations of species and/or assemblages. Thus, ecological uncertainty cannot be regulated to mitigate for any effects related to fishing or environmental impacts. At best, it should be possible to obtain a measure of the magnitude of ecological uncertainty, either from existing information (as in the case of this assessment for species in the OTLF) or by planning some sort of monitoring program. Once the magnitude of ecological uncertainty has been estimated it can be incorporated into the risk assessment process by categorising the likelihood of a species as being either risk-averse or risk-prone.

Statistical uncertainty refers to the likelihood of making an erroneous conclusion or interpretation based on a statistical analysis of data or an examination of information. In formal hypothesis testing these statistical errors are known as Type I (i.e. concluding that an action has a deleterious effect when in fact it doesn't) and Type II errors (i.e. concluding that an action has no deleterious effect when in fact it does) (Cohen, 1988; Underwood and Chapman, 2003) and the inverse relationship between these error types is known as statistical power (Cohen, 1988; Fairweather, 1991; Peterman and M'Gonigle, 1992; Underwood, 1997). In all probability-based statistical tests there is a trade-off between the probability of making Type I and Type II errors. Whenever a scientist/statistician attempts to minimise the probability of making a Type I error it is always the case that there is an increased probability of making a Type II error (Cohen, 1988; Peterman and M'Gonigle, 1992; Underwood, 1997). The corollary of this argument is that whenever a scientist/statistician attempts to minimise the probability of making a Type II error it is always the case that there is an increased probability of making a Type I error.

Several authors have argued that the potential consequences of making Type II errors can be more costly than Type I errors for environmental management (Fairweather, 1991; Peterman and M'Gonigle, 1992; Mapstone, 1995; Underwood, 1997; Underwood and Chapman, 2003). For example, the potential consequences arising from a Type I error do not impact on the resource but cause the management agency to respond in the short term by committing resources (people, time, money) to further monitoring until the false alarm is identified (Table B2.1). In contrast, the potential consequences arising from a Type II error could be ecologically, socially and economically catastrophic and irreversible (e.g. stock collapses, changes in trophic structures). Thus, Type II errors have the potential to adversely impact the resource base and also the management agency, which will be compelled to respond in the long term by committing resources (people, time, money) to monitor any recovery (note -– there is no guarantee that recovery will occur).

The likelihood of making Type I and Type II errors in any quantitative study can be described in terms of probability that can be calculated when the sample size, effect size, and significance criterion (Type I error rate) are known or have been specified (see Cohen, 1988; Mapstone, 1995). In comparison, a qualitative assessment of information does not permit a calculation of probability for making Type I and Type II errors. However, the concept of statistical uncertainty is equally valid in qualitative risk assessment because it is still possible to make wrong conclusions based on a qualitative assessment of available information. In qualitative approaches to risk assessment it may be helpful to think of "statistical uncertainty" in terms of "decision uncertainty" when deciding if assigned risk levels are sufficiently precautionary.

Therefore, given the consequences of making Type I and Type II errors, it is important to ensure that the risk levels assigned in these qualitative assessments account for the considerable scientific uncertainty associated with the best available knowledge approach that has been used in the assessments. As previously discussed, applying a “precautionary where necessary” approach, as opposed to the “precautionary at all times” approach (i.e. the Precautionary Principle) to decision uncertainty in a qualitative risk assessment enables the greatest potential for a component to be managed in such a way as to minimise the effects of undetected adverse impacts (i.e. decision errors analogous to Type II errors in quantitative assessments). However, it is possible that decision errors (analogous to either Type I and Type II errors in quantitative assessments) could still occur.

Table B2.1 The possible implications of making interpretation/decision errors (analogous to Type I and Type II errors) in a qualitative risk assessment.

Error types and associated scenarios			**Implications* of Interpretation/Decision Errors**		
Error type	**Interpretation or Decision**	**Reality**	**For management agency**	**For fisheries resource**	**For proponents**
False positive: a change is detected when none has occurred (analogous to Type I)	Increase in size of stock or population	No change in size of stock or population	No problem	No problem (but could become one if response was to increase effort)	Positive short term. Long term outcome may be decline in CPUE
	Decrease in size of stock or population	No change in size of stock or population	Short-term problem. Extra unnecessary monitoring wastes limited resources	No problem.	Negative due to unnecessary cost and decreased effort
False negative: no change is detected but change has occurred (analogous to Type II)	No change in size of stock or population	Increase in size of stock or population	No problem	No problem	Missed economic opportunity
	No change in size of stock or population	Decrease in size of stock or population	Long-term problem. Cost of recovery programs and legal liability	Long-term problem. Potential for stock collapses and irreversible changes to ecological processes	Short term economic gain. Long term cost as resource base depleted

* It should be noted that these implications assume that the management regime remains constant.

B2.1.4 Methods used to determine risk

The previous sections outlined the broad frameworks, principles and issues related to risk analysis, and this section will discuss how it is done, the actual mechanics by which risk is determined. There are no hard and fast rules about how to apply risk analysis, as every one is unique and the methods need to be determined on a case-by-case basis. The review of this fishery, the risk analysis literature and the ecosystem components that could be affected indicate that a combination of methods will be required to determine the risks of this fishery. Broadly, the methods will be described as literature reviews and the development of a risk matrix. The various ecosystem components that the methods will be applied to are discussed below.

B2.1.4.1 Literature review

As previously mentioned in the definition of risk characterisation, the risk analysis of the Ocean Trap and Line Fishery will comprise of two elements. The first is at the broad ecosystem level and will define and examine all ecosystem components that could be affected by the fishery. This is primarily done by a literature review of scientific reports examining similar fisheries and ecosystems, fishery-specific information and the expert opinion of fisheries managers and scientists, as well as the opinions of external reviewers and stakeholders through the consultation process. The available information will be presented and reviewed to broadly define the perceived levels of risk to each component. At that point, components at negligible or low risk are accepted and justified. Components at moderate or greater risk are deemed in need of further analysis, and represent the second element of the risk analysis. For many of these components, a more detailed review of the literature is all that is possible. It generally involves drawing inferences or conclusions following consideration of the spatial and temporal extent of the fishery compared to that of the component being examined, and where possible also considers other features of the component such as catch rates and/or biological traits.

B2.1.4.2 Development of a qualitative risk matrix

For the component of primary and key secondary species of the fishery, there is sufficient information upon which to base a risk matrix. Matrices are a common and often standard feature of risk assessments as they provide a visual way of integrating information about the sources of risk associated with an activity and the feature thought to be at risk. This approach is consistent with the Australia/New Zealand Standard, as well as an Australian study examining the impacts of prawn trawling on the sustainability of bycatch species (Stobutzki *et al*., 2001), although the latter was quantitative, not qualitative like the matrix used here.

Matrices provide a pictorial means by which available information collected during the literature review is condensed into a couple of simple, operational terms that when contrasted against each other provide a level of risk. In this assessment, a matrix is used to integrate information about the fishery (referred to below as the fishery impact profile) with the biological features of the species (referred to below as resilience) (Figure B2.3). The integration of these main factors determine which species may be being unsustainably fished and thus require management and/or research.

The vertical-axis indicates the level of fishery impact exerted on a species and the horizontal-axis indicates the level of resilience of a species. The fishery impact profile represents the overall disturbance that is exerted on these species. The various factors that make up the operation of the fishery were considered and a selection of those for which there was some data were used to determine the level of fishery impact being exerted on a species. Resilience has a formal definition in scientific publications (e.g. Underwood, 1989), which is a measure of the response a population or assemblage of species has to a disturbance of a known magnitude. For the OTLF we were unable to determine the magnitude of the disturbance on commercial species due to substantial knowledge gaps (e.g. discard rates), diminishing the applicability of that definition. Therefore resilience could only be described qualitatively for this assessment and was a theoretical description based on the biology of the species (detailed below). In the context of this risk assessment, the term resilience will be defined as the capacity of a natural fish stock or population to recover from the effects of fishing. It is important to recognise that a taxon's position on the resilience axis cannot be changed by management actions because biological characteristics are determined on an evolutionary timescale.

The two axes formed a five by five matrix (25 squares), which was divided into five equally-sized levels of risk (Figure B2.4). The utility of this qualitative risk matrix approach was to provide relative rankings for different taxa, thereby prioritising taxa according to their need for management action. This is extremely important because the definition of risk used in this assessment is based on the likelihood that the current activities of the OTLF (regulated by current management actions) will lead to ecologically unsustainable overfishing of populations of primary and key secondary species. Therefore, any changes in management actions that alter the position of a taxon on the fishery impact axis also changes its level of risk. The position of the five risk levels in the matrix were consistent with this concept and are described below.

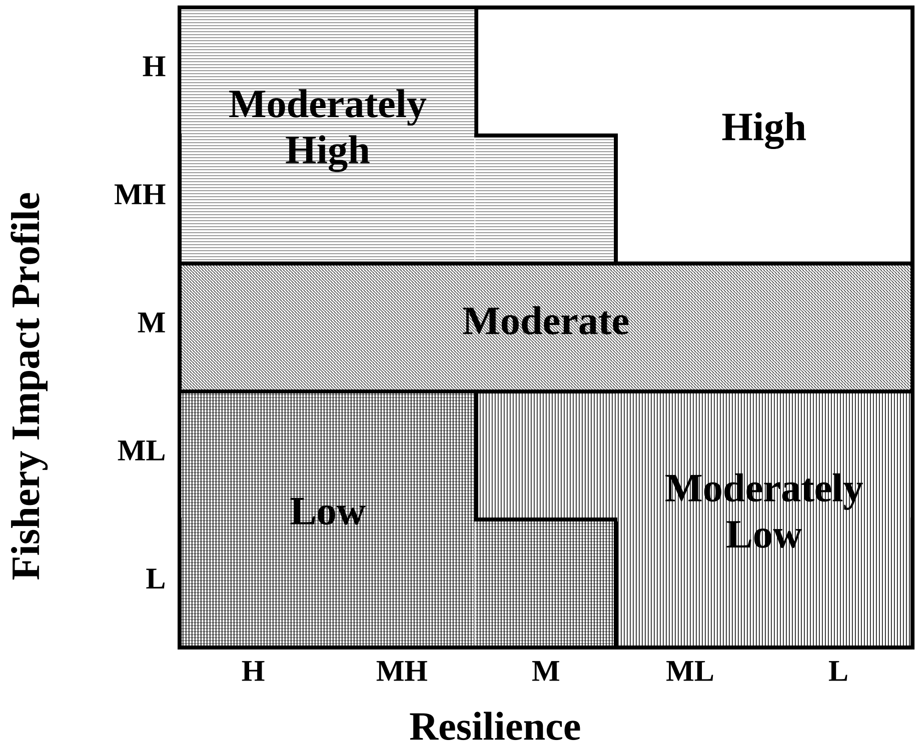


Figure B2.3 Qualitative risk matrix used to determine levels of risk for primary and key secondary species taken by the OTLF.

Where: H = High, MH = Moderately high, M = Moderate, ML = Moderately low, L = Low.

The top right hand corner and the bottom left hand corner represent the highest and lowest risk levels, respectively. High levels of risk correspond to species with lower resilience and largest level of fishery impact, whilst low levels of risk correspond to species with higher resilience and smallest level of fishery impact. Management measures should give first priority to species with highest levels of risk, which require direct and immediate action to decrease the level of the fishery impact exerted on them, thereby reducing their risk of becoming ecologically unsustainable. The top left hand corner and the bottom right hand corner of the matrix represent moderately high and moderately low levels of risk respectively. Moderately high levels of risk corresponded to species that have larger levels of fishery impact and are highly resilient. The focus of management action for species at this level should be to decrease their fishery impact but because their resilience is higher than those species at highest risk they would be second in priority rank. Moderately low levels of risk correspond to species that have smaller levels of fishery impact but lower resilience. The lower resilience of these species means that potentially any increase in the fishery impact could put these species at a higher level of risk. Therefore, management measures should be focused as a minimum on ensuring the fishery impact does not increase on these species. Moderate levels of risk correspond to species with a moderate level of fishery impact regardless of their resilience levels. Management measures for these species should focus on reducing their fishery impact starting with those species with lowest levels of resilience.

Fishery impact profile

A set of categories and sub-factors that describe the activities of the fishery were developed that collectively indicated the fishery impact profile on a species. Generally, these factors are ones that can be changed by management intervention. Unlike biological characteristics, which remain largely unchanged by management intervention, fishery factors represent those things management can alter to reduce the risk to primary and key secondary species of becoming ecologically unsustainable.

Eight factors of the operation of the OTLF were chosen out of 10 that were considered (Table B2.2). There was insufficient information about discard rates and the extent of use of bycatch reduction devices (could primarily be used in fish traps, although modified hooks could also be used) to be used in the assessment. Each factor was assigned decision criteria to determine if the fishery decreased (risk averse) or increased (risk prone) the potential impact on a species. A set of decision rules was then used to determine the overall fishery impact profile for each species by adding the number of risk prone factors (Table B2.3).

Table B2.2 List of fishery factors and decision criteria used to determine the fishery impact profile for the primary and key secondary species of the fishery.

Category	Factor	Explanation	Decision criteria	
			Risk averse	**Risk prone**
How much is caught	1. Catch levels & trends	Indicates consistency in catches - changes in trends over time could suggest stock decline	Stable over last 5 to 10 years	Highly variable over last 5-10 years
	2. Catch per unit effort (CPUE) trends	Simplistic index of abundance*	Stable over last 5 to 10 years	Highly variable over last 5-10 years
	Discard rate & composition	Potentially increases fishing mortality on target and non-target species; indicator of affected species and assemblages		
	3. Stock assessment & its adequacy	If assessed, indicates whether the information on which the stock assessment was based was sufficient	Yes and adequate	No or inadequate
	4. Exploitation status	Indicator of growth or recruitment overfishing (see Table B1.4)	Fully fished, under fished, moderately fished	Over fished, undefined
How is it fished	5. Gear selectivity	Indicates whether gear is catching fish of a size that allows the majority of the population to spawn at least once (assumes MLL, size at maturity and/or age at capture data)	Yes or data suggests adequate spawning stock levels	No, or insufficient biological data or data suggests inappropriate MLL
	Bycatch reduction devices (BRD)	Are they used and effective at reducing numbers of undersized fish		
How many are caught in OTLF	6. OTLF proportion of total catch[R]	Indicates the level of fishing pressure being exerted by the OTLF in comparison to other sectors	≤ 33%	> 33%
What is caught	7. Species identifications problems	If there are identification problems, then other relevant biological factors cannot be determined or managed with any confidence	No	Yes
Where is it fished	8. Spatial overlap with the fishery	Indicates whether a species has some of its distribution or habitat that is not fished by the OTLF	Yes	No

Discarding and BRD were not included because there is only very limited information for the fishery. They are shown for the purpose of highlighting their importance.

* CPUE should not be used as a stand alone index of abundance. It has been used here amongst other factors to lessen any potential bias in CPUE calculations. Where possible, inferences to abundances should be derived from multiple and independent sources of data.

R - denotes that ideally, the total catch would incorporate a reliable estimate of the recreational catch of a species as well, not just commercial catch, but this information is not available for most species in the fishery.

Table B2.3 Decision rules for assigning fishery impact profiles

Number of risk prone factors	Fishery impact profile
1 or 2	Low
3	Moderately Low
4	Moderate
5	Moderately High
> 5	High

Resilience - biological characteristics

Three broad biological categories were used to determine the resilience rating for each taxon: reproductive strategy, distribution and abundance, and growth and longevity (see Table B2.4). Decision criteria were determined for each biological category that distinguished between risk-prone and risk-averse character traits in a species. It is important to note that in an evolutionary sense, these traits are likely to all be beneficial, i.e. risk averse in this context, and in the absence of fishing mortality, it would not be necessary to classify traits in this way. But in the context of this risk analysis, it is necessary to determine resilience (capacity to recover from a decrease in population due to fishing pressure), and to do that, it is necessary to consider biological traits in terms of those that increase (risk averse) or decrease (risk prone) the likelihood of recovery in the presence of fishing pressure. Within the decision criteria, the reproductive strategy of live-bearing elasmobranchs (ovoviviparous and viviparous) was double-weighted, as that trait was seen as the major determinant of how well those species could respond to increased mortality due to fishing pressure. A set of decision rules was then used to determine the resilience of each species by adding the number of risk prone factors (Table B2.5).

Table B2.4 Biological categories and decision criteria used to determine resilience of the primary and key secondary species of the fishery.

Biological category	**Description and reasons for use**	**Decision criteria**
Reproductive strategy	An indicator of the capacity to maintain viable population sizes and to replenish populations after depletion. This category incorporates correlated biological characteristics such as, fecundity, egg type (demersal or pelagic), egg size, and larval type.	**Risk averse** - Taxa with pelagic eggs and larvae that are not sequential hermaphrodites (e.g. snapper, mulloway). **Risk prone** - Taxa with demersal eggs (e.g. gobies, leatherjackets, spanner crabs, cephalopods); mouthbrooders (e.g. cardinal fish, catfish); oviparous elasmobranchs (e.g. Port Jackson sharks); taxa with pelagic eggs that are sequential hermaphrodites (e.g. some large groupers - *Epinephelus spp.*, some wrasse species). **2 x Prone (double-weighting)** - Viviparous and ovoviviparous elasmobranchs (e.g. whaler sharks, wobbegong sharks).
Distribution and abundance	An indicator of rarity expressed in terms of: (a) prevalence (restricted geographical range and/or narrow habitat specificity); and/or (b) intensity (local populations are small and non-dominant and overall the entire population size is small).	**Risk averse** - Taxa having widespread distributions/broad habitat specificity and relatively large populations (e.g. kingfish, bream). **Risk prone** - Taxa having restricted distributions/narrow habitat specificity and/or relatively small populations (e.g. gemfish).
Growth and longevity	An indicator of productivity, population turnover and hence capacity to recover from depletion. This category incorporates correlated biological characteristics such as, size and age at maturity.	**Risk averse** - Taxa having fast growth rates and are relatively short-lived (e.g. dolphinfish, many squid species). **Risk prone** - Taxa having slow growth rates and/or relatively long-lived (10+ years for fish, 5+ years for invertebrates). Examples include jackass morwong, snapper, spanner crab.

The resilience rating used in this risk assessment was constructed so that it would be generally applicable across all taxa of commercially harvested crustacean, cephalopod, finfish and elasmobranch taxa. The resilience scores, decision rules and overall resilience ratings were intended to provide a simple structure that could be used to rank taxa according to their biological capacity to recover from fishery-related impacts. It was recognised that the general utility of this simple scheme relied on its ability to: (a) separate taxa across the entire resilience axis; and (b) provide relative rankings that were logical and consistent with current ecological interpretations regarding the relative resilience of different taxonomic groups. For example, the resilience of most elasmobranch populations is considered to be much lower than the resilience of most teleosts.

Table B2.5 Decision rules for assigning a resilience rating.

Resilience rating	Risk-prone score
High	0
Moderately high	1
Moderate	2
Moderately low	3
Low	4

B2.2 Risk Analysis of the Current Operation of the Fishery - Broad Ecosystem

In this section the risk analysis framework described in Section 2.1 will be applied to the OTLF. This will be done in a series of iterative steps that include:

a) defining the context for the risk analysis

b) identifying and assessing the sources of risk at the broad scale level of the whole ecosystem

c) justifying the elimination of sources of negligible and low risk from subsequent analyses and

d) re-analysing sources of medium to high risk at a finer scale by examining individual ecosystem components and their constituent elements (e.g. individual taxa and habitat types).

Parts a - c will be discussed below in this section and Part d will be addressed in Sections 2.3 to 2.5.

B2.2.1 Risk context

The guidelines for the Environmental Impact Assessment of the OTLF issued by the DP in February 2003 (Appendix A2) state that the environmental assessment should test the sustainability of authorised fishing activities, and under the framework for this analysis, needs to incorporate a definition of risk and the temporal and spatial coverage.

The risks being assessed can be defined as:

a) the likelihood that the current activities of the OTLF will lead to the widespread degradation (i.e. the undesirable event or consequence) of major ecological processes, biodiversity and marine habitats, and

b) the likelihood that the current activities of the OTLF will lead to ecologically unsustainable impacts on populations and communities of primary and key secondary species; non-commercial species; and protected and threatened species.

Those ecosystem components at risk due to the operation of the fishery are listed and defined in Table B2.6, and chapter references are also provided outlining where those aspects are discussed in detail. The temporal coverage of the risk analysis was set at 20 years, because it may take more than a decade for many fishery-related impacts to become evident, and it is also thought to be the average turnover time of a generation of fish assemblages for NSW oceanic waters (Kailola *et al*., 1993). The spatial coverage of the risk analysis was defined as the entire area in which the OTLF is permitted to operate and is subject to the jurisdiction of NSW. As the context cannot change throughout the risk analysis, this part of the analysis will not be repeated for the finer scale assessments of the individual ecosystem components, e.g. habitats or primary species.

Table B2.6 Ecosystem components - definitions and references to relevant chapter sections.

Ecosystem component	Definition	Chapter sections dealing with related issues
Ecological processes	Any biological process that may affect the ecology of finfish and shellfish populations, biodiversity, and the environment in which these populations live.	2.3
Biodiversity	The variability among living organisms from all sources (including marine and other aquatic ecosystems and the ecological complexes of which they are part). Includes: (1) diversity within species and between species; and (2) diversity of ecosystems.	2.3
Species assemblages	A species assemblage is a group of organisms that are present in the same place at the same time (Underwood 1986).	2.3, 2.4, 2.5
Primary species	The key species taken in the fishery.	2.4
Key secondary species	Species that are not primary species, but are captured and retained for sale. In multi-species fisheries the catch of key secondary species may be critical for the economic viability of fishing businesses and receive greater management attention than secondary species.	2.4
Secondary species	Species that are not a primary or key secondary species, but are captured incidentally and retained for sale. In this particular multi-species fishery, secondary species are of less economic importance to fishing businesses and thus receive less management attention.	2.4
Bycatch	Species that are captured by the fishery and then discarded.	2.2, 2.4
Protected species	Species protected under the NSW legislation (Fisheries Management Act or National Parks and Wildlife Act) or Commonwealth legislation (Environment Protection and Biodiversity Conservation Act).	2.2, 2.5
Threatened species, populations or ecological communities	Species, populations or ecological communities listed as vulnerable, endangered or presumed extinct under the Fisheries Management Act, Threatened Species Conservation Act or Environment Protection and Biodiversity Conservation Act.	2.2, 2.5
Marine habitats	The geological, environmental and biological structure that supports biological communities self-organised from the available species mix (Bax and Williams 2001). There are three distinct types of marine habitats: (a) geological structures which include rocky reefs and sediment deposits; (b) biogenic structures which include sponges, corals, marine algae, bryozoans and ascidians; and (c) the water column.	2.2

B2.2.2 Risk identification

As previously defined, the aim of risk identification is to generate a list of potential sources of risk. A combination of literature reviews and meetings between the fishery management and environmental assessment teams within DPI was used to divide the fishery into its individual activities and definitions thereof (Table B2.7). It is important to note that the activities of the fishery can affect the environment both directly and indirectly and the risks of all of these effects need to be considered in the analysis.

Table B2.7 Description of activities related to the operation of the Ocean Trap and Line Fishery and their potential ecological impacts.

Activity	Definition of activity and potential impacts
Harvesting catch (for sale)	Those components of a fish stock that are caught and kept for sale. Potential impacts may include recruitment overfishing, growth overfishing, changes in population structure and trophic cascades.
Harvesting catch (not sold - bait for personal use)	Those components of a fish stock that are caught and kept as bait for personal use, rather than being sold at market. Potential impacts of capturing and using these local bait sources may include overfishing of species taken for bait, changes in population structure and trophic cascades. A variety of fishing methods can be used to take these fish for bait (e.g. bait traps, demersal fish traps or line fishing methods). The methods "purse seine" and "submersible lift net" were excluded because they are covered under the Ocean Hauling Fishery.
Discarding catch	Those components of a fish stock that are caught and thrown back. Discards can include: (a) commercially valuable species such as primary and key secondary species; (b) non-commercial species; and (c) threatened and protected species. Potential impacts may include high mortality rates of discards that contribute to recruitment overfishing, growth overfishing, changes in population structure and trophic cascades.
Physical contact with fishing gear but not captured (excludes harvesting and discarding)	Physical contact of fishing gear with ecological components of the environment that does not result in capture and handling by the fisher. This includes fish escaping through the mesh of traps, fish escaping from line fishing gear following hooking, disentanglement from the mesh of spanner crab nets, predation whilst caught or following escape from fishing gear, and the accidental entanglement and escape/release of marine mammals, turtles and seabirds from fishing gear. Total mortality rates of some populations may increase as a result of these physical impacts attributable to fishing gear. The physical impacts of demersal fish traps, spanner crab tangle nets and fishing lines and terminal tackle (hooks, lures and sinkers) on substrata/habitats is included in this category. Potential direct impacts may include structural damage to habitats. Potential indirect impacts may include responses of fauna to damaged habitat.
Loss of fishing gear	Fishing gear or debris lost during fishing operations resulting in impacts to ecological components due to interactions with that gear. This includes the effects of "ghost-fishing" and entanglement in lost gear such as fish traps, fishing lines and terminal tackle (hooks and lead weights), spanner crab nets, ropes, and head gear (e.g. floats).
Usage of imported fish baits and non-fish baits	This includes the use of imported fish bait (e.g. pilchards, squid taken from waters outside NSW) and the use of non-fish baits (e.g. chicken gut). Potential impacts of these imported fish baits could include the introduction of exotic pests and diseases into fish populations and the general environment. Potential impacts of non-fish baits could include the introduction of viral and/or bacterial diseases into fish populations and the general environment.
Presence in the area during fishing operations	Disturbance to fauna that may occur during fishing operations. Potential impacts may include disruption of migratory, schooling or spawning behaviours in response to noise and light regimes associated with fishing operations, as well as the physical presence of boats. (Presence includes the time spent fishing and the time travelling to and from the fishing grounds).
Boat operations and maintenance.	All aspects involving the operation and maintenance of fishing boats. Potential impacts to ecological components include exposure to engine emissions, accidental leaks or spills of fuel and/or oil, and chemicals that leach from anti-fouling paints on the hull of the boat.

B2.2.3 Risk characterisation

This section will establish the links between the ecosystem components (Table B2.6) and the potential sources of risk identified above (Table B2.7). It will (a) integrate qualitative information about the potential sources of risk (i.e. activities of the fishery), (b) assign risk levels to each source on the basis of their likelihood of causing ecologically unsustainable impacts on each ecosystem component (Table B2.8), (c) accept and justify low or negligible risks, and (d) highlight those sources of moderate or high risk that will require finer detail assessments (which will be presented in sections B2.3 - B2.5).

Table B2.8 Summary of qualitative risk levels for each ecosystem component that is attributable to the activities of the Ocean Trap and Line Fishery.

Ecosystem component	**Activities of the Ocean Trap and Line Fishery**							
	Harvesting catch (for sale)	**Harvesting catch (not sold - bait for own use)**	**Discarding catch (not kept)**	**Physical contact with fishing gear but not captured (excludes harvesting and discarding)**	**Loss of fishing gear (ghost-fishing)**	**Usage of imported fish baits & non-fish baits (introduction of exotic disease)**	**Presence in the area during fishing operations (disturbance)**	**Boat operations & maintenance (pollution due to emissions, leaks and spills)**
Ecological processes & biodiversity	**H**	**H**	L	L	-	L	-	-
Primary and key secondary species	**H**	**H**	**H**	L	**M**	L	-	-
Bycatch species	-	-	**H**	L	**M**	L	-	-
Threatened & protected species: (a) fish	L	L	most L, few **M-H**	L	L	L	-	-
(b) mammals, turtles & birds	**M***	**M***	**M***	L	**M**	L	L	-
Marine habitats (biological & physical)	-	-	-	L	-	-	-	-

Note: The ecosystem component 'species assemblages' is not presented separately as it is a product of the other components. Each cell in the table may contain multiple indirect and direct impacts. The highest risk level is reported for each cell. * denotes the risk is indirect, largely unknown and thus requires finer detail assessment

RISK LEVELS: Dash = Negligible; L = Low risk; M = Moderate risk; H = Higher risk.

Table B2.8 indicates that at the broad ecosystem level, most activities of the fishery are thought to pose negligible or low risks to most ecosystem components. The following sections will:

a) discuss each of these low risk activities to justify accepting the low risks that they are purported to pose to an ecologically sustainable Ocean Trap and Line Fishery

b) briefly discuss the activities of high risk that will require more detailed assessments

c) discuss the ecosystem components at negligible or low risk that will not be assessed in more detail, and

d) summarise the issues arising from this risk assessment at broad level of ecosystems.

B2.2.3.1 Activities of the fishery that pose low or negligible risk

Harvesting

Bycatch species, threatened species and marine habitats are not harvested by the fishery and are thus at low direct risk, although the harvesting of prey species provides competition for some threatened species. Fisheries that capture the natural prey species of other animals may have an impact on those animals by depleting their food resources. In the case of most of the threatened fish that could be affected by the fishery, except for the sharks and perhaps some serranids, most of them do not feed on the species targeted in the fishery. For grey nurse shark and black cod, which are relatively more cryptic species (i.e. they do not move very far on a regular basis), removal of prey resources from their habitats could have an impact both directly via competition, and indirectly by forcing them to move further afield in search of food. Overall, competition with the fishery via harvesting of prey resources is likely to be a low risk for most threatened fishes, although some of them will be examined in finer detail due to potential impacts related to catch (during harvesting) and subsequent discarding. At the broad level of ecosystems, it is not readily obvious as to the impact for marine mammals, reptiles and birds, so as a precautionary measure, a medium risk has been assigned to most of them so that these components will be assessed in finer detail. Some threatened species can be readily dismissed from the finer detail assessment, due to lack of overlap and/or interaction with the fishery, and these are discussed in B2.2.3.3.

Physical contact with fishing gear but not captured

As previously defined in Table B2.7, this activity of the fishery includes those interactions where an animal has come into some form of contact with gear used in the fishery, but it has not resulted in the animals capture to the point where it is landed on the vessel. The concern is that total mortality rates of some populations may increase as a result of such interactions, and as such this form of impact is often referred to as unaccounted mortality as it is generally not considered into fishing mortality estimates (see Chopin *et al*., 1996 and Chopin and Arimoto, 1995). In comparison to other sources of fishing-related mortality, however, such as harvesting and discarding, the additional mortality attributable to physical contact with fishing gear without capture may only be a minor proportion of the overall fishing mortality.

Fish and invertebrates escaping from fishing gear could potentially be subjected to increased levels of stress, barotrauma impacts (if escapement occurs after being pulled into shallow water), other physical injuries (e.g. scale loss or wounds), or sub-lethal effects (expressed as reduced fitness, reduced reproductive capacity, impaired immune response, behavioural change). The susceptibility of fish to injury varies with gear type, fish size and behaviour (Davis, 2002). As is likely to be the case for many fisheries, there are no data that describe the fate of fish and invertebrates that escape from fishing gear in the OTLF. This lack of information describing the impacts attributable to physical contact with fishing gear but without capture is identified as an information gap for the OTLF, but it is also acknowledged that it would be both difficult and expensive to accurately quantify the relative size of this source of additional fishing mortality. In the environment of limited resources that this fishery exists in, it should thus be considered a low priority.

Threatened species also encounter fishing gear and sometimes vessels whilst in operation. Those interactions can be either accidental or deliberate if it is raiding bait, catch or discards for food (Hickman, 1999), or encountering lost fishing gear (discussed separately below). Seals, cetaceans and seabirds known to forage on the bait, catch or discards of line fishing gear can collide with and become entangled in the gear (e.g. Commonwealth of Australia, 2003; Environment Australia, 1998a; Nitta and Henderson, 1993; Ferris and Ferris, 2002). Marine mammals and turtles can also entangle in the head floats and attached lines of traps and passive line fishing gear (Nitta and Henderson, 1993; Environment Australia, 2003), although there are no documented cases in the OTLF. Due to the mobility of seabirds, turtles and marine mammals such encounters are difficult to document and hence the level of impact of these contacts between fishing gear and threatened species is unknown, but is thought to be low. Only when interactions between threatened species and the OTLF have been documented can there be a clear picture of the level of impact (if any) by the OTLF, which can be determined and acted upon.

Loss of fishing gear (ghost-fishing)

When fishing-related gear (nets, traps, lines and debris) is lost at sea it may continue to catch fish and other animals and hence cause additional mortality to those animal populations. This phenomenon is known as “ghost-fishing”. Fishers can lose their gear as a result of unfavourable weather conditions, bottom snags, ship collisions, mobile fishing methods that inadvertently tow the gear or remove marker buoys, human error, vandalism and gear failure (Laist, 1996; Anon, 2003). Other fishing-related debris, such as fragments of nets, rope, lines, floats, bait bags and packaging bands (Jones, 1995), may also be either deliberately disposed of or accidentally find its way into the sea and waterways. OTLF fishers are most likely to dispose of un-biodegradable material at land-based sources as it is in their best interest and the dumping of synthetics at sea is illegal.

The potential for ghost-fishing varies for different fisheries and different gear types (Laist 1996, Jennings and Kaiser 1998). Three pieces of information are needed to assess the potential impacts of ghost-fishing: (a) the quantity and type of lost gear; (b) the hazard-life of the gear (length of time that the gear is likely to continue fishing) (Laist 1996, Jennings and Kaiser 1998); and (c) the types of animals caught and their level of mortality. There is currently no quantitative information for any of those aspects for gear used in the OTLF.

While no investigations into gear loss by this fishery have been conducted, most studies of debris found on Australian beaches have recorded fishing-related items (Herfort, 1997; Cunningham and Wilson, 2003; Kiessling, 2003; Slater, 1991; Whiting, 1998; Haynes, 1997), indicating its presence in the surrounding ocean (Jones, 1995). A study of selected ocean beaches in NSW found 13% of the debris to be fishing related, 60% of which was from commercial origins and the remaining 40% recreational (Herfort, 1997). Amongst the fishing debris recorded on NSW beaches, there was a dominance of prawn trawl debris on the State’s northern beaches, trap fishing gear on the central NSW beaches, fish trawl debris on the southern beaches and recreational fishing gear on beaches around urban centres, especially those on the central coast of NSW (Herfort, 1997). Considering the cost of gear, fishers would probably attempt to retrieve any lost gear if they thought it was possible. The ghost-fishing of intact lost traps and lines generally affects fish and crustaceans rather than mammals, turtles and birds (Laist, 1996).

Anecdotal reports suggest that there is minimal gear loss in the fishery. Fishers indicate that traps used in the fishery have a maximum life of about a year and that this is often shorter when using escape panels. Some overseas[2] studies suggest that gear can fish for more than a decade and catch between 3-30% of the annual reported commercial catch, to say nothing of the non-commercial catch (Laist, 1996; Mathews *et al.*, 1987; Chopin *et al.*, 1997). An Australian study based on the use of underwater video suggests that there is minimal potential for ghost-fishing, as fish are able to readily swim in and out of fish traps (Moran and Jenke, 1989). Those overseas fisheries for which lost gear-caught catches are high are primarily crustacean fisheries using crab-pots, as opposed to large demersal fish traps used in the OTLF. Some of those fisheries where ghost-fishing was thought to be significant have investigated the use of escape panels and biodegradable escape panel fasteners (Bullimore *et al.*, 2001; Selliah *et al.*, 2001; Fogarty, 1996; Guillory, 1993; Mathews *et al.*, 1987).

[2] Different naming systems makes it difficult to readily compare overseas studies to Australian ones, as the term ‘trap’ is often used overseas to include a variety of semi-permanent net types, such as fyke nets or similar structures that trap fish during tidal movements. Further, the term ‘pot’ is used in many overseas studies to encompass everything from the beehive-type lobster pot used in Australia, mesh-covered frames like those used in the OTLF, through to wooden boxes with single entrances - see Bjordal, 2002.

Many trap fishers within the OTLF currently use some form of escape panel, although they are not compulsory nor consistently applied.

The entanglement in or ingestion of marine debris, particularly that of a plastic or synthetic nature, by marine mammals, reptiles and seabirds, has been identified as a key threat to the survival of these species (Laist, 1987; NSW Scientific Committee, 2003; Threatened Species Scientific Committee, 2003). It is the floating debris that poses the greatest threat to these surface-dependent species that are attracted to it as a food source or shelter. Debris types that may originate from the OTLF that would probably float include line segments perhaps with attached hooks, ropes, floats and bait packaging. Such debris types have been found to influence marine vertebrates in other parts of the world (e.g. Fowler, 1987; Laist 1987, 1996). From the limited information available on the entanglement or ingestion of fishing material by marine vertebrates in NSW (i.e. DEC Marine Fauna Management Database), it is difficult to determine if the OTLF contributed to the 12 animals affected by lines, hooks, ropes and buoys over the last ten years, and whether the animals interacted with active fishing gear or debris. Locating the origin of marine debris types that are found to have an impact on animals can be difficult as marine debris can travel over long distances, and debris may break down into unidentifiable particles.

Overall, lost fishing gear probably poses a low to moderate risk to most ecosystem components, and there is no information upon which to base a more detailed risk assessment. Owing to the considerable uncertainty related to gear loss in the fishery and its potential impact, it is identified as an information gap that needs to be addressed by the draft FMS.

Usage of imported fish baits & non-fish baits

The usage of imported fish baits and non-fish baits in the OTLF has the potential to introduce exotic pathogens into fish populations and the marine environment. In 1995 and 1998/99 mass mortality events affecting Australian pilchards were recorded over large geographical areas and resulted in significant declines in the breeding stock (Whittington *et al.,* 1997, Gaughan *et al.,* 2000). The cause of these mass mortality events was believed to be an infectious disease agent that was not present before in Australian pilchard stocks (Whittington *et al.,* 1997). The importation of baitfish was identified as a possible mechanism for the introduction of exotic microbial pathogens into Australian coastal waters (Whittington *et al.,* 1997). Some commercial fishers in the OTLF use pilchards, mackerel and squid for bait imported from other States and overseas, as well as from other fishers within the State, whilst some others use raw chicken offal to bait demersal fish traps. The extent, frequency and magnitude of these bait usage practices and thus the potential extent, frequency and magnitude of impacts are unknown.

The fish disease (viral haemorrhagic septicaemia virus – VHSV) was discovered in Californian pilchards and mackerel in 2001 (AFFA 2003). Australia imports frozen pilchards and mackerel from the west coast of the United States for a variety of uses which include aquaculture feed and bait for recreational and commercial fishers. Concerns about the biosecurity risk to Australia of introducing this exotic disease into populations of wild baitfish in Australia led to a formal risk assessment which considered three major uses of the imported frozen pilchards: (a) rock lobster fishing; (b) recreational and commercial line fishing; and (c) aquaculture feed, specifically tuna farming (AFFA 2003). The risk assessment concluded that the "VHSV risk associated with importation from any country of whole frozen pilchards and mackerel for direct introduction into Australian natural waters is determined to be ***very low***." (AFFA 2003). The ***very low*** qualitative likelihood assigned to this risk assessment corresponds to a probability ranging between 0.001 and 0.05 (AFFA 2003). That is, the likelihood ranges between 'one chance in a thousand' and 'one chance in twenty'. It is thought that the transmission of exotic pathogens is more likely to occur from closely related taxa (e.g. imported pilchard to local pilchard) than from distantly related taxa (e.g. chicken offal to local pilchard). Accordingly, the risk of introducing exotic pathogens from non-fish sources of bait is also very low.

Presence in the area during fishing operations

The fishery occurs over a significant spatial extent and takes place sporadically throughout most of the year, limiting the potential for discrete components to be significantly affected by vessels of the fishery. In addition to collisions, the mere presence of vessels in an area is known to disrupt the behaviour of some marine mammals, especially cetaceans (Clapham *et al.*, 1999). The most likely mechanism of disturbance is noise from the vessel, although visual and other cues may also be involved. The short term reactions to such disturbance range from attraction to avoidance, while the long term effects are largely unknown, but could include abandonment of certain areas if disturbance is severe (Richardson *et al.*, 1995).

The noise and light from OTLF vessels when travelling to and from fishing grounds is only likely to disturb seabirds when they are foraging. Little is known of the general effects of noise on foraging seabirds. A study on disturbance in a coastal bay found that seabirds (gulls and terns) were the birds least affected by human disturbance and they usually landed where they had been prior to the disturbance (Burger, 1981). As this noise source is a travelling one and is not likely to remain for too long in an area where a bird is foraging, the birds should only experience minor short-term effects. A positive effect for those species that are adapted to feeding from OTLF vessels is that they may use the emitted noise and light to locate the vessels.

Marine turtles are not likely to be disturbed by boating noise as they have poor hearing and generally only hear low frequencies (Environment Australia, 2003).

Boat operations & maintenance

Boat operations and maintenance (e.g. pollution impacts due to emissions, leaks and spills) were assessed as having a negligible level of risk for all ecosystem components, and in the absence of a significant pollutant audit, it would not be possible to determine the proportional impact of this fishery. Planktonic organisms (e.g. phytoplankton, zooplankton and ichthyoplankton) can be impacted by commercial fishing activities, as well as a host of other boat-based activities, and thus it is possible that ecological processes occurring in the plankton could become degraded. Impacts on planktonic assemblages may occur because of engine emissions, petrochemical spills and leaks and/or the leaching of anti-fouling agents from the hull of a vessel into the water column. The risk level for these types of fishery-related impacts on primary production and the dispersal of planktonic propagules/larvae have been assessed as negligible because of the relatively small size of the fishing fleet and the dilution effect of relatively small discharges into a vast area.

B2.2.3.2 Activities of the fishery that pose moderate or high risk

Harvesting

The activity of harvesting catch (for sale and as bait for personal use) was identified as posing a high level of risk to ecological processes and biodiversity and to primary and key secondary species (Table B2.8). At the broad ecosystem level of this preliminary analysis, target species and the associated non-target species that are also harvested would naturally fall into the high risk category, until individual species can be examined in more detail to determine a more appropriate level of risk.

Discarding

Discarding catch was identified as posing a high level of risk to primary and key secondary species, bycatch species and to some protected and threatened species (Table B2.8). Discarding appears to be poorly understood within the fishery, but there is some data for commercial species to indicate that it does occur, and with the potential for many species of the fishery that do not currently have size limits to receive them in the future, discarding could increase. The potential impact of discarding will be examined in finer detail for the commercial species of the fishery, as there is some data for that component.

Unfortunately, there are no data for the non-commercial species (i.e. they are always discarded) that are affected by the fishery. Given the extent of the list of reported landings for the fishery (Table B1.2), it would appear that there are very few species that could be caught by the methods of the fishery that are not retained for sale. Table B1.3 lists only two species that are known to be discarded from traps that are not also sometimes retained for sale, namely boxfish and turret fish. Other ostraciids (cowfishes and boxfishes), odacids (herring cales and weed whitings), aplodactylids (rock cales), tetraodontids (toadfishes) and diodontids (porcupinefishes) are also likely to be caught and always discarded. With the potential for an impact on these non-commercial species, and as a result, ecological processes and biodiversity, discarding of non-commercial species is considered an important information gap that needs to be addressed by the draft FMS. Any measures proposed to better understand composition and rates of discarding for the commercial species should simultaneously address non-commercial species. The absence of any data precludes finer detail analysis, but discarding of non-commercial species is an issue for the fishery that can be readily addressed by the draft FMS.

Some threatened or protected species, such as grey nurse shark and blue groper, are known to caught and released in the fishery, so the potential for that to occur and for other threatened species needs to be examined in more detail.

B2.2.3.3 Ecosystem components at low or negligible risk

Some threatened and protected species

Some threatened and protected species were considered to be at negligible or low risk as they do not interact with the fishery due to zero or extremely limited geographical overlap of historical or present range with the spatial extent of the fishery. Those species for which it is considered unnecessary to complete the more rigorous risk assessment are listed in Table B2.9.

In the assessment, the phrase “waters off NSW” covers the water out to 80 nm from the NSW coastline. A preliminary assessment was made that considered all threatened species that are listed under the relevant parts of the FM Act, TSC Act or EPBC Act in order to establish a smaller list for which every species would have a detailed risk assessment. The assessment also included species of fish protected under sections 19 (protected from fishing) and 20 (protected from commercial fishing)of the FM Act.

Based on preliminary assessment, 24 listed species, groups or communities of fish (as defined under the FM Act), one marine alga, 26 birds, two reptiles and four mammals do not require further assessment, because of the very small probability of their interacting with the OTLF.

Table B2.9 Listed threatened species that do not require further analysis

Common name	Legislation	Status	Justification
Fish			
Atlantic salmon	FM	Section 20	Freshwater species
Australian grayling	FM; EPBC	Section 19; Vulnerable	Freshwater species
Brook trout	FM	s. 20	Freshwater species
Brown trout	FM	s. 20	Freshwater species
Eastern freshwater cod	FM; EPBC	Endangered	Freshwater species
Eel-tailed catfish	FM	s. 20	Freshwater species
Golden perch	FM	s. 20	Freshwater species
Macquarie perch	FM; EPBC	Vulnerable; endangered	Freshwater species
Murray cod	FM; EPBC	s. 20; Vulnerable	Freshwater species
Murray hardyhead	FM; EPBC	Endangered; vulnerable	Freshwater species
Oxleyan pygmy perch	FM; EPBC	Endangered	Freshwater species
Pegasidae (seamoths - *Pegasus volitans* & *Eurypegasus draconis*)	FM	s. 19	Limited to no interaction in terms of diet, behaviour or movement, and limited spatial overlap as primarily estuarine
Rainbow trout	FM	s. 20	Freshwater species
Silver perch	FM	Vulnerable	Freshwater species
Solenostomidae (ghost pipefishes) - *Solenostomus paradoxus,* *S. cyanopterus,* *S. leptosomus,* *S. paegnius*	FM	s. 19	Very limited potential overlap with the fishery, particularly as a proportion of potential geographic range, predominantly pelagic lifecycles, and when they do settle to the substratum the species is predominantly found on reefs and similar complex habitat in sheltered coastal waters and estuaries where they feed on mysids and other shrimp.
Southern pygmy perch	FM	Vulnerable	Freshwater species
Syngnathidae (approximately 29 species of seahorses, seadragons, pipefish & pipehorses	FM; EPBC	s. 19; P248	Very limited to no interaction in terms of diet, behaviour or movement, and limited spatial overlap
Trout cod	FM; EPBC	Endangered	Freshwater species
Western population of olive perchlets	FM	Endangered population	Freshwater species
Western population of purple-spotted gudgeons	FM	Endangered population	Freshwater species
Invertebrates			
Adams emerald dragonfly	FM	Vulnerable	Freshwater species
Buchanans fairy shrimp	FM	Vulnerable	Freshwater species
Freshwater crayfish	FM	s. 20	Freshwater species
River snail	FM	Vulnerable	Freshwater species
Marine algae			
Bennetts seaweed	FM	Presumed extinct	Rocky shores of coastal areas. It was only ever collected from Sydney Harbour, beyond the range of this fishery

Table B2.9 cont.

Common name	Legislation	Status	Justification
Birds			
Abbott's booby	EPBC	Endangered	Range does not include the waters off NSW
Antarctic tern	EPBC	Endangered	Range does not include the waters off NSW
Australian lesser noddy	EPBC	Vulnerable	Range does not include the waters off NSW
Fairy prion	EPBC	Vulnerable	Range does not include the waters off NSW
Soft-plumaged petrel	EPBC	Vulnerable	Range does not include the waters off NSW
Round Island petrel	EPBC	Critically Endangered	Range does not include the waters off NSW
Masked booby	EPBC	Vulnerable	Rare vagrant to the waters off NSW
Macquarie shag	EPBC	Vulnerable	Range does not include the waters off NSW
Herald petrel	EPBC	Critically Endangered	Range does not include the waters off NSW
Heard shag	EPBC	Vulnerable	Range does not include the waters off NSW
Grey-headed albatross	EPBC	Vulnerable	Rare vagrant to the waters off NSW
Pacific albatross	EPBC	Vulnerable	Rare vagrant to the waters off NSW
Tristan albatross	EPBC	Endangered	Unlikely to be found in the waters off NSW
Blue petrel	EPBC	Vulnerable	Unlikely to be found in the waters off NSW
Shorebirds (12 species)	TSC, JAMBA, CAMBA	Vulnerable (10) Endangered (2)	Species habitat and prey will not be affected by the OTLF
Mammals			
Fin whale	EPBC	Vulnerable	Seemingly rare in waters off NSW, only two unconfirmed records to date
Sei whale	EPBC	Vulnerable	Seemingly rare in waters off NSW, only two unconfirmed records to date
Southern elephant seal	EPBC	Vulnerable	Occasional stragglers to the waters off NSW, only six records to date
Sub-Antarctic fur-seal	EPBC	Vulnerable	Occasional stragglers to the waters off NSW, only seven records to date
Reptiles			
Flatback turtle	EPBC		Generally a tropical species, only recorded off NSW as a rare extra-limital vagrant
Olive ridley turtle	EPBC		A tropical species that has not been recorded off NSW

Note: JAMBA & CAMBA refer to the Japan- & China-Australia Migratory Bird Agreements, respectively.

Marine habitats

Marine habitat may be defined as the geological, environmental and biological structure that supports biological communities self-organised from the available species mix (Bax and Williams 2001). This broad definition includes three distinct types of habitat structure:

1) geological structures, which include rocky reefs, sediment deposits, submarine canyons, bedrock outcrops

2) biogenic structures which consist of living biota and any physical structure they create (e.g. sponges, corals, kelp beds, bryozoans, worm tubes, ascidians, sea pens and sea whips)

3) the water column

Seabed habitat is an important factor that influences the composition and distribution of biological communities (Anderson and Millar, 2004; Bax and Williams 2001; Williams and Bax, 2001; Glasby, 1998; Underwood and Chapman, 1995). The distribution and composition of fish and invertebrate communities living on the continental shelf of New South Wales are also influenced by factors such as latitude, depth and hydrology (Gray and Otway, 1994; Connell and Lincoln-Smith, 1999; Bax and Williams, 2000; Williams and Bax, 2001). Biological communities, including commercially targeted stocks of fishes and invertebrates, depend on substratum features (geological and biogenic) to provide spawning sites, feeding areas and refuge areas from marine predators and fishing fleets. Bax and Williams (2001) have suggested that existing physical refuges from fishing activities may play an important role in sustaining the productivity of many commercially fished species.

The water column is also an important part of the three dimensional marine environment. The seawater may vary in salinity, temperature, and density, all of which are important factors that influence the behaviour of marine organisms. The oceanic water mass in which marine biological communities exist also contains currents which bring oxygen and food to many species, disperses the pelagic eggs and larvae of many invertebrates and bony fishes away from spawning sites, and currents are used by many species to assist migratory movements. Therefore, it is essential that the quality of the water column is maintained in order to sustain biological communities in the long-term.

In the context of this assessment, the risk being assessed for marine habitats can be defined as the likelihood that marine habitats will be degraded by the current activities of the fishery such that the populations or stock levels of species associated with these degraded habitats will become ecologically unsustainable within the next 20 years. To accurately determine that risk to habitats, considerable information gaps would have to be filled, including but not limited to: the spatial distribution, size, type, temporal changes, recovery rates and species composition of various habitats; and the frequency, duration, proportion of fished habitat and effects of OTL fishing methods on those habitats. If the latter was well understood, for example that the gear in the fishery had little to no impact, then the rest of the information would be superfluous as the risk of habitat modification, and the flow-on effect to species assemblages, would be negligible.

Such an outcome would be consistent with the work of Eno *et al*., (2001) and Casement and Svane (1999) and Moran and Jenke (1989). Eno *et al*., (2001), in their study of the effects of crustacean traps on benthic fauna in some Scottish sea lochs, reported minimal immediate detrimental impacts, and that some intuitively vulnerable species, such as sea pens, were generally not affected by crab pots or were able to re-establish themselves in muddy substratum after smothering or uprooting. Similarly, lobster and crab pots hauled from rocky substrata in southern England also appeared to leave habitats and their associated communities relatively unaffected (Eno *et al*., 2001). A study of the effects of lobster pots on shallow subtidal reef in South Australia also reported that habitats appeared to be physically unaffected by the activity (Casement and Svane, 1999). A similar study in Western Australia using underwater video observed that traps generally lifted vertically when pulled and did not appear to cause physical damage to corals and soft sponges present in the areas where traps were set (Moran and Jenke, 1989), although there was no comparison to other non-trapped areas or any ongoing effects. There are no studies or information specific to the OTLF methods and the habitats in which it operates.

In the absence of such information, this preliminary assessment considers there to be low to moderately-low risk to marine habitats due to the methods of the fishery. That said, however, information gaps present a risk in and of themselves. Without such information, it is not possible to review this component in more detail. The low to moderately-low risk level is primarily due to the likelihood that the geological habitats and water column are likely to have low vulnerability to the gear in this fishery, whereas biogenic habitats would be moderately to highly vulnerable, as the latter have little to no resistance against fishing gears and are likely to take years to recover following impact. But it is unlikely, albeit uncertain, that the fishery operates over all such habitats, thus providing refuge areas for those habitats, which are also likely to occur in many protected areas closed to the fishery. This uncertainty about the extent, frequency, and duration of fishing and the habitats in which it occurs and thus the extent and magnitude of potential impact is identified as an information gap that needs to be addressed in the draft FMS.

B2.2.4 Issues arising from the ecosystem level risk analysis

Based on the preliminary assessment at the level of ecosystems, the ecosystem components of ecological processes and biodiversity, primary and key secondary species, and some threatened and protected species need to be assessed in finer detail to examine how they are affected by the high risk activities of the fishery, that is harvesting and discarding. The assessment of the other activities of the fishery suggests they are low risk, except for gear loss (ghost-fishing) which is low to moderate. Those activities will not be discussed in the finer detail analysis, nor will the ecosystem component of marine habitats and some of the threatened and protected species, which were assessed as at low risk by all activities of the fishery.

For the activity of gear loss and the ecosystem components of marine habitats and non-commercial species, there is no information upon which to base a finer detailed assessment. Although these aspects are probably only low to moderately low risks, the uncertainty and the potential for wider ranging impacts as a result of impact on these aspects, means that as a precautionary measure, they are considered a moderate risk. On that basis, they warrant some form of management action in the draft FMS, which as a minimum, should aim to fill these information gaps by collecting data about the magnitude of gear loss, distribution of habitats and fishing effort, and of the spatial and temporal rate and composition of discarding. Relative to better understanding the potential impacts of the fishery on the primary and key secondary species, these issues are probably a low priority, but given the relative ease of obtaining most of this information, they should still be addressed in the draft FMS.

B2.3 Risk Analysis for Ecological Processes, Biodiversity and Species Assemblages

Ecosystem-based fisheries management takes into account the effects of fishing on parts of the system other than the harvested species, and acknowledges that effects on these other parts of the system may also have consequences for targeted species. The aim of ecosystem-based fisheries management is to ensure that the marine ecosystem, including its component populations, habitats and ecological processes, is maintained so that it supports viable and sustainable fisheries (Pitcher and Pauly, 1998). This section will begin by discussing the ecological processes and biodiversity of the waters in which the fishery operates. Then the risk analysis framework described in section B2.1 will be applied to those ecological processes and biodiversity to determine the risk of an unsustainable fishery and how well it meets the aim described by Pitcher and Pauly (1998). Species assemblages will be restricted to planktonic assemblages and will be discussed within ecological processes as the two are intrinsically linked. Other species assemblages will be addressed in other related sections of this chapter. Vertebrate assemblages will be covered in the sections for biodiversity (section B2.3), primary and key secondary species (section B2.4) and protected and threatened species (section B2.5). Sessile invertebrates, macroalgal assemblages and benthic motile invertebrates (e.g. sea urchins, crabs, marine worms) were discussed in the section for marine habitats.

B2.3.1 Ecological processes and biodiversity associated with the OTLF

B2.3.1.1 Ecological processes

The scientific discipline of Ecology is concerned with quantifying the patterns of distribution and abundance of living organisms and the processes that create those patterns. An ecological process, broadly defined, is any biological process that may affect the ecology of finfish and shellfish populations, biodiversity, and the environment in which these populations live. Ecological processes can be identified at the level of individual organisms (e.g. interactions such as competition, predation, commensalism, mutualism, parasitism, physiological effects of temperature, light, nutrient availability on individual organisms) but ecologists are generally concerned with the cumulative effects of such interactions at the population or assemblage level. Theoretical understanding at the population level is made tractable by distilling the combined effect of many processes into population parameters such as birth rate, mortality rate, and various coefficients of interaction strength (e.g. competition coefficients). Understanding these cumulative effects at the assemblage level becomes an increasingly complex task, because it involves understanding large numbers of ecological processes, each of which may interact with other processes, and each of which is subject to its own natural variability. Another set of ecological processes, often identified at the "ecosystem" level, results from the cumulative effects of individual and population level interactions. Ecosystem level processes include primary production, secondary production, energy flow through the food web, and the cycling of nutrients. These processes cannot be identified at the level of individuals because they are complex, involving multiple interactions between multiple organisms. Such processes are also difficult to predict based on the structure of the system, and are often referred to as "emergent properties" of the system.

Ecological processes provide the link between different states of a species population or assemblage, and between different components of the system. For example, secondary production is the result of consumption of primary producers (photosynthetic organisms) and its conversion into biomass of secondary producers. The process of growth links the state of eggs or larvae of an organism to its juvenile state (see Fig B2.2). If these processes are inhibited, impaired or changed in some way there could be knock-on or indirect effects to other species, assemblages and ecological processes. For example, frequent disturbance (natural or from commercial fishing) could decrease secondary production through the removal of secondary producers, which would make less food available to higher trophic levels. Figure B2.4 illustrates in a simplistic model how natural events and human activities can influence ecological processes and how they affect species assemblages and populations. The natural event of increasing sea temperatures may act on the eggs of a species by affecting their development and hatching. This may increase the proportion of eggs reaching the larval stage because warmer temperatures may provide a more favourable environment for egg development than cooler temperatures. On the other hand the fishing activity of harvesting will act on the adult spawning stocks of a species by decreasing numbers of fish able to spawn. This may eventually reduce recruitment back into the adult population because over time there may be a decrease in the number of recruits due to the decrease in the spawning stocks.

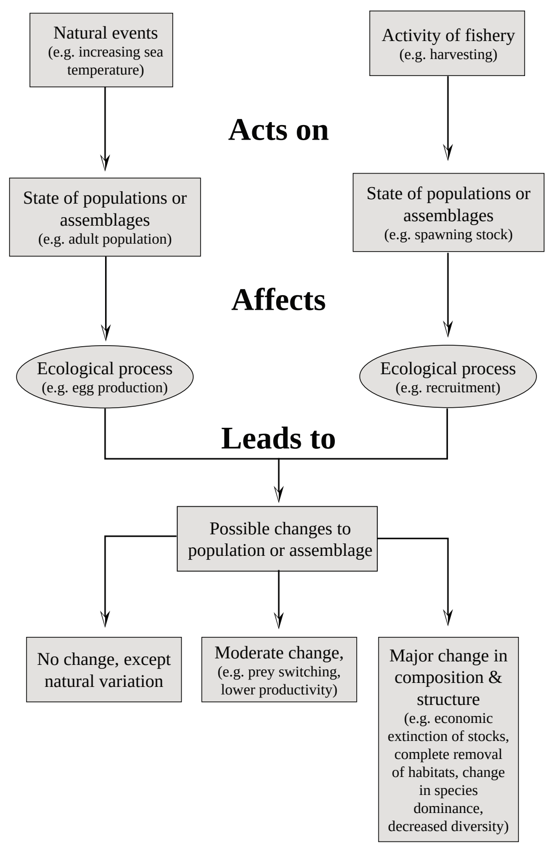


Figure B2.4 Flow diagram illustrating how both natural events and human activities affect ecological processes in the marine environment.

B2.3.1.2 Biodiversity

Biodiversity includes diversity within and between species, and diversity of ecosystems (see Table B2.6). Gray (2000) provides an extensive review of the different types of marine diversity and how they are measured. For the purposes of this discussion, biodiversity will be confined to the diversity within and between species.

Marine species diversity in Australian oceanic waters is very rich. At the broad taxonomic level of plants, vertebrate and invertebrate species diversity shows a latitudinal division. For example, of the 3400 species of marine fish in Australia, over half, 1900 species, occur in northern tropical waters. Many of these are common to the Indo-west Pacific region (Poore, 1995). The southern temperate waters have fewer species but they contain a very high degree of endemic fish species, 85% compared to 10% in the northern tropical waters (Table B2.10) (Poore, 1995).

Table B2.10 Percentage of endemic species found in northern tropical and southern temperate marine waters of Australia for a few broad taxonomic groups.

Group	**Region**	
	Northern tropical	Southern temperate
Fish	13	85
Molluscs	10	95
Echinoderms	10	90
Sponges	47	71

Other broad taxonomic groups show even stronger latitudinal patterns of endemism. Species of molluscs (95%) and echinoderms (90%) found in southern temperate marine waters have high rates of endemism (Poore, 1995; Ponder *et al.*, 2002). Marine macroalgae are 90% endemic to Australian temperate waters (Phillips, 2001). Because the NSW coastal and oceanic waters stretch from the southern temperate region to the northern tropical region it would be expected that these waters would reflect the above broad scale patterns of species diversity, including a high degree of endemism in southern waters.

Studies of species diversity on the continental slope, shelf and oceanic waters of NSW is very patchy, limited to a few major taxa and localised areas (e.g. fish – Gray and Otway, 1994; Connell and Lincoln Smith, 1999; and Andrew *et al.*, 1997; and for sponges - Roberts and Davis, 1996; and Hooper *et al.*, 2002). Apart from these studies there is very little information about the magnitude and characteristics of species diversity for the oceanic waters in which the OTLF operates. However, at a broad spatial scale a large proportion of marine species are unique to Australian waters. Added to this is the fact that there are still many undescribed and undiscovered species, especially marine invertebrates (Ponder *et al.*, 2002), because large areas of Australia's EEZ have not yet been explored (including large parts of the NSW continental shelf and slope). Therefore, the level of species diversity and endemism could be even in greater in NSW oceanic waters.

B2.3.2 Risk identification

The potential sources and categories of risk at the broad-scale of ecosystems for ecological processes and biodiversity were previously identified and summarised in Table B2.8. This section will examine ecological processes and biodiversity at a finer ecological scale by identifying the important aspects needed to sustain these ecosystem components. Table B2.11 lists and defines these aspects for ecological processes. In addition, there are two broad aspects needed to sustain biodiversity, namely ecological processes (see Table B2.6) and habitat diversity and connectivity. Habitat diversity and connectivity refers to the diverse range of marine habitats (geological, biogenic, water column) and their connectivity, which is important for mitigating the risk of localised extinctions.

Table B2.11 List of important aspects needed to sustain ecological processes relevant to the marine environment and the potential impacts on them from commercial fishing.

Process/aspect	Description	Potential impacts from commercial fishing
Nutrient cycling	The manner in which nutrients move through an ecosystem. For example, the release of nutrients, such as nitrate and phosphate, from organic matter by decomposers, to be harnessed by phytoplankton to produce organic matter.	Harvesting biomass removes nutrients from system. Large-scale oceanic factors such as currents and upwellings provide nutrients into coastal waters.
Primary production	Primary production is a process that converts the sun's energy into carbon compounds that are then available to other organisms. As such it is the single most important factor for potential catches and productivity. Much primary productivity in marine systems is produced by phytoplankton.	Pollutants from the fishing fleet may have an adverse impact on phytoplankton. If the pollution is extensive it is possible that the amount of primary production can be decreased.
Food webs	The network of feeding relationships within an ecosystem or assemblages of species, e.g. the predator-prey relationships.	Removal of major predators and/or prey may lead to changes in species composition and structure of assemblages; tendency to fish down to lower trophic levels
Species interactions	Positive and negative interactions between species that favour or inhibit mutual growth and functioning of populations. Interactions may take the form of competition, predation, parasitism, commensalism or mutualism.	Reduction of predators may increase prey species which may lead to increased competition within populations and among assemblages; depletion of habitat may intensify species interactions competing for limited food and refuges
Spawning sites & spawning aggregations	The type of habitat required by a fish species for spawning (i.e. release of ova, fertilized or to be fertilized) The process of grouping of fish for releasing of ova and fertilisation	Damage to habitats may reduce availability of spawning and/or pupping sites. The targeting of spawning aggregations makes commercial fishing practices more efficient, which in turn can lead to overfishing.
Dispersal of propagules/larvae	A movement of early life history stages away from the place of birth. Larval transport can be active (a combination of orientated larval behaviour and swimming) or passive (a direct result of current transport e.g. pelagic eggs).	Pollutants from the fishing fleet may have an adverse impact on planktonic eggs and larvae. If the pollution is extensive it is possible that mortality rates may be high.
Recruitment (larval/juvenile recruitment into populations and sub-adult recruitment into fished stocks)	Larval/juvenile recruitment is the process by which juveniles of mobile fish species and sessile invertebrates complete the planktonic phase of their life history, settle from the plankton and become part of a non-planktonic population of juveniles and adults. Recruitment into fished stocks is the process by which fish enter the exploitable stock and become susceptible to fishing. The process may be short but for most species takes more than one year.	Severe depletion of spawning stock may reduce the number of recruits available to join adult stocks.
Growth	The increase in size (biomass) of a fish per year (or season).	Overfishing of prey species may lead to reduction in food available for growth
Distribution & movement	The movements of fish from feeding ground to spawning ground and back again, from nursery ground to feeding ground, and from spawning ground to nursery ground. This may be seasonal and/or stochastic over various spatial scales.	Reduction in distribution or quality of habitats may result in species having to travel further to suitable areas, increasing energy expenditure.

B2.3.3 Risk characterisation

Determining the level of risk to ecological processes and biodiversity from the activities of the OTLF is hampered by our limited understanding of how ecological processes function in the oceanic waters of eastern Australia. For example, we do not know the diversity, extent or distribution of habitats on the continental shelf off NSW or what fish populations and assemblages are associated with them. Nor do we know the fishing intensity being exerted on the specific habitats and what effect this may have on ecological processes and biodiversity. This lack of knowledge about the activity (source of risk) and the system in which it takes place means it is very difficult to determine the level of risk posed by the fishery.

Despite these obvious shortcomings, qualitative risk levels for OTLF-related impacts on ecological processes (Table B2.12) and biodiversity (Table B2.13) will be determined from collective expert opinion by integrating the available information about ecological processes and biodiversity with relevant information from commercial fisheries in other parts of the world. It is important to remember that during this finer detail assessment only harvesting has been considered, as it was the only aspect of the fishery previously identified (Table B2.8) as of moderate or greater risk to ecological processes and biodiversity. Discarding, contact but not capture, ghost-fishing, bait use, disturbance and boat operations were of low or negligible risk and accepted with an appropriate justification (section B2.2).

B2.3.3.1 Ecological processes

Table B2.12 summarises the level of risk that harvesting (for sale and as bait for personal use) has on the many important aspects needed to sustain ecological processes. In some marine environments, harvesting has been shown to impact food webs and species interactions by causing changes to predator/prey relationships (Christensen 1996, Jennings and Kaiser 1998, Pitcher and Pauly 1998). The removal of top predators (i.e. keystone species) can result in an increase in the biomass of prey populations as they are released from predation pressure (Christensen, 1996; Reynolds *et al.,* 2002). The strength of the evidence for predator-based control of prey species abundance varies in different aquatic environments and according to different spatial scales (Jennings and Kaiser 1998). The evidence for predator-prey coupling is strongest in some low diversity systems (e.g. freshwater lakes) and weakest in high diversity systems (e.g. coral reefs) **-** (see Jennings and Kaiser 1998 for a review). There does not appear to be a tight coupling of predators and prey among the demersal fish assemblages of the south-eastern Australian continental shelf. Bulman *et al.,* (2001) found that the diets and trophic groups of 70 demersal fish species on the continental shelf of southeastern Australia were very diverse. Overall, the diet of the fish assemblage was equally split between benthic and pelagic prey species, and there was no single apex predator species that played a key role in shaping the prey species assemblages. Consequently, harvesting of certain key predator species may not severely affect trophic relationships in this system. Nevertheless, the removal of a large biomass of predators could be considered likely (without invoking any keystone effect) to have some effect on the biomass of smaller forage fish species, but such effects have not been measured in NSW waters.

Commercial fishing may also lead to a practice known as fishing down the food chain, which has occurred in many overseas fisheries (Pitcher and Pauly, 1998). The practice involves harvesting of progressively smaller, less valuable species as the larger, more valuable species decline, with a number of knock-on effects for other parts of the ecosystem. Targeting species at lower trophic levels could reduce the availability of prey, causing further declines in large predator abundance. This can then lead to the release of more fish at lower trophic levels, which may then be targeted by fishers (Pitcher and Pauly, 1998). Fishing down the food chain is considered unlikely in NSW because the primary and key secondary species targeted by the OTLF are primarily predators, and although it also catches species from lower trophic levels and catch levels of targeted species have fluctuated over time, there has not been a distinct shift to targeting species from the lower trophic levels. The OTLF catches a variety of species with a range of life-history characteristics. Commercial fishing practices can change the species composition and size frequency of demersal fish assemblages (Andrew *et al.*, 1997, Sainsbury *et al.*, 1997). These changes to the structure of demersal fish assemblages can occur because species that are larger, slower growing and late maturing (e.g. elasmobranchs) will decline to a greater extent than smaller, faster growing species (Gislason, 2002; Link *et al.*, 2002; Kirkwood, *et al.*, 1994; Jennings *et al.*, 1999).

Any process that removes large amounts of nutrients from the marine ecosystem must have an effect on nutrient cycles. The activity of harvesting (for human and/or animal consumption) removes large amounts of biomass from the marine ecosystem and this impact is long-term. However, the ecosystem effects of harvest fisheries on nutrient cycling are largely unknown. Accordingly, we have taken a precautionary approach and assessed the activity of harvesting as having a higher risk level for potentially impacting nutrient cycles in the marine environment (see Table B2.12).

Planktonic organisms (e.g. phytoplankton, zooplankton and ichthyoplankton) can be impacted by commercial fishing activities and thus it is possible that ecological processes occurring in the plankton could become degraded. The risk level for these types of fishery-related impacts on primary production and the dispersal of planktonic propagules/larvae was previously assessed as negligible to low because of the relatively small size of the fishing fleet and the dilution effect of relatively small discharges into a vast area.

The impacts of commercial fishing activities on the recruitment, growth, distribution and movement, spawning sites and spawning aggregations are discussed in detail for primary and key secondary species (section 2.4) and for protected and threatened species (section 2.5).

Table B2.12 Summary of qualitative risk levels for each important aspect needed to sustain ecological processes that are attributable to harvesting in the fishery.

Aspects needed to sustain ecological processes	**Harvesting catch (for sale)**	**Harvesting catch (not sold - bait for personal use)**
Primary production	-	-
Food webs	H	H
Nutrient recycling	H	-
Species interactions	H	H
Spawning sites and spawning aggregations	M	M
Dispersal of propagules/larvae	-	-
Recruitment (larval/juvenile recruitment into populations & sub-adult/adult recruitment into fished stocks)	H	H
Growth	H	H
Distribution & movement	M	M

RISK LEVELS: Dash = Negligible; L = Lower risk; M = Moderate risk; H = Higher risk.

B2.3.3.2 Biodiversity

Table B2.13 summarises the level of risk that the various activities of the OTLF pose on many important aspects needed to sustain biodiversity. The two most important aspects needed to sustain biodiversity are ecological processes (discussed above) and habitat diversity and connectivity (Table B2.13). Marine biodiversity is believed to be linked to the proper functioning of ecosystems (Naeem, 2002). Generally, the greater the number of species the greater the capacity of the ecosystem to function normally. Some ecologists believe that species biodiversity is essential for ecosystem functioning (see review by Naeem, 2002). If species diversity is decreased then the ecosystem function will also be impaired in some manner. However, there are few demonstrated examples of links between species diversity and ecosystem function (see Duarte, 2000 and references therein). Duarte (2000) suggests that ecosystem function is strongly correlated with the types of species in an area, rather than simply the numbers of species because the functions they provide are species-specific. Duarte (2000) found that it was the variability in species size in seagrass assemblages that was correlated to functional variability in seagrass ecosystems, rather than the number of species. Even so, Duarte (2000) suggested the possibility that diverse assemblages in ecosystems may have many "unrealised functional potentials" that may be essential to the sustainability of an ecosystem in the face of chronic disturbance. Further, these studies have only examined linkages and relationships as opposed to proving any causal link between biodiversity and ecosystem functions.

Habitat diversity and connectivity are important aspects needed to sustain biodiversity. Habitat diversity is important because many species use different habitats during different stages of their life cycle. For example, most fish species have a pelagic larval phase, many fish species use seagrass habitats as nursery areas, and adults often use many different types of habitat structure. Thus, the loss or reduction of habitat diversity could lead to changes in the structure of fish assemblages as the populations of some strongly habitat-specific taxa may decrease, whilst the populations of habitat-generalists may either increase or remain stable. Habitat connectivity, a linkage among habitats for fish that occurs by larval dispersal and juvenile or adult migration, provides a buffer against severe localised impacts from environmental (e.g. storms/cyclones) or human causes (e.g. oil spills or the effects of fishing). This buffering effect is important for the long-term persistence of marine assemblages in an area.

The impacts of commercial fisheries on biodiversity depend on the spatial and temporal scales that are considered in the assessment. Studies of commercial fisheries in other parts of the world and Australia have shown that effects on biodiversity differ depending on the taxonomic group, area studied, intensity of fishing, spatial and temporal scale and how diversity was measured (Gray, 2000). Whilst it is unclear what the actual role of biodiversity is in the sustainability of ecosystems, the current consensus of ecologists is that caution should be exercised when allowing activities in oceanic environments that change or diminish this biodiversity over an extended period of time and space.

The risk to the viability of the OTLF and to the marine ecosystem in NSW waters is that they may become increasingly less productive. The temporal and spatial scales and degree of change over which this could occur is unknown, and until there is information about the extent and intensity of the fishery, such change could not be estimated. There is sufficient evidence from other parts of the world with significantly larger commercial fisheries than the OTLF that damage to marine ecosystems may lead to irreversible losses of biodiversity, including some economically important fish species (e.g. Fu *et al.*, 2001). The possibility that this could occur in NSW should not be ruled out, especially given the large number of species that are retained in this fishery by relatively non-selective fishing methods, which is more likely to reduce biodiversity than damage to ecosystems resulting from the operations of the fishery.

Table B2.13 Summary of qualitative risk levels for each important aspect needed to sustain biodiversity that is attributable to harvesting.

Aspects needed to sustain biodiversity	**Harvesting catch (for sale)**	**Harvesting catch (not sold - bait for personal use)**
Ecological processes	H	H
Habitat diversity and connectivity	-	-

B2.3.4 Issues arising from the risk assessment of ecological processes, biodiversity and species assemblages

B2.3.4.1 Lack of knowledge for adequate management

It is evident that there is an inadequate knowledge base on which to determine effective management action. Research is needed in the following areas:

1) describing and understanding the way ecological processes function and their linkage to: (a) biodiversity; (b) habitats; (c) primary, key secondary and secondary species; and (d) other species assemblages

2) describing and understanding spatial and temporal distribution patterns for: (a) biodiversity; (b) habitats; (c) primary, key secondary and secondary species; and (d) other species assemblages in the fishing grounds and adjacent areas used by the OTLF

3) describing and understanding the association between different habitat types and fish assemblages (commercial and non-commercial) in the fishing grounds and adjacent areas used by the OTLF

4) spatial and temporal extent of OTLF fishing grounds and the level of intensity of commercial fishing on these grounds

Lack of knowledge in these areas is an impediment to the ability of management to significantly reduce the risk arising from fishery-related impacts. The lack of knowledge about ecological processes, their linkage to major ecological components of the ecosystem (i.e. biodiversity, habitats and species assemblages) and the association between habitats and fish assemblages inhibits our ability to adequately manage exploited fish populations and other assemblages. This has been clearly demonstrated in the case of the changed composition and structure of the exploited fish assemblage on the North West Shelf of Australia (Sainsbury, 1988; Sainsbury *et al.*, 1997). Commercial trawling was responsible for widespread habitat modification on the North West Shelf, which in turn led to major changes in the relative composition of the multispecies fish assemblage because of the habitat dependence of some species (Sainsbury *et al.*, 1997). Had this habitat dependence been known earlier, then not only could major habitat degradation have been minimised but the high value exploitable fish assemblage could also have been sustained for the benefit of the fishery.

The long term sustainability of the exploitable fish assemblages harvested by the OTLF will be jeopardised without more detailed knowledge of the ecological processes upon which they depend. One thing that is clear in this fishery is that it retains a considerable number and different types and sizes of species, and although many are retained in very small amounts, it indicates that if ecosystem functioning is dependent upon biodiversity, then there is considerable potential for an impact. To reduce the risk of deleterious ecosystem impacts, the draft FMS could limit the number of species allowed to be retained by the fishery, or similarly establish an annual quota (as a percentage of total catch) for all species other than the primary or key secondary species of the fishery. Such measures have been introduced in other commercial fisheries in NSW, namely the Lobster Fishery and the Ocean Hauling Fishery. Such measures are simpler to adopt in the more targeted Ocean Hauling Fishery, but their use in the Lobster Fishery, which uses the same traps as the OTLF, indicates that they can be applied to the OTLF.

Several studies have advocated the use of an adaptive management approach to filling such knowledge gaps (Walters, 1986; Williams, 1999; Sainsbury *et al.*, 2000). It is recommended that major management actions be proposed in the draft FMS using a rigorous and robust scientific method, such as that which underpins adaptive management (Walters, 1986; Underwood, 1995). This type of approach will provide the best opportunity to systematically address knowledge gaps in the OTLF whilst implementing precautionary management initiatives at the same time. It is acknowledged that the collection of such information, and in that particular fashion, is both expensive and requires a long-term commitment of resources, which is likely to be beyond this fishery alone. There is clearly a need at the fishery level to balance such research on these factors against other research priorities of the fishery, and that a greater commitment to fill such knowledge gaps needs to be addressed across all fisheries and involve multiple levels of government.

B2.3.4.2 Ensure management measures are sufficiently precautionary

The high level of uncertainty generated from the large knowledge gaps associated with ecological processes, biodiversity and species assemblages means that management measures need to be precautionary. Consequently, the draft FMS should ensure the proposed management regime will provide the best possible chance for degraded ecosystem components to recover in the face of an unexpected catastrophic event. Several recent reviews of precautionary management for marine fisheries and how it can be achieved should be used in determining optimal ways that this approach could be used for the OTLF (Okey and Harrington, 1999; Auster, 2001; Gerrodette *et al.*, 2002; Agardy, *et al.*, 2003).

B2.4 Risk Analysis for Primary, Key Secondary and Secondary Species

This section is divided into five main parts. The first part provides a summary of biological information for the primary and key secondary species in the OTLF.

The second part examines fishery information, including the quality of the available fishery data, historical production trends for the primary and key secondary species, production of all species taken in the OTLF during 2001/02 (the most recent year for which data are complete and checked for gross errors), catches of primary and key secondary species in other NSW fisheries and in adjacent jurisdictions, and discard information for commercial species taken by the OTLF.

The third part describes the major potential impact of the fishery on its commercial species, that of overfishing.

The fourth part re-analyses the risks to the primary and key secondary species from harvesting and discarding that were identified in section 2.2 (see Table B2.8), but at a finer scale. This process facilitates the identification and characterisation of sources of risk that are relevant for better understanding of the potential impacts of the OTLF.

The fifth part summarises the main issues arising from the risk analysis for primary, key secondary and secondary species.

B2.4.1 General biological information for primary and key secondary species

A review of all available biological information was undertaken for the primary and key secondary species taken in the OTLF (see Tables B2.14 and B2.15). Information derived from studies done in NSW waters was preferentially sought to describe the biological characteristics of the NSW stocks of finfish and invertebrates. Biological information from other areas (e.g. New Zealand, South Africa, other Australian states) was used whenever data from NSW were not available. The "best available information" derived at a coarser taxonomic resolution (generic or family or order level) was in some cases used to infer general biological traits or characteristics such as reproductive modes and strategies.

An examination of Tables B2.14 and B2.15 shows that major information gaps exist for many primary and key secondary species taken by the OTLF. The paucity of basic biological and ecological information for so many primary and key secondary species, while common in fisheries worldwide, should be of great concern to fisheries managers. Information gaps lead to increased scientific uncertainty for proposed management outcomes, which in a precautionary framework, must be treated as a higher risk.

Table B2.14 Biological information summaries for primary species taken by the Ocean Trap and Line Fishery.

Common name and taxonomic name	Distribution	Reproductive strategy	Size at maturity	Age at maturity	Longevity	Growth rate	Yield per recruit	Egg per recruit
Yellowtail kingfish *Seriola lalandi*	Qld, NSW, Vic., SA, WA, Tas. & NZ	Pelagic eggs and larvae Fecundity: Unknown, assumed to be millions	83 cm FL (50% ♀) 47 cm FL (50% ♂); 94 cm FL (50% ♀) & 81 cm (50% ♂) FL in New Zealand	1 year (50% males)	Long lived Max. age 21+ yrs	Rapid growth for juveniles reach 60 cm TL in 2 years	Existing MLL of 60 cm set below the optimum yield length	Unknown
Snapper *Pagrus auratus*	Qld, NSW, Vic., SA, WA, NZ & Indo-Pacific	Pelagic eggs and larvae Serial spawner Fecundity: up to 22.5 million	22 cm FL (50%) 33 cm FL (100%)	2 years (50%) 5 years (100%)	Long lived Max. age 35+ yrs	Rapid growth for juveniles, slow thereafter	Existing MLL of 30 cm set below the optimum yield length	Unknown
Leatherjackets Monacanthidae (various spp.)	All Australian states, NZ	Demersal eggs - pelagic larvae Fecundity - Max about 2 million*	31 cm (100%)*	3-4 years*	Probably short lived. 9+ years (females)* 7+ years (males)*	Probably fast. Mean growth of 28 cm in 2 years*	Unknown for NSW fish	Unknown for NSW fish
Silver trevally *Pseudocaranx dentex*	All Australian states, NZ	Pelagic eggs and larvae 220,000 to 1 million eggs (moderate fecundity) serial spawners	18-26 cm FL	2-6 years	Long lived Max. age 25-30 yrs & ~ 65 cm	Rapid growth for juveniles, slow thereafter	Optimum size at first capture >30 cm FL	Unknown
Australian bonito *Sarda australis*	Qld, NSW, Vic., Tas., & NZ	Tunas have pelagic eggs and larvae. Fecundity: Unknown for *S. australis*, others known to have high fecundity (millions of eggs)	Unknown	Unknown	Probably short lived Max. 5+ years for *S. sarda*	Probably fast. *S. sarda* has fast growth	Unknown	Unknown
Blue-eye trevalla *Hyperoglyphe antarctica*	Southern circum-global	Pelagic eggs and larvae Fecundity - High, from 1.3-11 million eggs, with exponential increase with length of females	62 cm FL ♂ 71 cm FL ♀	~ 8-9 years for males ~11-12 yrs for females	Max. age 40+ years,	Juveniles have rapid growth	Current age at first capture estimates at 2-3 years (45-55 cm FL) in OTLF & SEF, i.e. immature, newly recruited fish	Unknown
Rubberlip morwong *Nemadactylus douglasii*	Qld, NSW, Vic., Tas., & Northern NZ	Pelagic eggs and larvae - congeneric species have an extended pelagic larval stage Fecundity - Unknown	Unknown	Unknown	Long lived >20 years	Slow growth	Unknown	Unknown

Table B2.14 cont.

Common name and taxonomic name	**Stock structure**	**Stock recruitment relationship**	**Spawning season**	**Spawning areas**	**Movements and migration**	**Natural mortality (M/year)**	**Fishing mortality (F/year)**	**Comments**	**References**
Yellowtail kingfish *Seriola lalandi*	Population in eastern Aust considered a single stock	Unknown	Spring to Summer; GSI highest Oct-Jan	Unknown - assumed to be in deep offshore waters	Tagging studies show some fish make large-scale movements (>500 km). Anecdotal evidence that older fish move offshore.	Total mortality (Z) estimated to be 35% to 55% per year. Natural mortality estimated to be 20% of Z, i.e. 7% to 11%.	Fishing mortality estimated to be 80% of total mortality, i.e. 28% to 44%.		Gillanders *et al.*, 1999a & 2001, Stewart *et al.* 2004, Poortenaar *et al.* 2001, Smith *et al.* 1991
Snapper *Pagrus auratus*	Several stocks around Aust. One east coast stock.	Unknown	Winter to Spring	Coastal waters	Tagging studies show some east coast fish make large-scale movements (>200 km). Most fish move only short distances.	0.08 to 0.15	0.2 to 1.1		Kailola *et al.*, 1993, Ferrell and Sumpton 1997
Leatherjackets Monacanthidae (various spp.)	Unknown for NSW fish	Unknown	Varied (species dependent) Autumn*	Coastal and offshore waters (most spp.)	Unknown for most species. Chinaman jacket juveniles found in estuaries and inshore bays. Adults found in deep offshore waters*	Unknown for NSW fish 40-45% in 1989 for South Australian fish*	Unknown for NSW fish Estimated 24% in 1989 for South Australian fish*	The asterisk * denotes information for the chinaman leatherjacket (*Nelusetta ayraudi*). Biological characteristics are unknown for most species.	SPCC 1981, Grove-Jones and Burnell 1991, Kailola *et al.*, 1993
Silver trevally *Pseudocaranx dentex*	Uncertain	Unknown	Spring to Autumn	Coastal waters	Unknown	Unknown in OTLF, Z of 0.4-0.6 and M of 0.1 in SEF	Unknown for OTLF, 0.3-0.5 in SEF		Rowling & Raines 2000, SPCC 1981, Smith & Wayte, 2002
Australian bonito *Sarda australis*	Unknown	Unknown	Unknown	Coastal and offshore waters.	Unknown	Unknown	Unknown	Biology of *Sarda australis* is unknown. Inferences are drawn from other tuna species, particularly *Sarda sarda*.	Collette and Nauen 1983, Hutchins and Swainston 1993
Blue-eye trevalla *Hyperoglyphe antarctica*	Single Australian stock	Unknown	April to June off NSW	see comments column	Near seabed during day and disperse throughout water column at night	Unknown for OTLF, Z of ~ 0.2-0.3 and M of 0.1 in the SEF dropline fishery	Unknown for OTLF, ~ 0.1-0.2 in the SEF	Indications are that spawning is widespread and takes place on Continental slope grounds and offshore seamounts	Horn 1988, Baelde 1996, Smith & Wayte 2002, Central Ageing Facility unpub.
Rubberlip morwong *Nemadactylus douglasii*	Unknown	Unknown	Unknown	Coastal & Offshore waters	Unknown	Unknown	Unknown		Doug Ferrell (unpublished data), Kailola *et al.*, 1993

Table B2.14 cont.

Common name and taxonomic name	**Distribution**	**Reproductive strategy**	**Size at maturity**	**Age at maturity**	**Longevity**	**Growth rate**	**Yield per recruit**	**Egg per recruit**
Yellowfin bream *Acanthopagrus australis*	Qld, NSW, Vic	Pelagic eggs and larvae Fecundity - Unknown Probably similar to *A. butcheri*, 3 million eggs	21 cm FL male 24 cm FL female	Variable 22 cm FL fish from NSW ranged from 2 to 10+ years	Long lived 22+ years	Variable, slower after maturity. Females grow faster and attain a greater maximum length.	Unknown	Unknown
Bar cod *Epinephelus ergastularius*	Uncertain due to taxonomic uncertainty South-West Pacific, Qld, NSW, Vic	Pelagic eggs and larvae Fecundity - Unknown	Unknown - could be 70 to 80 cm FL for females which is ~ 6-8 kg	Unknown	Unknown - probably long-lived	Unknown - probably slow - grows to at least 157 cm TL and 66 kg	Unknown - current average size at first capture estimates of 60 cm FL (4 kg) suggests catch is primarily made up of immature females, and thus low proportion are likely to reach male stage (assumes that like most epinephelids, bar cod are protogynous hermaphrodite)	Unknown
Gummy shark *Mustelus antarcticus*	NSW, Vic, Tas, SA, WA.	Ovoviviparous Fecundity (1-38 pups) mean = 14	80 cm TL males 85 cm TL females	Unknown	Medium lived 16 years	Slow growth	Unknown	Unknown
Spanner crab *Ranina ranina*	Widespread Indo-Pacific, Qld, NSW, WA.	Eggs attached to female until hatching. Larvae are pelagic. Fecundity 100,000 to 200,000 eggs per year.	70-75 mm CL females	2 years	Long lived when compared to other crustaceans 9+ years	Slow growth	Unknown	Unknown

Table B2.14 cont.

Common name and taxonomic name	Stock structure	Stock recruitment relationship	Spawning season	Spawning areas	Movements and migration	Natural mortality (M/year)	Fishing mortality (F/year)	Comments	References
Yellowfin bream *Acanthopagrus australis*	Single stock along east coast of Australia	Unknown	Winter-Summer	Coastal waters	Pre-spawning migration from estuarine to coastal waters and along the coast. Tagging studies show some fish travel large distances (>500 km).	Unknown	Unknown		SPCC 1981, Kailola *et al*., 1993, Gray *et al*., 2000
Bar cod *Epinephelus ergastularius*	Unknown	Unknown	Unknown	Coastal and offshore waters	Unknown	Unknown	Unknown	Species-specific biological characteristics unknown. Other large epinephelid groupers are protogynous hermaphrodite (all fish females first then change sex to male at larger sizes).	Hutchins and Swainston 1993, Pogonoski *et al*. 2002, Heemstra and Randall 1993, Rowling 1996
Gummy shark *Mustelus antarcticus*	Single stock in southern Australia	Unknown	Spring & Summer	Coastal waters	Tagging studies show some sharks move large distances	11-18% per year	Unknown		Kailola *et al*. 1993, Last and Stevens 1994
Spanner crab *Ranina ranina*	East coast stock is highly likely to be a single reproductive stock	Unknown	Spring to Summer	Coastal waters	Unknown	Unknown	Unknown	Biomass-dynamic model suggests current annual harvests in NSW are sustainable but because of larval transport patterns the health of the NSW population is dependent on that in Qld.	Brown 1986, Kennelly *et al*., 1990, Kailola *et al*., 1993, Kennelly and Watkins 1994, Chen and Kennelly 1999, Kennelly and Scandol 1999 and 2002

Table B2.15 Biological information summaries for key secondary species taken by the Ocean Trap and Line Fishery.

Common name and taxonomic name	Distribution	Reproductive strategy	Size at maturity	Age at maturity	Longevity	Growth rate	Yield per recruit	Egg per recruit	Stock structure
Sharks (mixed species)* Elasmobranchs (various spp.)	All Australian states, NZ	Ovoviviparous, Fecundity (15-43 pups) mean = 30[S] Viviparous, Fecundity (3-14 pups)[D]	140 cm TL Females, Males smaller[S] 280 cm TL[D]	12 years females[S] 14-18 years[D]	Long lived 55+ years[S] 35+ years[D]	Slow growth	Unknown	Unknown	A southern Australian stock[S] Unknown[D]
Wobbegong sharks *Orectolobus ornatus* and *O. maculatus*	Qld, NSW, Vic, SA, WA, New Guinea	Ovoviviparous Fecundity 20+ pups	*O. ornatus;* 63 cm males (?), 175 cm females: *O. maculatus* 60 cm males (?)	Unknown	Unknown, probably long lived, grows to ~320 cm (*maculatus*) or 288 cm (*ornatus*)	Unknown Probably slow growth	Unknown	Unknown	Unknown
Silver sweep *Scorpis lineolatus*	Qld, NSW, Vic, Northern NZ	Pelagic eggs and larvae Fecundity - Unknown	Unknown	Unknown	Long lived >50 years	Slow growth	Unknown	Unknown	Unknown
Mulloway *Argyrosomus japonicus*	Widespread Indo-Pacific, WA, SA, Vic, NSW, Qld, Japan, Korea, South Africa	Pelagic eggs and larvae Fecundity - at least 1 million eggs	75 cm TL	6 years	Long lived 30+ years	Fast growth based on aquaculture data	Unknown	Unknown	Single stock in eastern Australia
Gemfish *Rexea solandri*	Cape Moreton (QLD) to central WA & New Zealand	Pelagic eggs and larvae Fecundity - Max 5 to 6 million eggs	75 cm FL	5-6 yrs	Medium longevity Max. age 17 yrs	Fast growth	Unknown	Unknown	SE Australian stock (eastern Vic. & Tas. & NSW)
Teraglin *Atractoscion aequidens*	Angola to South Africa NSW, Qld	Pelagic eggs and larvae Fecundity - Unknown	Unknown for Australian population. South African fish: 90 cm FL (50%) 93 cm FL (100%)	Unknown for Australian population. South African fish: 5 years (50%) 6 years (100%)	Short to Medium lived 9+ years for South African fish	Slow after maturity - South African fish	Unknown	Unknown	Unknown
Jackass morwong *Nemadactylus macropterus*	Southern Indian and Pacific Oceans - NSW, Vic, Tas, SA, WA, NZ,	Pelagic eggs and larvae distributed by EAC and STCZ. Specialised pelagic juvenile form. Fecundity - > 1 million eggs (mean for 10 year old fish)	25 cm FL females 27 cm FL males for 50% maturity in eastern Tasmanian waters	3 years (both sexes)	Long lived: 50+ years in NZ waters; recent ageing in Australian waters of 30 years for females and 41 years for males	26 cm after three years, then slows markedly	Unknown	Unknown	Uncertain, could be 3, including a NSW/Vic stock, or a single southern Australia stock

Table B2.15 cont.

Common name and taxonomic name	Stock recruitment relationship	Spawning season	Spawning areas	Movements and migration	Natural mortality (M/year)	Fishing mortality (F/year)	Comments	References
Sharks (mixed species)* Elasmobranchs (various spp.)	Unknown	Summer[S] Year round with a Summer peak[D]	Inshore coastal waters	Inshore movements of females to have pups [S,D]	10% per year[S] Unknown[D]	Unknown	[S] denotes information for the school shark (*Galeorhinus galeus*). [D] denotes information for the dusky whaler (*Carcharinus obscurus?*). Biological characteristics for these taxa are used as general indicators for all shark taxa in this group.	Kailola *et al.*, 1993, Last and Stevens 1994
Wobbegong sharks *Orectolobus ornatus* and *O. maculatus*	Unknown	Unknown	Coastal waters	Unknown	Unknown	Unknown	Preliminary results of reproductive studies have shown that there are likely to be 3 wobbegong species taken by the OTLF.	Last and Stevens 1994, N. Otway NSWDPI, pers. comm. Compagno 1984 & 2001, Cavanagh *et al*., 2003
Silver sweep *Scorpis lineolatus*	Unknown	Winter	Coastal waters	Unknown	Unknown	Unknown		Dedual and Pankhurst 1992, John Stewart (unpublished data)
Mulloway *Argyrosomus japonicus*	Unknown	Summer - Autumn	Coastal waters	Tagging studies show some fish make large-scale movements (>500 km).	Unknown	Unknown	FRDC-funded study in progress by NSW DPI	SPCC 1981, Hall 1986, Battaglene and Talbot 1994, Griffiths and Hecht 1995a, Steffe and Neira 1998
Gemfish *Rexea solandri*	Unknown	Winter	Upper slope waters in central/north NSW	Mature fish aggregate off north-east Bass Strait before migrating northwards along the upper slope (300-400m depth) to spawning grounds in central-north NSW	0.6 to 0.7 males 0.45 to 0.55 females	Not reported	Fishing mortality estimates have been used in an age and sex structured population dynamics model but are not reported separately.	Kailola *et al.*, 1993, Rowling and Makin 2001
Teraglin *Atractoscion aequidens*	Unknown	Summer (larvae found in NSW coastal waters)	Coastal waters	Unknown for Australian population. South African fish undergo age-related migrations along the eastern South African seaboard	Unknown	Unknown	Biological information mainly derived from South African studies	Hutchins and Swainston 1993, Griffiths and Hecht 1995b, Steffe and Neira 1998.
Jackass morwong *Nemadactylus macropterus*	Unknown	Summer to Autumn	Mid to outer shelf waters	Older juveniles actively disperse from nursery areas (inner shelf) to adult (mid & outer shelf) habitats.	Unknown in OTLF, 0.1 in SEF	Unknown in OTLF, 0.1 in SEF		Vooren 1977, Smith 1982, Smith 1983, Kailola *et al.*, 1993; Jordan 1999 & 2001a&b, Bruce *et al*., 2001

Table B2.15 cont.

Common name and taxonomic name	Distribution	Reproductive strategy	Size at maturity	Age at maturity	Longevity	Growth rate	Yield per recruit	Egg per recruit	Stock recruitment relationship
Dolphin fish *Coryphaena hippurus*	Circum-global in tropical waters, Atlantic, Indian, Pacific Oceans	Pelagic eggs and larvae Fecundity - Unknown Batch spawners - at least 2-3 times per spawning period Max batch fecundity about 1.5 million eggs	43 cm FL males 45 cm FL (50% females) 55 cm FL (100% females)	4-7 months	Short lived Max age 5+ years	Fast growth	Unknown	Unknown	Unknown
Spotted mackerel *Scomberomorus munroi*	Southern New Guinea, Qld, NSW, NT, WA.	Pelagic eggs and larvae. Fecundity - Unknown	50-55 cm FL (50% females) 40-45 cm FL (50% males)	2 years for females 1 year for males	Short lived 5+ females 7+ males	Fast growth Females grow faster and larger than males	Not reported	Not reported. Instantaneous egg count estimate at 50 cm TL 94,000 eggs	Unknown
Pearl perch *Glaucosoma scapulare*	Rockhampton in Qld south to about Port Jackson in NSW	Eggs and larvae undescribed. Presumed to have pelagic eggs and larvae on basis of closely related taxa (Family level comparisons). Fecundity - 700,000 Max	25-30 cm FL (females)	2-3 years	Medium lived 14 years max	Slow growth - maximum size about 70 cm TL	Unknown	Unknown	Unknown
Hapuku *Polyprion oxygeneios*	Southern circum-global - Aust., NZ, Chile, South Africa	Pelagic eggs and larvae Fecundity - Unknown Not hermaphroditic like large Epinephelid groupers.	85 cm (50%) males 88 cm (50%) females	10-13 years (both sexes)	Long lived Max. recorded 63 years	Probably similar to that of bass groper	Unknown	Unknown	Unknown
Bass groper *Polyprion americanus*	North and South Atlantic, Southern Indian, Mediterranean Sea, South-west Pacific	Pelagic eggs and larvae Fecundity - Unknown Not hermaphroditic like large Epinephelid groupers.	80-90 cm TL	8-10 years	Long lived, 76 & 62 years for male & female resp., southwestern Atlantic fish	Rapid at first, 40 cm TL at 1 year, then slow, ~ 60 cm TL at 4 years & 100 cm at 8-12 years	Unknown	Unknown	Unknown
Black-spot pigfish *Bodianus unimaculatus*	South-west Pacific, Qld, NSW, Vic, NZ	Pelagic eggs and larvae Fecundity - Unknown	Unknown	Unknown	Unknown Probably medium to long lived	Unknown Probably slow growth	Unknown	Unknown	Unknown
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Widespread Indo-Pacific, WA, NT, NSW, Qld	Pelagic eggs and larvae Fecundity - Unknown Spawning occurs several times over a season (2-6 days apart)	East coast fish 72-79 cm FL (females) 65 cm FL (males)	about 2 years	Medium lived 10+ males 14+ females	Fast growth (particularly in juveniles, females grow faster than males)	Unknown	Unknown	Unknown

Table B2.15 cont.

Common name and taxonomic name	**Stock structure**	**Spawning season**	**Spawning areas**	**Movements and migration**	**Natural mortality (M/year)**	**Fishing mortality (F/year)**	**Comments**	**References**
Dolphinfish *Coryphaena hippurus*	Unknown	Extended period - year round in tropical waters	Offshore waters	Seasonal migrations southward along NSW coast are linked to movement of warm water in Summer and Autumn.	High Total annual mortality estimated to be more than 98%	Unknown	Most biological information comes from Atlantic Ocean fish.	Beardsley 1967, Palko *et al.*, 1982, Oxenford 1999, Kingsford and Defries 1999
Spotted mackerel *Scomberomorus munroi*	A single stock	August to October in North Qld waters Winter to Spring	Coastal waters	Extensive seasonal migrations - north in Winter and south in Summer	Not reported	Not reported	Total mortality and annual mortality rates used in population modelling. Survival rate of 0.36 females and 0.56 males.	Begg *et al.* 1997, Begg *et al.* 1998, Cameron and Begg 2002
Pearl perch *Glaucosoma scapulare*	Unknown	October to May	Coastal & Offshore waters	Unknown - diurnal pattern thought to be from deeper shelf water (90m) to shallow offshore waters near reefs	Unknown	Unknown		McKay 1997, Wayne Sumpton (personal communication)
Hapuku *Polyprion oxygeneios*	Unknown	Unknown	Offshore waters	Switch from pelagic to demersal life at about 50 cm and 3 years age	Unknown	Unknown	Biological information derived mainly from New Zealand studies	Johnson 1984, Roberts 1989, Francis *et al.*, 1999
Bass groper *Polyprion americanus*	3 stocks - North & South Atlantic, South Pacific (Aust & NZ)	Unknown	Offshore waters	Only inter-basin migrations Switch from pelagic to demersal life at about 45-55 cm and 1-3 years age	Unknown	Unknown	Biological information derived mainly from North American & New Zealand studies	Johnson 1984, Roberts 1989, Sedberry *et al.*, 1996 & 1999, Francis *et al.*, 1999; Ball *et al.*, 2000; Peres and Haimovici 2004
Black-spot pigfish *Bodianus unimaculatus*	Unknown	Unknown	Coastal and offshore waters	Unknown	Unknown	Unknown	Biological information inferred from knowledge of other Labrid species, particularly *Achoerodus viridis*	Leis and Rennis 1983, Kuiter 1993, Gillanders 1995a and b
Narrow-barred Spanish mackerel *Scomberomorus commerson*	Northern Great Barrier Reef to NSW forms an Australian East coast stock	Spring to Summer	Coastal waters - near reefs at the inner edge of the Great Barrier Reef	Some fish undertake seasonal migrations covering large distances (>1000 km) whilst some other fish remain resident on reefs.	Unknown	Unknown		Shaklee *et al.*, 1990, McPherson 1992, McPherson 1993, Kailola *et al.*, 1993

Footnote: * Elasmobranchs (various spp.) - includes whalers, dogfishes, hammerheads, mako, tiger, angel sharks, fiddler/banjo sharks, saw sharks, Port Jackson sharks, ghost sharks, shovel nose sharks, and all catches reported as unspecified/mixed shark.

B2.4.2 General fishery information

B2.4.2.1 Quality of commercial fishery data used in the assessment

The NSW commercial fishery data used in the risk assessment of primary and key secondary species in the OTLF were extracted from the NSW DPI catch database. Mandatory monthly catch return forms filled out by commercial fishers are the primary data source for the NSW DPI held within the database. The records in this database are continually updated as current and historical catch return forms are received and corrections are made when reporting or data entry errors are detected. Thus, catch data from different data extractions may vary because of the continual additions and corrections made to the database.

Commercial catch data for a 30 year period (1972/73 to 2001/02) were used to describe trends in total production (estuarine and marine combined) for the primary and key secondary species taken by the OTLF (see B2.4.2.2). The data sources used to describe these commercial production trends were: (a) Pease and Grinberg (1995) for the period 1972/73 to 1983/84; and (b) a database extraction done during late October 2003 for the period 1984/85 to 2001/02.

The quality of the data used for the assessment of the OTLF has major limitations. Three major factors have compromised the accuracy of, or ability to compare, these data: (1) changes in form design; (2) the lack of independent verification of monthly catch return data; and (3) jurisdictional issues between the NSW and Commonwealth governments. Whilst these difficulties with the database are recognised it is also acknowledged that the current catch database is the only available long-term data of reported landed catch for the OTLF. In accordance with the precautionary principle (Myers and Mertz, 1998), limitations in the data can't be used as a reason to avoid assessment of the fishery. Consequently, to complete the assessment, the database information was used in conjunction with "expert judgement" and advice from industry to provide an overview of the trends in reported landings and effort, but only tentative conclusions were drawn from these trends. Catch data are more reliable than the effort data, but subsets of effort data can, and have been extracted under careful consideration.

Changes in form design

There have been many significant changes to the catch return forms during the 30 year period for which production trends were examined (see B2.4.2.2). The changes have delivered a continuous improvement in data collected by seeking more detailed information and/or making the forms more user-friendly for fishers. Table B.2.16 provides a detailed summary of these changes in form design and the issues involved with interpreting the data that are relevant to species taken by the OTLF.

Form changes have provided better taxonomic resolution of catches (more separate species listed), improvements in the reporting of fishing effort data and the partitioning of catch by area, linking of catch and fishing method (and therefore effort), and the collection of data specific to individual restricted fisheries. Unfortunately, long-term production trends should be viewed with caution, as there are many shortcomings in the historical dataset that cannot be corrected. For example, processing information for catches (e.g. gutted, filleted, whole) was not collected prior to July 1997. This means that historical production data are likely to under-estimate whole weights for some species. Since July 1997, gross correction factors have been available to convert processed catches into whole weights. The catch data used in this assessment include pre-1997 data that cannot be corrected for processing effects. Thus, the 30 year production trends have not been corrected for process method.

Table B2.16 Summary of changes in monthly catch return form designs and related data interpretation issues.

Form Used and Relevant Period	**Requested Information and Form Changes**	**Data Interpretation Issues**
Extra-territorial waters (Form 48) 1972/73 to 1976/77	Catch information from waters outside 3 nautical miles for 35 categories of finfish and invertebrates. Port of landing.	Self-reported catch data. Most taxonomic groupings contain multiple species. No fishing effort data requested. Catch rates estimated from these data are based on catch per reported fisher month, where the effort unit is derived from the presence/absence of a monthly catch return not the actual amount of fishing done within a month. Fishing methods used are not identified. Port of landing is not a reliable location reference for extra-territorial fisheries (Pease and Grinberg 1995)
Inshore ocean and estuary waters (Form 50) 1972/73 to 1976/77	Catch information from inshore ocean waters (inside 3 nautical miles) and from estuarine waters for 45 categories of finfish and invertebrates. Area in which main quantity of fish captured. Prawn catches from ocean and estuarine waters are requested separately.	Self-reported catch data. Most taxonomic groupings contain multiple species. No fishing effort data requested. Catch rates estimated from these data are based on catch per reported fisher month, where the unit of effort is derived from the presence/absence of a monthly catch return not the actual amount of fishing done within a month. Fishing methods used are not identified. Multiple estuaries and inshore areas may have been fished during the month but these are assigned to the nominated "main area".
Ocean and estuary waters (Form 49) 1977/78 to 1989/90	Inclusion of more taxonomic categories. Catch information from all ocean waters for 53 categories of finfish and invertebrates. Zone fished (10 ocean zones at 1 degree of latitude intervals). Port of landing. Catch information from all estuarine waters for 45 categories of finfish and invertebrates. Name of estuary, tidal river, bay, tidal lake or tidal inlet fished. Total number of days fished during the month (all waters and methods combined). Main fishing method used during the month (all waters combined but separated for fish and prawns)	Self-reported catch data. Some taxonomic categories contain multiple species. Catch and fishing effort data are not partitioned by area fished or method used, except when only a single method and/or area is fished during a month. Thus, the effort data may amalgamate catches and fishing effort from multiple ocean zones and/or estuaries and from multiple methods. Multiple fishing methods may have been used during the month but all catch and effort is assigned to the nominated "main fishing method".
Ocean waters (Form 19 - Vers. 1) July 1990 to December 1991	Ocean and estuarine data collected on separate forms (see Form 19 Estuarine waters - Version 1). Inclusion of more taxa - 88 categories of finfish and invertebrates listed on form. Catch reporting for unlisted species permitted.Zone fished (10 ocean zones at 1 degree of latitude intervals). Separate monthly form to be lodged for each ocean zone fished during a month. Port of landing. Total number of days fished for each fishing method used during the month.	Self-reported catch data. Some taxonomic categories contain multiple species. Reporting catches of unlisted species is probably inconsistent within the fishery (between and among fishers). Post-reporting modification for catch validation. "Fish, mixed" category is used frequently making catch records for other taxa less accurate. Catch data are not partitioned by method used, except when only a single method is used during a month. Fishing effort data may be over-reported when multiple methods are used during the same day. That is, three methods used during one day may be reported as one day of fishing for each method used. Forced introduction of forms was not used, i.e. change over uncertainty from Form 49 to Form 19

Table B2.16 cont.

Form Used and Relevant Period	**Requested Information and Form Changes**	**Data Interpretation Issues**
Estuarine waters (Form 19 - Ver. 1) July 1990 to December 1991	Estuarine and ocean data collected on separate forms (see Form 19 Ocean waters - Version 1). Inclusion of more taxa - 51 categories of finfish and invertebrates listed on form. Catch reporting for unlisted species permitted. Separate monthly form to be lodged for each major estuary fished during a month. Total number of days fished for each fishing method used during the month. Number of days when more than one method used.	Self-reported catch data. Some taxonomic categories contain multiple species. Reporting catches of unlisted species is probably inconsistent within the fishery (between and among fishers). "Fish, mixed" category is used frequently making catch records for other taxa less accurate. Catch data are not partitioned by method used, except when only a single method is used during a month. Fishing effort data may be over-reported when multiple methods are used during the same day. That is, three methods used during one day may be reported as one day of fishing for each method used.
Ocean waters (Form 19 - Vers. 2) Jan 1992 to June 1997	Revised form layout and more detailed instructions. Inclusion of more taxa - 146 categories of finfish and invertebrates listed on form. Catch reporting for unlisted species permitted. Zone fished (10 ocean zones at 1 degree of latitude intervals). Separate monthly form to be lodged for each ocean zone fished during a month. Port of landing. Total number of days fished for each fishing method used during the month.	Same issues as per Ocean waters (Form 19 - Version 1)
Estuarine waters (Form 19 - Vers. 2) Jan 1992 to June 1997	Revised form layout and more detailed instructions. Inclusion of more taxa - 80 categories of finfish and invertebrates listed on form. Catch reporting for unlisted species permitted. Separate monthly form to be lodged for each major estuary fished during a month. Total number of days fished for each fishing method used during the month. Number of days when more than one method used.	Same issues as per Estuarine waters (Form 19 - Version 1)
Restricted fisheries (7 separate forms) July 1997 to 2001/02	Separate forms for each of the 7 restricted fisheries: Estuary general; Estuary prawn trawl; Ocean hauling; Ocean prawn trawl; Fish trawl; Ocean trap and line; and Inland. Separate catch and effort information for each restricted fishery by method. Processing information (e.g. whole, gutted, filleted, bait for personal use) for each taxon/method/ocean zone/estuary fished combination. The Ocean Trap and Line monthly catch return form requests catch information for 63 separate categories of finfish and invertebrates. Additional taxa have been added. Catch reporting for unlisted species permitted.	Self-reported catch data. Some taxonomic categories contain multiple species. Reporting catches of unlisted species is probably inconsistent within the fishery (between and among fishers).

Lack of independent verification of monthly catch return data

The commercial catch return data are self-reported by commercial fishers and the size and the identification of the declared landed catches have not been fully verified by independent observation since 1994/95. Prior to that, catch returns were checked by Fisheries Officers and they maintained a system of catch cards. That system ceased in 1995 so as to refocus compliance effort into field-based operations. So primarily, the accuracy of these data depend entirely on the honesty and competence of the commercial fishers.

Commercial fishers were required to satisfy certain criteria based on their past catch history for entry into the seven restricted fisheries, including the Ocean Trap and Line Fishery. Catch histories for the calendar years 1986 to 1993 were used, among other things, to determine a fisher's eligibility for entry into a restricted fishery. The catch records from this period are often referred to as "validated catch histories", however, the process involved only a limited validation of catches against market records. Instead, the outcome of the consultation process was an "agreed catch history" that was then used to determine entitlements and entry into the restricted fishery. The update, where necessary, of the database to include all of these "agreed catch histories" in electronic form is still incomplete.

Jurisdictional issues between the NSW and Commonwealth governments

In 1986, a memorandum of agreement was entered into between NSW Agriculture and Fisheries (now DPI) and the Australian Fisheries Service (now AFMA) which allowed fishers endorsed to operate in the South East Trawl Fishery (now the South East Fishery – SEF) to submit Form 49 catch returns (see Table B.2.16) without giving catch weights for each species (Pease and Grinberg 1995). Instead, these SEF endorsed fishers were allowed to report a total catch weight incorporating all species. This data was entered into the database as "Finfish, other". Many other SEF-endorsed fishers reported their catches by species on the Form 49 catch returns, however, these catches were taken outside NSW waters.

A further, more recent complication has occurred because NSW minimum legal lengths (MLL) do not apply to the Commonwealth-managed fishery (i.e. the SEF) and this has allowed the landing of small fish, although MLL were originally adhered to by Commonwealth fishers. These jurisdictional issues have had a large impact on the accuracy of the NSW catch records.

B2.4.2.2 Long-term (30 year) production trends for primary and key secondary species across all commercial fisheries

Long-term production trends (1972/73 to 2001/02) were examined so that the impacts arising from the current operation of the OTLF could be put into a realistic perspective. Historical catch data have many short-comings that cannot be corrected (see B2.4.2.1 for a summary). Consequently, the 30-year production trends discussed in this section are based on self-reported commercial catch data that have not been corrected for processing method because this type of data correction is only possible post-July 1997. Data from all NSW commercial fisheries have been combined because fishery-specific data are not available prior to July 1997 (discussed below).

The long-term production trends discussed below should be interpreted with caution because the many confounding factors influencing the data quality make it impossible to identify any "cause and effect" relationship. For example, declines in fish production could be due to a variety of factors, including but not limited to:

a) a reduction in stock size due to overfishing

b) a reduction in fishing effort due to structural changes in the fishery, or

c) a combination of these and other factors.

Figures B2.5 and B2.6 graphically illustrate the annual commercial production for up to the last 30 years for the primary and key secondary species of the fishery, respectively. Species for which the OTLF accounts for less than 90% of the commercial catch also show the OTLF catch over the period 1997-02, e.g. trevally and bream (discussed below). Catch-per-unit-effort (CPUE) data is also provided for the principal method used to catch a species within the OTLF, and does not necessarily reflect the CPUE for that species in all fisheries that catch it.

There are a variety of ways of presenting CPUE, and in the kingfish graph, three methods have been shown: Sum CPUE, which is simply total production for a year over the total number of days fished; Average CPUE , which is the average across all fishers for a year; and Median CPUE, which is the CPUE figure of a fisher for which there are as many values greater than it as there are less than it. In terms of trying to determine when there has been a significant shift in CPUE for the purposes of setting catch trigger points, the Median provides a more stable (relatively) and representative calculation than either the Sum or Average. For that reason, only the Median CPUE is presented for the other species.

Primary species

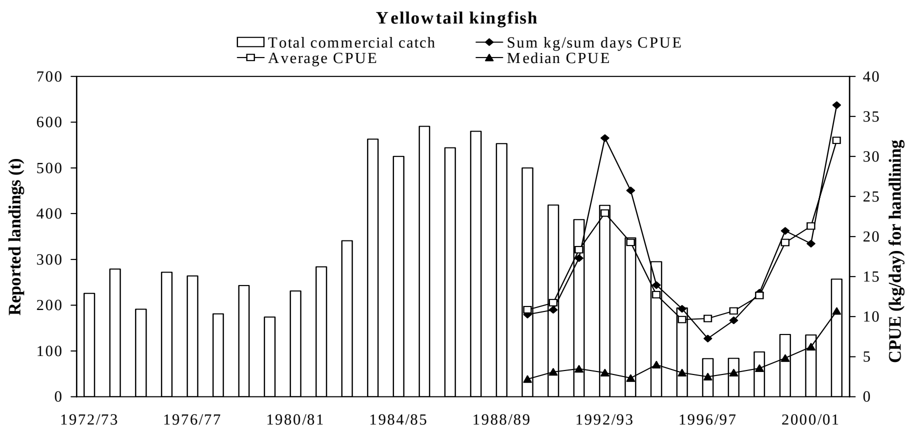
Production across all commercial fisheries has declined over the long-term for 8 of the 11 primary species: kingfish, snapper, silver trevally, Australian bonito, blue-eye trevalla, rubberlip morwong, yellowfin bream and spanner crab (Figure B2.5, Appendix B1). The 2001/02 production figure expressed as a percentage of the historical highest catch ranged from 7.0% (rubberlip morwong) to 46.0% (yellowfin bream) for this group of taxa. Catch-per-unit-effort within the OTLF was highly variable over the period for which data is available, with five of 11 increasing and six showing a general decline in CPUE over that period.

Kingfish data needs to be treated more cautiously than most, as management changes are likely to have significantly contributed to the variable, but generally declining landings. In 1990, a MLL of 60 cm total length was imposed. Further, in 1996, pelagic traps were banned, which back then were the principle method by which the species was caught. Encouragingly, production and CPUE figures appear to be steadily increasing since 1996, but the 2001/02 figure still only represents approximately 43% of the highest historical figure of almost 600 tonnes in 1985/86.

Of those eight species that have shown a continual decline in production, rubberlip morwong and bonito have not yet had an appraisal of their exploitation status ('undefined' in Table B1.4). A cursory appraisal based solely on the presented catch and CPUE data would suggest that at best, those species are fully fished and possibly overfished. Additional data and analysis, in the form of historical size and age composition of landings, is required before an assessment of overfished could be determined for any species. The DPI has collected this information for some species and is in the process of completing more detailed stock assessments.

Production and CPUE appears to be relatively stable or increasing for the other three primary species, namely leatherjackets, gummy shark and particularly for bar cod (Figure B2.5). Production of bar cod has shown a fairly continuous increase over the last 20 years and the 2001/02 figure was almost the highest for the species. Bar cod have not as yet had an appraisal of exploitation status, and given their probable high take in the recreational fishery and uncertain taxonomic status, it would appear timely to investigate the species. Gummy shark appears stable, however, the historical peak catches for this species probably occurred prior to its separate listing on catch return forms. The CPUE for trotlining for gummy shark is highly variable, with a marked increase in the last 10 years, but a drop over the last five. It must be emphasised that the specification of fishing effort by method is difficult prior to July 1997, when the catch-effort forms were modified to gather this information.

In many cases below, there is a clear proportional relationship between catch and CPUE. This can be interpreted in a number of ways. First, it may suggest that fishers are "harvesting to abundance", that is, whenever fish are significantly abundant such that fishing becomes economical, they are targeted. When these species are not present, or the density is too small, then fishers target other species. An alternative explanation is that the effort data (measured in days) are at too coarse a scale to measure actual fishing activity (e.g. data should be collected by hook or by pot-lift) and that the effort data are uninformative and CPUE simply mirrors commercial landings.



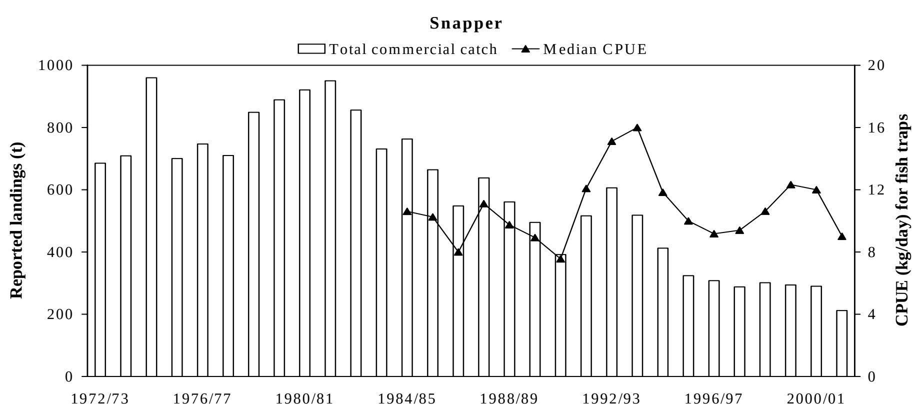


Figure B2.5 Annual production trends (tonnes) and CPUE (kg/day) for the major method by which the primary species are taken in the OTLF, from 1972/73 - 2001/02.

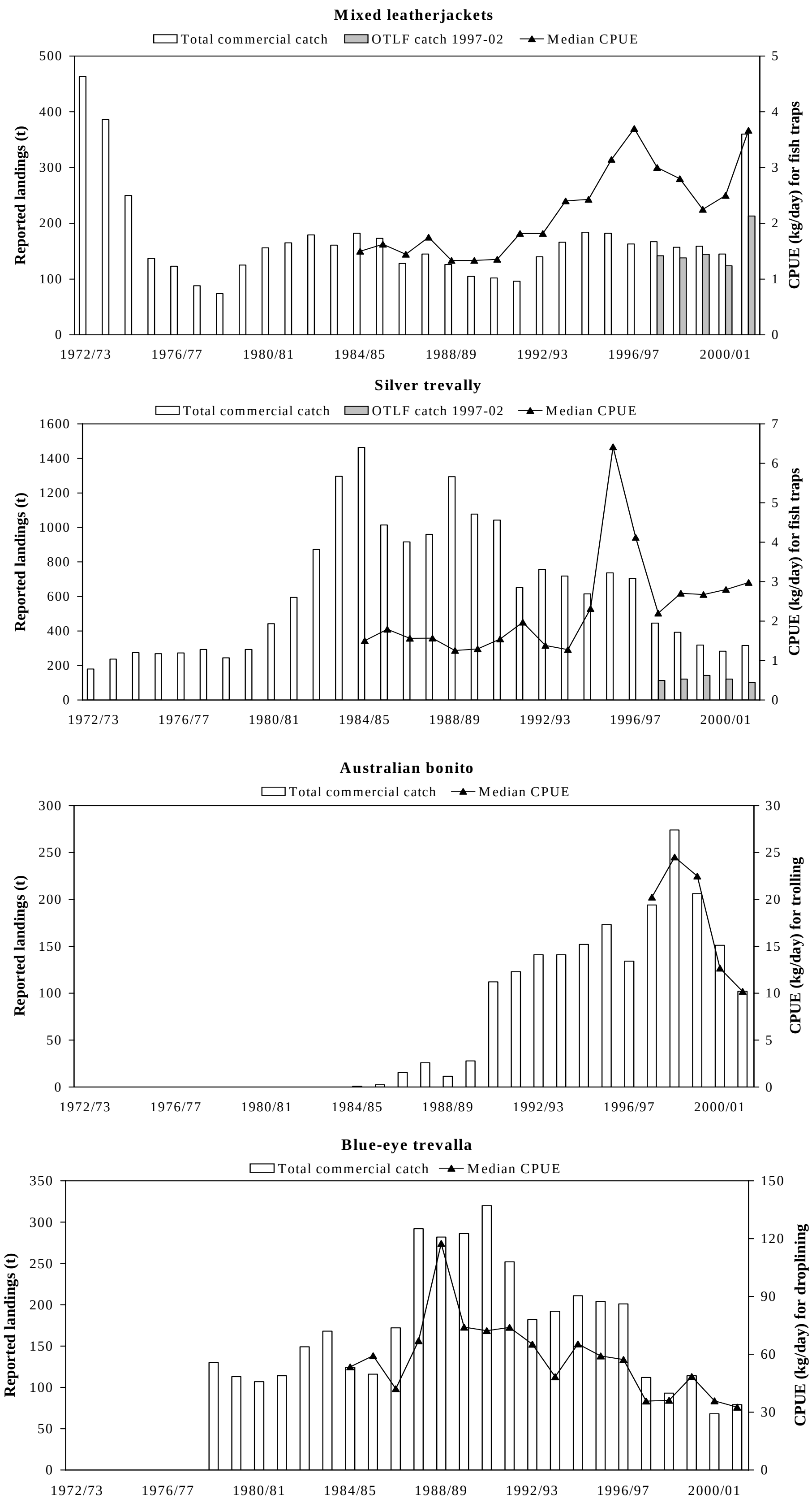


Figure B2.5 cont. - production and CPUE for the primary species

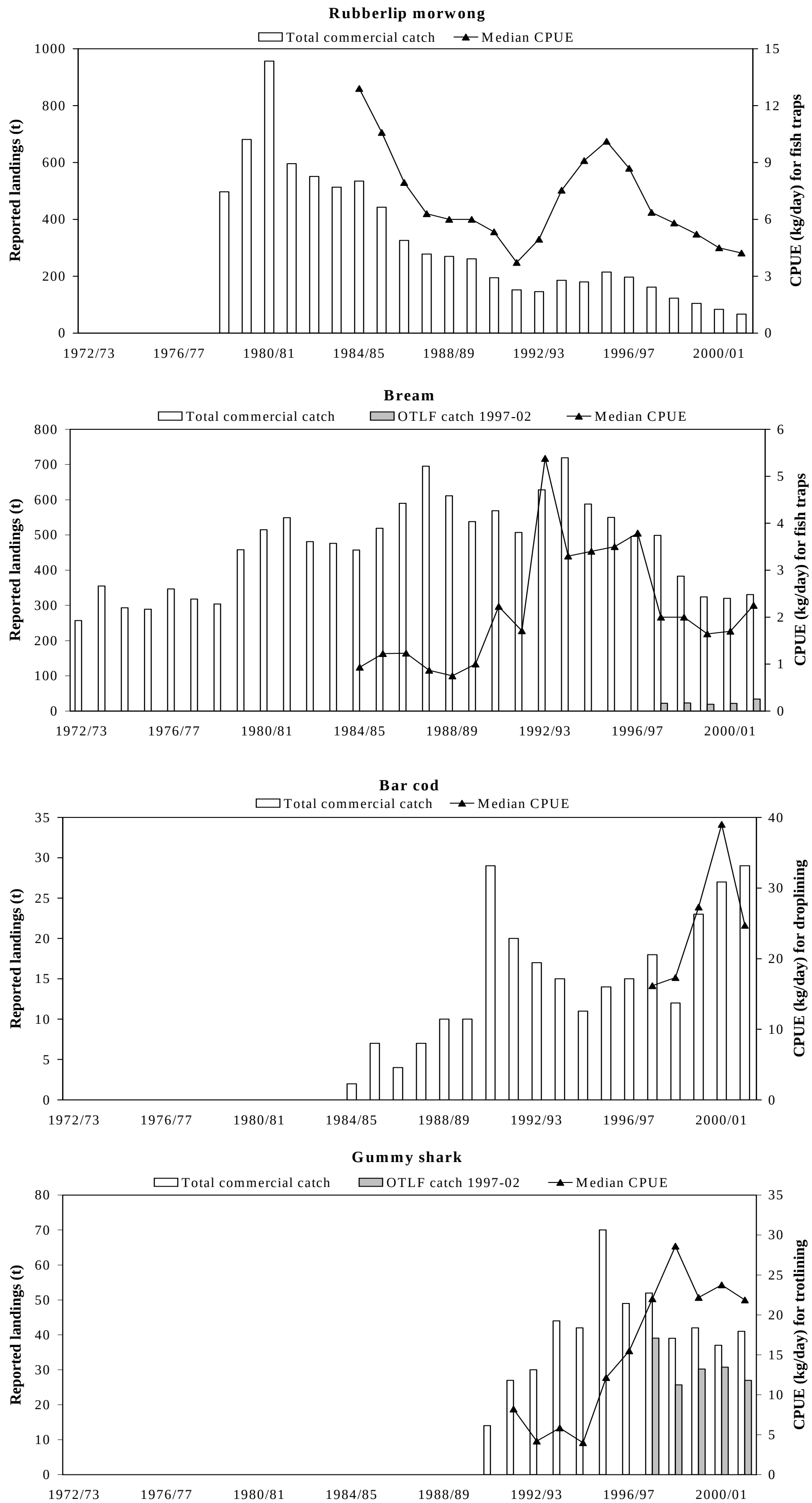


Figure B2.5 cont. - production and CPUE for the primary species

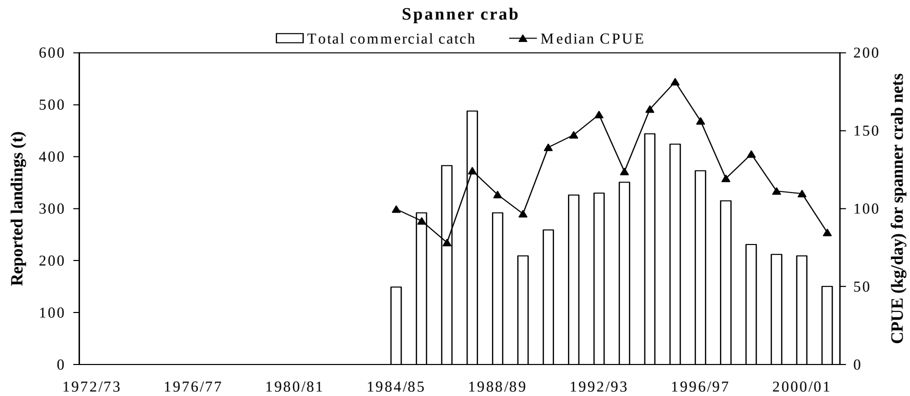


Figure B2.5 cont. - production and CPUE for the primary species

Key secondary species

As with most of the primary species, total production across all fisheries has declined for 12 of the 14 key secondary species: sharks (mixed spp.), wobbegong sharks, silver sweep, mulloway, gemfish, teraglin, jackass morwong, spotted mackerel, hapuku and bass groper (reported as such prior to 1997 and there are known identification issues with these species), black-spot pigfish and narrow-barred Spanish mackerel (Figure B2.6, Appendix B1). Catch-per-unit-effort for those species has been highly variable, but appears to be increasing for five species, stable for eight and only decreasing in sweep. The sharp rise in CPUE for gemfish between 1991 and 1998 and subsequent fall represents the imposition of 50 kg/day trip limits that apply to commercial catches of gemfish. The 2001/02 production figure expressed as a percentage of the historical highest catch ranged from 0.4% (gemfish) to 59.8% (wobbegongs) for this group of taxa.

Production and CPUE has been highly variable for dolphinfish and pearl perch, showing no apparent trend (Figure B2.6). The 2001/02 production figure expressed as a percentage of the historical highest catch for these species was 41.7% and 52.9% respectively. No key secondary species showed an increase in production (Figure B2.6).

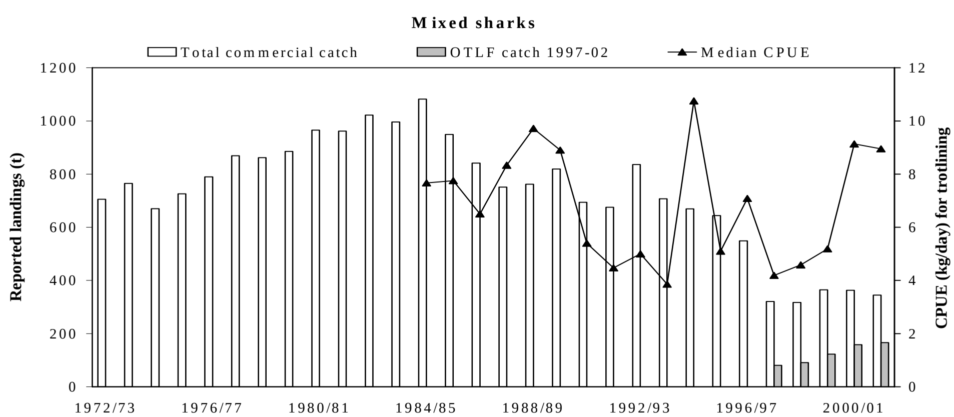


Figure B2.6 Annual production trends (tonnes) and CPUE (kg/day) for the major method by which the key secondary species are taken in the OTLF, from 1972/72 - 2001/02.

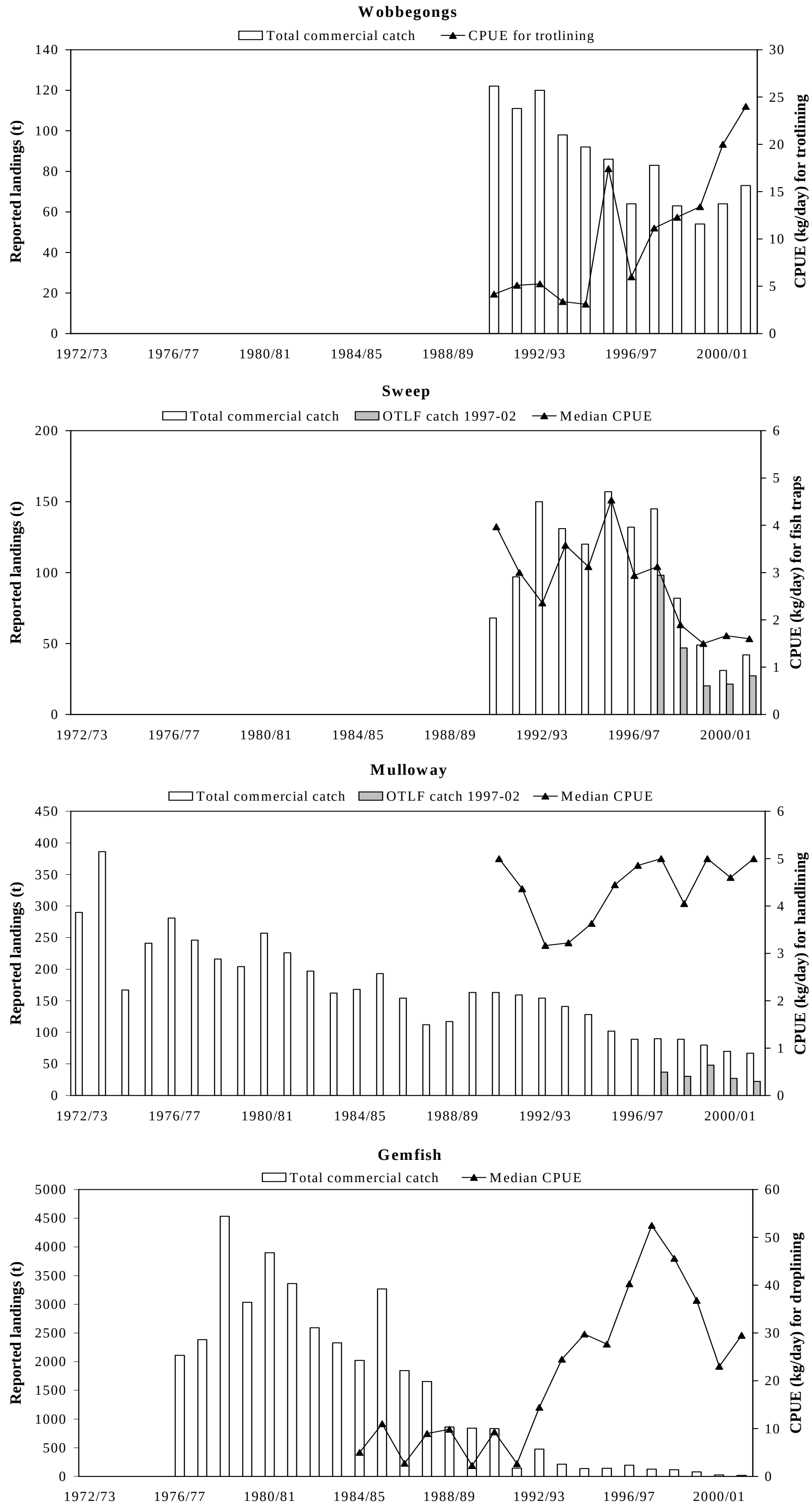


Figure B2.6 cont. - production and CPUE for the key secondary species

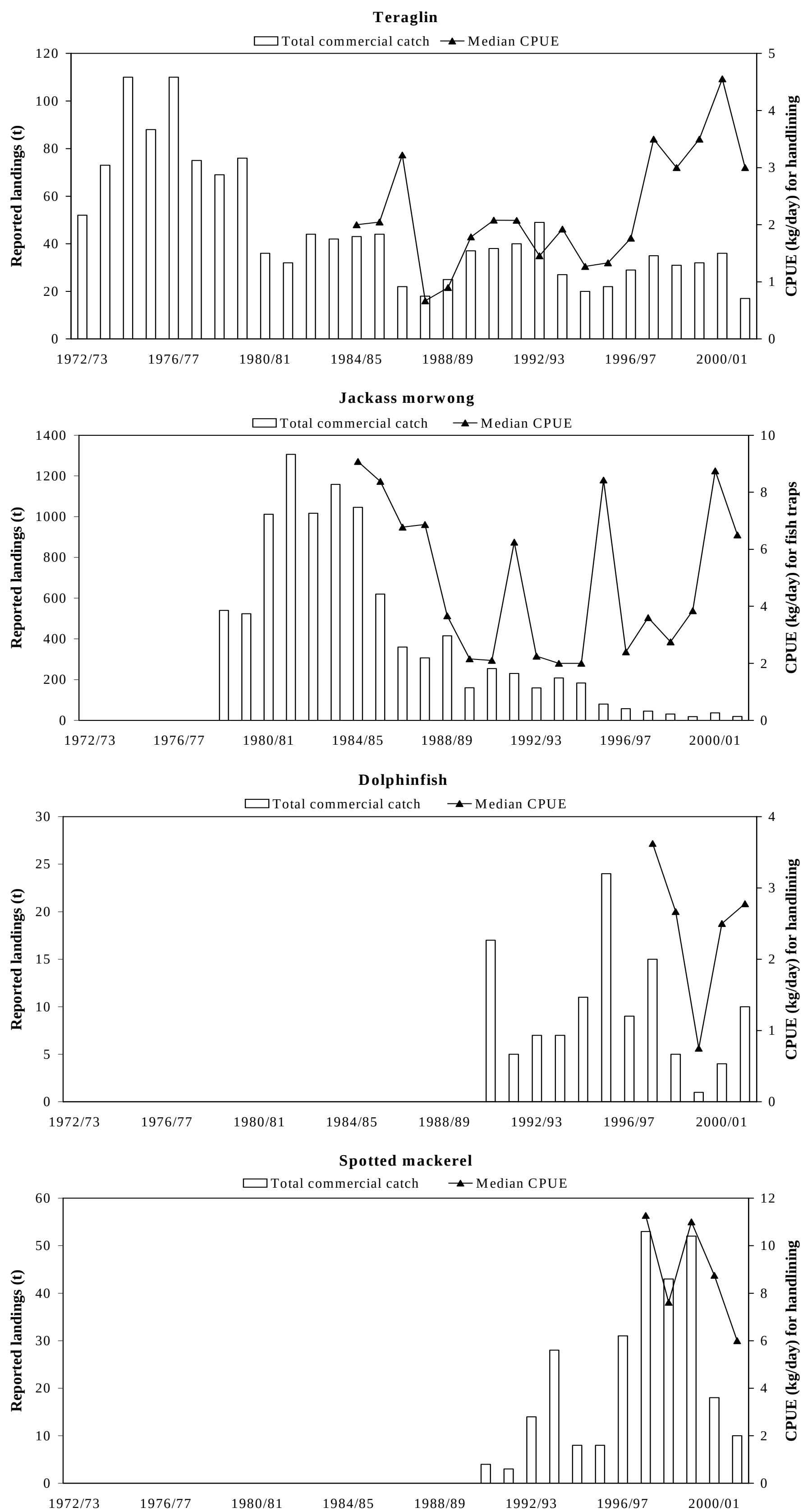


Figure B2.6 cont. - production and CPUE for the key secondary species

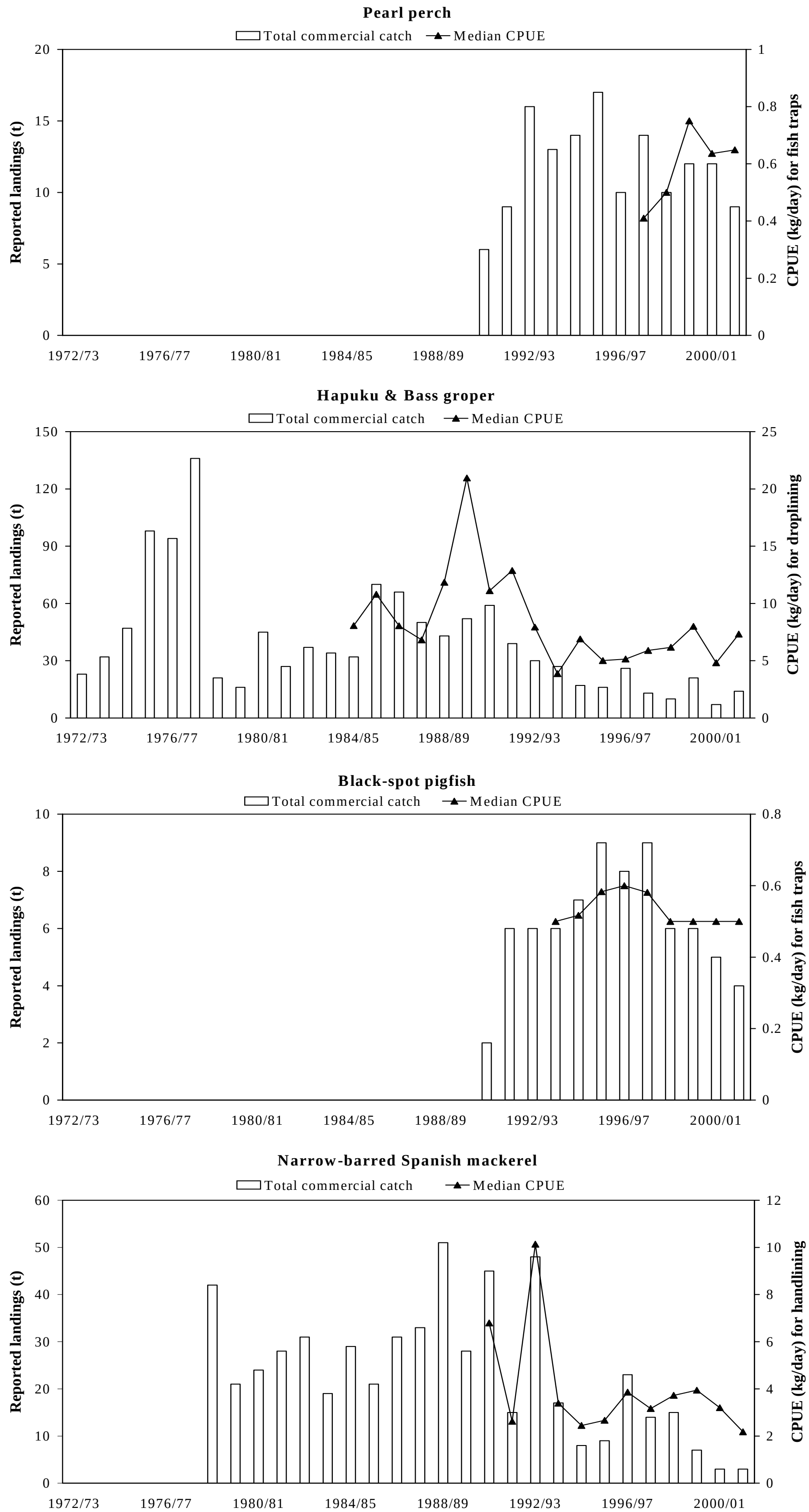


Figure B2.6 cont. - production and CPUE for the key secondary species

B2.4.2.3 Short-term production trends in the OTLF, 1997/98 - 2001/02

Fishery-specific data has only been available since 1997/98, and although some method-specific reporting has been available for longer period, unfortunately it is not always a good indicator of which fishery the data could have been reported against. Table B2.17 summarises the total OTLF catch for the primary and key secondary species, and species for which the OTLF accounts for less than 90% of the commercial catch are also shown as shaded bars in Figures B2.5 and B2.6. No conclusions will be drawn against the data given the relatively short time period over which it was collected and the potential for errors, but some general observations can be made.

One of the more apparent trends is the continual decline in total fishery production of 20% over the period 1997-02. The OTLF is either the major harvester or harvests a significant proportion of most of the primary and key secondary species of the fishery. It is not surprising then that for most of those species, the short-term trends within this fishery are consistent with the longer-term downward trend across all commercial fisheries.

There are a few species, however, for which the OTLF catch has either remained relatively stable or increased over the five years 1997/98-2001/02. Kingfish, bream and mixed sharks all appear to have experienced short-term increases. The OTLF is almost the sole commercial harvester of kingfish and such increases could reflect an increase in abundance of fish over the 60 cm MLL. The Estuary General Fishery and the Ocean Hauling Fishery catch nearly seven and two times as much bream, respectively, than the OTLF, and so it is probable that any long-term declines have been dictated by those fisheries with little, but potentially positive impact in the OTLF. Historically, trawl fisheries have caught the greatest proportion of mixed sharks and significant declines in trawl catches have been reported for shark numbers in NSW waters, but it appears to have had little impact on the catch within the OTLF.

Table B2.17 Annual OTLF production of the primary and key secondary species from 1997-02.

	Annual OTLF Production (kg)				
	1997/98	**1998/99**	**1999/00**	**2000/01**	**2001/02**
Primary Species					
Yellowtail kingfish	83,469	97,659	136,835	131,716	252,251
Leatherjacket (mixed species)	141,861	138,013	144,299	123,840	213,149
Snapper	296,806	311,364	300,088	296,971	205,888
Spanner crab	314,679	233,166	212,159	217,647	150,013
Silver trevally	112,425	121,132	141,435	121,204	101,315
Australian bonito	186,819	268,352	198,849	149,312	101,183
Blue-eye trevalla	124,938	102,890	119,851	75,315	91,480
Rubberlip morwong	142,635	110,159	94,517	76,377	55,996
Gummy shark	39,061	25,707	30,204	30,748	35,892
Yellowfin bream	22,204	23,253	19,156	21,844	34,153
Bar cod	18,011	11,654	23,133	27,460	28,590
Key Secondary Species					
Sharks (excludes gummy & wobbegong)	80,325	90,600	122,684	158,006	165,839
Wobbegong sharks	93,985	67,920	61,270	76,292	89,802
Silver sweep	98,128	46,908	20,231	21,326	27,252
Mulloway	36,976	30,505	47,913	27,047	22,290
Gemfish	116,056	117,110	82,773	25,691	17,211
Teraglin	36,485	30,053	32,341	36,196	16,967

Table B2.17 cont.

	Annual OTLF Production (kg)				
	1997/98	**1998/99**	**1999/00**	**2000/01**	**2001/02**
Key Secondary Species cont.					
Jackass morwong	18,954	15,653	15,153	35,916	16,551
Spotted mackerel	58,522	48,157	59,133	19,604	10,903
Dolphinfish	15,550	4,858	1,249	4,160	10,478
Pearl perch	10,499	9,146	10,438	11,387	9692
Hapuku	8,618	7,582	15,633	3,636	8399
Bass groper	4,364	2,321	5,983	3,021	5165
Black-spot pigfish	7,404	5,191	5,459	5,477	4546
Narrow-barred Spanish mackerel	16,928	17,745	8,735	3,337	2913
TOTAL	**2,085,702**	**1,937,098**	**1,909,521**	**1,703,530**	**1,677,918**

B2.4.2.4 Short-term effort levels in the fishery, 1997/98 - 2001/02

Fishing effort has shown a continual downward trend over the period 1997-02 in terms of the active entitlements in the fishery, total number of months fished across the fishery and by method, and of active entitlements by method (Table B2.18). Decreases in effort could be attributable to a variety of factors, including but not limited to buy-outs, surrenders, amalgamations of fishing businesses and declining catches. These decreases have occurred as the number of businesses endorsed in the fishery has increased, however, this may be a reflection of the Restricted Fisheries Review and Administrative Decisions Tribunal processes. Whilst it is apparent that broad effort levels have decreased, it is not possible to determine if actual fishing pressure/fishing power has decreased, because there is no information about the uniformity of gear use or improvements in fishing gear and/or boats that can lead to greater fishing efficiency.

Irrespective of the possible reasons, the discrepancies between the number of endorsed businesses and those that are actively fishing indicates that there is a considerable amount of inactive effort across the fishery, averaging ~30% over the examined period and peaking at 42% in 2001/02 (Table B2.18). These numbers are even higher when the main method types are examined, averaging 46% and 40% for line and trap methods, respectively. The 2001/02 peak for line and trap methods was in excess of 50%, and just below 40% for the spanner crab component. Further, the reasonably consistent averages of fishing months for the active businesses suggests that they represent the core of the fishing activity and remain constant irrespective of other less active businesses.

Given the declining catches of most species within the fishery and declining CPUE for some of them, the fully fished or overfished status of all species that have been assessed, and uncertainties about fishing power, this potential for a considerable increase in fishing activity (of unknown fishing power) poses a significant risk to the species and thus the fishery. This point is highlighted in the definitions of exploitation status (Table B1.4), which state that for fully fished stocks (bream, blue-eye and spanner crab), significant increases in fishing effort above current levels may lead to overfishing, and for over fished species (snapper, kingfish, gemfish and trevally), that current fishing levels may not be sustainable. The significant amount of latent effort within the fishery increases the chances of fully fished species becoming overfished, and overfished species of becoming further depleted.

Even before completing the risk assessment for each species, it is apparent from this rudimentary analysis of fishing effort that the draft FMS will need to effectively eliminate the currently latent effort and decrease the currently active effort in a bid to reduce the risk of overfishing to the species of the fishery. The reduction should seek to reduce effort across the fishery by limiting/standardising effort and power on each of the gear types within the fishery, and/or by using output controls for certain species where appropriate.

Table B2.18 Fishing effort (months) within the fishery by method type from 1997-02.

Fishing effort	Financial Year				
	1997/98	**1998/99**	**1999/00**	**2000/01**	**2001/02**
By Fishing Businesses					
Number of OTLF endorsed FB*	574	592	640	657	617
Number of active** FB	492	459	428	392	358
% Active/Latent Effort	86/14	78/22	67/33	60/40	58/42
Reported total OTLF months of activity	3646	3315	3190	2972	2697
Average months per active FB	7.4	7.2	7.5	7.6	7.5
By Line Methods					
Number of Line E/W/S&GS endorsed FB*	78/518/25	94/538/31	118/595/31	123/613/33	119/578/33
Total line endorsements	621	663	744	769	730
Number of active** line endorsements	443	414	380	341	304
% Active/Latent Effort	71/29	62/38	51/49	44/56	42/58
Reported total line fishing months of activity	2808	2532	2466	2239	2022
Average months per active FB	6.3	6.1	6.5	6.6	6.7
Reported months of activity by line method					
Driftline	37	34	20	15	23
Dropline	612	480	487	454	456
Handline	1769	1606	1557	1431	1260
Jigging	70	53	70	80	64
Longline (midwater/pelagic)	59	22	29	22	22
Poling	16	18	14	21	8
Setlining	194	146	152	180	173
Spanner crab net	346	294	252	259	239
Trolling	570	561	537	422	447
Trotline (bottom set)	234	233	225	199	163
By Fish Traps					
Number Fish Trap endorsements*	280	301	328	338	334
Number of active** fish trap endorsements	215	193	189	173	164
% Active/Latent Effort	77/23	64/36	58/42	51/49	49/51
Reported total fish trap months of activity	1523	1341	1324	1264	1156
Average months per active FB	7.1	6.9	7.0	7.3	7.0
By Spanner Crab Nets					
Number Spanner Crab N/S endorsements*	62/14	63/14	64/14	64/14	58/13
Total Spanner Crab endorsements	76	77	78	78	71
Number of active** Spanner Crab FB	53	50	40	39	43
% Active/Latent Effort	70/30	65/35	51/49	50/50	61/39
Reported spanner crab net months of activity	346	294	252	259	239
Average months per active FB	6.5	5.9	6.3	6.6	5.6

* denotes the number as at August/September of each year; ** denotes reporting 1 or more months of appropriate methods that fiscal year; E/W/S&GS = East, West and School & Gummy Shark endorsements; Source: ComCatch (08-10-04 extraction), data may contain section 37 activities.

B2.4.2.5 Production by fishing method within the OTLF for 2001/02

The OTLF is an extremely diverse fishery, which includes the use of multiple methods (see Table B2.18) to catch a large number of different taxa. The methods used in the OTLF can be divided into three major groups: (a) spanner crab nets; (b) demersal fish traps; and (c) line fishing methods. These broad groups of fishing methods can have very different impacts on exploited fish populations.

Line fishing methods can be further divided into active and passive methods. Active line fishing methods are those attended fishing techniques that involve the immediate landing of fish as they are hooked. Active line methods reported by fishers in the OTLF include handlining, jigging, poling, and trolling. Passive line fishing methods are those unattended techniques that involve the setting of gear so that the fish hook themselves. The landing of hooked fish into the fishing vessel is often delayed because the fish may be hooked much earlier than the time at which the set-gear is checked. Passive line methods reported by fishers in the fishery include the use of driftlines, droplines, setlines, and trotlines. The use of longlines (midwater/pelagic) was also reported by commercial fishers in the OTLF. These records were added to the setline data. It should be noted that the method of pelagic longline fishing beyond 3 nm is managed as part of a Commonwealth fishery.

The OTLF production data presented in this section refer to the reported landings during the 2001/02 financial year. This is the most recent year for which the commercial catch records are sufficiently complete and have been checked for gross errors, although there may still be some errors within the data. The production in the OTLF is reported in two usage categories: (a) total production, the majority of which is taken for sale, and (b) that portion of the landed catch that is taken as bait for own use. The total fishery production attributable to major method types for each taxon is provided in Tables B2.19 (primary and key secondary species) and B2.20 (secondary species).

Total production

In 2001/02, the ocean trap and line fishers reported a total fishery production of approximately 1882 tonnes (Tables B2.19 and B2.20). The reported catch included 131 separate taxa of finfish and invertebrates. The production of the 11 primary and 14 key secondary species was approximately 1678 tonnes, or 89% of total fishery production (Table B2.19). Of the 106 secondary species, 28 species accounted for a further 186 tonnes or ~10% of total fishery production, and the other 78 secondary species comprised ~1% of fishery production (Table B2.20).

Table B2.19 Total production of primary and key secondary species taken by the methods of the fishery during 2001/02.

Note: total production is estimated whole weight in kilograms

	Fishing Methods				Production	
	Spanner Crab Net	Fish Trap	Line Fishing		Total OTLF Production	% Total OTLF Production
			Active	Passive		
Primary Species						
Yellowtail kingfish	-	1,570	235,214	15,467	252,251	13.40
Leatherjackets (mixed)	-	211,222	740	1,187	213,149	11.33
Snapper	-	170,370	16,482	19,036	205,888	10.94
Spanner crab	150,013	-	-	-	150,013	7.97
Silver trevally	-	94,180	5,800	1,335	101,315	5.38
Australian bonito	-	1,458	98,777	948	101,183	5.38
Blue-eye trevalla	-	-	61	91,419	91,480	4.86
Rubberlip morwong	-	50,851	1,888	3,257	55,996	2.98

Table B2.19 cont.

	Fishing Methods				Production	
	Spanner Crab Net	Fish Trap	Line Fishing		Total OTLF Production	% Total OTLF Production
			Active	Passive		
Primary Species cont.						
Gummy shark	-	289	500	35,103	35,892	1.91
Yellowfin bream	-	32,588	1,558	7	34,153	1.81
Bar cod	-	2,536	4,134	21,920	28,590	1.52
Key Secondary Species						
Sharks (excludes gummy & wobbegong)	-	5,110	14,906	145,823	165,839	8.81
Wobbegong sharks	-	15,438	16,815	57,549	89,802	4.77
Silver sweep	-	23,314	2,755	1,183	27,252	1.45
Mulloway	-	3,089	18,765	436	22,290	1.18
Gemfish	-	-	-	17,211	17,211	0.91
Teraglin	-	632	16,031	304	16,967	0.90
Jackass morwong	-	15,603	196	752	16,551	0.88
Spotted mackerel	-	45	10,429	429	10,903	0.58
Dolphinfish	-	-	10,235	243	10,478	0.56
Pearl perch	-	3,951	3,761	1,980	9,692	0.51
Hapuku	-	-	10	8,389	8,399	0.45
Bass groper	-	-	44	5,121	5,165	0.27
Black-spot pigfish	-	4,101	261	184	4,546	0.24
Narrow-barred Spanish mackerel	-	69	2,721	123	2,913	0.15
TOTAL primary & key secondary	**150,013**	**636,416**	**462,083**	**429,406**	**1,677,918**	**89.14**

Table B2.20 Total production of secondary species taken by the methods of the fishery during 2001/02.

Note: total production is estimated whole weight in kilograms

	Fishing Methods				Production	
Secondary Species	Spanner Crab Net	Fish Trap	Line Fishing		Total OTLF Production	% Total OTLF Production
			Active	Passive		
Tuna, Skipjack / Striped	-	221	18,257	675	19,153	1.02
Tailor	-	394	16,108	37	16,539	0.88
Fish, Ocean Mixed / Unspecified	-	11,439	795	1,936	14,170	0.75
Mackerel, Slimy / Common/Blue	-	1,566	8,249	2,808	12,623	0.67
Tuna, Mackerel	-	691	11,377	277	12,345	0.66
Yellowtail	-	573	9,958	977	11,508	0.61
Wrasse, mixed	-	6,344	2,031	348	8,723	0.46
Tarwhine	-	7,511	850	59	8,420	0.45
Ling	-	639	4	7,509	8,152	0.43
Samson	-	717	6,567	644	7,928	0.42
Perch Ocean / Coral Cod	-	2,050	144	4,902	7,096	0.38
Crab, Blue Swimmer & Sand	6,460	19	-	-	6,479	0.34
Octopus	-	6,300	42	36	6,378	0.34
Redfish / Nannygai	-	2,304	470	2,345	5,119	0.27
Tuna, Yellowfin	-	21	4,246	586	4,853	0.26
Cod, Red Rock	-	962	3,139	60	4,161	0.22
Hairtail	-	-	3,872	-	3,872	0.21

Table B2.20 cont.

Secondary Species	Fishing Methods				Production	
	Spanner Crab Net	Fish Trap	Line Fishing		Total OTLF Production	% Total OTLF Production
			Active	Passive		
Crab, Hermit	-	3,658	-	-	3,658	0.19
Cuttlefish	-	3,097	467	32	3,596	0.19
Eel, Mixed / Unspecified	-	3,235	41	167	3,443	0.18
Eel, Southern Conger	-	3,085	42	209	3,336	0.18
Perch, Orange	-	81	96	2,690	2,867	0.15
Morwong, Red	-	2,473	36	17	2,526	0.13
Wirrah	-	1,444	919	18	2,381	0.13
Flathead, Sand & Blue Spotted	-	911	840	99	1,850	0.10
Salmon, Australian	-	1	1,603	14	1,618	0.09
Wrasse, Maori	-	82	1,491	28	1,601	0.09
Stingray/Ray/Flaps Mix/Unspecified	-	49	25	1491	1,565	0.08
Goatfish /Red Mullet / Barbounia	-	1,395	55	2	1,452	0.08
Calamari, Southern	-	47	1,186	16	1,249	0.07
Oilfish	-	66	1	1127	1,194	0.06
Trumpeter	-	904	1	266	1,171	0.06
Cobia / Black Kingfish	-	52	925	123	1,100	0.06
Ribbonfish / Southern Frostfish	-	18	1	921	940	0.05
Perch, longfinned	-	57	-	865	922	0.05
Albacore	-	20	253	532	805	0.04
Amberjack	-	80	547	84	711	0.04
Flathead, Tiger	-	544	135	21	700	0.04
Tuna, Longtail	-	-	442	133	575	0.03
Rainbow Runner	-	11	526	23	560	0.03
Catfish, Mixed	-	161	254	3	418	0.02
Tuna, Bigeye	-	51	-	348	399	0.02
Rosy Job Fish	-	34	52	300	386	0.02
Tuna, Mixed / Unspecified	-	239	96	31	366	0.02
Sergeant Baker	-	137	142	86	365	0.02
Pike	-	77	286	-	363	0.02
Drummer	-	220	136	-	356	0.02
Cod / Mixed / Unspecified	-	121	136	70	327	0.02
Cod, Maori	-	185	69	26	280	0.01
Trevally, Black / Happy Moments	-	254	-	-	254	0.01
Squid, Mixed / Unspecified	-	24	197	23	244	0.01
Emperor, Spangled	-	110	17	95	222	0.01
Mangrove Jack	-	-	210	-	210	0.01
Perch, Mixed / Unspecified	-	170	5	25	200	0.01
Wahoo	-	24	159	-	183	0.01
Latchet / Sharp-beaked Gurnard	-	53	-	129	182	0.01
Luderick / Blackfish	-	60	100	-	160	0.01
Alfonsino	-	-	-	154	154	0.01
Tuna, Southern Bluefin	-	-	154	-	154	0.01
Perch, Moses	-	53	92	7	152	0.01
Whiting, Mixed/Unspecified	-	-	115	-	115	0.01

Table B2.20 cont.

Secondary Species	Fishing Methods				Production	
	Spanner Crab Net	Fish Trap	Line Fishing		Total OTLF Production	% Total OTLF Production
			Active	Passive		
Wrasse, Crimson Banded	-	81	16	18	115	0.01
Surgeon	-	84	8	16	108	0.01
Eel, Short-finned Conger	-	83	-	20	103	0.01
Trumpeter, Tasmanian	-	83	-	18	101	0.01
Trumpeter, Bastard / Moki	-	93	-	-	93	< 0.01
Warehou, Spotted / Silver	-	-	72	-	72	< 0.01
Mado	-	66	-	-	66	< 0.01
Swordfish, Broadbill	-	-	21	38	59	< 0.01
Imperador	-	-	-	53	53	< 0.01
Crab, Mixed/Unspecified	-	46	-	-	46	< 0.01
Mackerel, Other Mix/Unspecified	-	-	46	-	46	< 0.01
Sweetlip	-	26	13	-	39	< 0.01
Emperor, Red	-	8	20	4	32	< 0.01
Shells	-	29	-	-	29	< 0.01
Dart	-	-	28	-	28	< 0.01
Gurnard, mixed/unspecified	-	-	-	26	26	< 0.01
Dory, Spiky / Spiky Oreo	-	-	-	23	23	< 0.01
Snapper, queen	-	-	9	13	22	< 0.01
Eel, Common Pike	-	19	-	-	19	< 0.01
Boarfish / Penfish	-	2	-	16	18	< 0.01
Rudderfish	-	-	9	8	17	< 0.01
Flathead, Marbled	-	16	-	-	16	< 0.01
Flounder, Mixed	-	15	1	-	16	< 0.01
Barracouta/Snoek	-	-	14	-	14	< 0.01
Dory, John	-	5	4	5	14	< 0.01
Warehou, Blue	-	-	-	11	11	< 0.01
Longtom	-	-	10	-	10	< 0.01
Grenadier, Blue	-	-	-	9	9	< 0.01
Mackerel, Jack/Cowanyoung / Horse	-	9	-	-	9	< 0.01
Morwong, Mixed/Unspecified	-	8	-	-	8	< 0.01
Old Maid/Butterfish	-	8	-	-	8	< 0.01
Warehou, Blue & Silver Mixed	-	-	-	8	8	< 0.01
Catfish, Forktailed / Silver	-	-	6	-	6	< 0.01
Flathead, Dusky/Black/River	-	-	6	-	6	< 0.01
Leadenall (Frigate Mackerel)	-	-	5	-	5	< 0.01
Opah / Moonfish	-	-	-	5	5	< 0.01
Sole, Black	-	5	-	-	5	< 0.01
Whiting, Trumpeter	-	5	-	-	5	< 0.01
Hussar	-	2	-	1	3	< 0.01
Tilefish, Pink	-	-	2	1	3	< 0.01
Diamond Fish	-	-	2	-	2	< 0.01
Mullet Mixed / Unspecified	-	-	2	-	2	< 0.01
Whiting, Red Spot/School/ Trawl	-	2	-	-	2	< 0.01
Fusilier	-	-	-	1	1	< 0.01
Whiting, Rock/Grass (wrasse)	-	1	-	-	1	< 0.01
TOTAL secondary	**6,460**	**65,730**	**98,255**	**33,668**	**204,113**	**10.86**
TOTAL all species by method	**156,473**	**702,146**	**560,338**	**463,074**	**1,882,031**	

Harvest – bait for own use

A relatively small amount of total production in the OTLF is harvest that is not to be sold but instead taken for use as bait by the commercial fisher concerned. In 2001/02, of the 1882 tonnes of reported landings, harvest of bait was approximately 25 tonnes or 1.3% of total production (Table B2.21). That 25 tonnes was comprised of 5.5 tonnes of primary and key secondary species and 19.5 tonnes of secondary species. The harvest taken for bait attributable to major method types for each taxon is provided in Table B2.21.

Table B2.21 Total bait taken for own use by species and methods in the fishery during 2001/02.

Note: total production is estimated whole weight in kilograms

	Fishing Methods				**Production**	
			Line Fishing			
	Spanner Crab Net	**Fish Trap**	**Active**	**Passive**	**Total Bait for Own Use**	**% Total Species Production**
Primary Species						
Australian bonito	-		1,402		1,402	1.39
Leatherjacket (mixed spp)	-	150			150	0.07
Snapper	-		95	40	135	0.07
Gummy shark	-			54	54	0.15
Rubberlip morwong	-	6		19	25	0.04
Yellowtail kingfish	-			14	14	0.01
Silver trevally	-			12	12	0.01
Key Secondary Species						
Sharks (mixed spp)	-	240		3,530	3,770	2.27
SUB-TOTAL		**396**	**1,497**	**3,669**	**5,562**	**0.33%**
Secondary Species						
Tuna, Skipjack / Striped		166	6,202	259	6,627	34.60
Yellowtail			4,126	65	4,191	36.42
Mackerel, Slimy / Common / Blue		810	2,197	387	3,394	26.89
Crab, Hermit		1,994			1,994	54.51
Cuttlefish		943	400		1,343	37.35
Tuna, Mackerel		104	912	214	1,230	9.96
Sergeant Baker		4	116	82	202	55.34
Pike			196		196	53.99
Amberjack		70	6		76	10.69
Salmon, Australian			75		75	4.64
Octopus		69			69	1.08
Redfish/Nannygai		46			46	0.90
Squid, Mixed/Unspecified			45		45	18.44
Tailor			40		40	0.24
Crab, Mixed/Unspecified		30			30	65.22
Tuna, Yellowfin			25		25	0.52
Eel, Southern Conger		6			6	0.18
Calamari, Southern			5		5	0.40
Cod, Red Rock		4			4	0.10
Flathead, Sand & Blue Spotted		4			4	0.22
SUB-TOTAL		**4,250**	**14,345**	**1,007**	**19,602**	**1%**
TOTAL		**4,646**	**15,842**	**4,676**	**25,164**	**1.33%**

B2.4.2.6 Catches of ocean trap and line species in other fisheries

The information describing the commercial catches from adjacent jurisdictions should be treated as indicative because it is incomplete. The available published reports (ABARE 2004; Anon 2004) provide summary data for the main species and some larger amalgamated taxonomic categories taken within their jurisdiction. More detailed comparisons of relative catches for separate taxa are only possible if detailed database extractions from these other jurisdictions are examined.

The recreational estimates of harvested biomass should be treated as indicative because there is considerable uncertainty associated with the conversion from numbers harvested to estimates of biomass. The national recreational fishing survey (Henry and Lyle 2003) was a large-scale study in which related species were generally grouped together. Additional comparisons of relative catches for some separate species are possible from detailed database extractions (e.g. yellowtail kingfish, snapper, mulloway, trevally, tailor and bream), however, for many species it is not possible to disaggregate the data into distinct units for most single species (Reid and Murphy, NSW DPI, pers. comm.).

The data problems outlined above were sufficient reason to restrict the comparisons of relative catches across the commercial and recreational fisheries within NSW and with the commercial fisheries of adjacent jurisdictions to primary and key secondary species. For secondary species of the fishery, the only comparisons that could be done with any confidence were those of relative catches across the commercial fisheries within NSW.

Primary and key secondary species

Almost all primary and key secondary species (Table B2.22) were also caught by other NSW commercial fisheries during 2001/02. The OTLF takes the largest share of the NSW commercial catch for 21 of 25 primary and key secondary taxa. The exceptions are (a) silver trevally which are subject to a recovery program under the Ocean Trawl Fishery; (b) yellowfin bream which are taken mainly in the Estuary General Fishery; (c) sharks (excluding gummy and wobbegong sharks) which are taken in greater quantities in the Ocean Trawl Fishery; and (d) mulloway which are taken mainly in the Estuary General Fishery (Table B2.22).

Commercial fisheries in adjacent jurisdictions (Victoria, Queensland and the Commonwealth South East Fishery) and the recreational sector within NSW also catch considerable quantities of the primary and key secondary species (Table B2.23).

The recreational harvest estimates indicate that for some species the recreational sector is the largest user group (Table B2.23). Species harvested in greater quantities by the NSW recreational sector were bream, rubberlip morwong, mulloway, teraglin, dolphinfish and pearl perch. Catches of other species for which recreational harvest estimates are not available are also likely to be equal to or greater than that within the OTLF, including bar cod, hapuku, bass groper and narrow-barred Spanish mackerel.

Secondary species

Ninety percent (93 of 106) of the secondary species are also taken in other commercial fisheries, although 33 are only taken in the OTLF and one other fishery (Table B2.24). This is also reflected in the fact that the OTLF takes the largest commercial share in NSW for 47 of those species. Those species are dominated by scombrids (tunas and mackerels), carangids (trevallies and kingfishes), serranids (ocean perches) and labrids (wrasses).

Table B2.22 Total production of primary and key secondary species taken by different commercial fisheries in NSW during 2001/02.

Note: figures are estimated whole weights in kilograms

	Estuary General	Estuary Prawn Trawl	Ocean Hauling	Ocean Fish Trawl	Ocean Prawn Trawl	Ocean Trap and Line	Total NSW Commercial Production	% OTL of Total NSW Production
Primary Species								
Yellowtail kingfish	645	-	3,936	250	425	252,251	257,507	98.0
Leatherjacket (mixed species)	10,696	11	17	131,838	4,461	213,149	360,172	59.2
Snapper	2,326	-	75	3,466	687	205,888	212,442	96.9
Spanner crab	11	-	-	-	81	150,013	150,105	99.9
Silver trevally	23,890	480	391	189,137	219	101,315	315,432	32.1
Australian bonito	361	-	781	5	3	101,183	102,333	98.9
Blue-eye trevalla	-	-	-	-	-	91,480	91,480	100.0
Rubberlip morwong	75	-	2	11,132	398	55,996	67,603	82.8
Gummy shark	549	-	-	9,720	5,553	35,892	51,714	69.4
Yellowfin bream	231,366	9	60,360	5,044	361	34,153	331,293	10.3
Bar cod	-	-	-	160	305	28,590	29,055	98.4
Key Secondary Species								
Sharks (excludes gummy and wobbegong)	17,787	352	725	173,135	75,192	165,839	433,030	38.3
Wobbegong sharks	401	10	-	3,794	3,497	89,802	97,504	92.1
Silver sweep	3	-	15,037	46	5	27,252	42,343	64.4
Mulloway	41,576	147	3,095	1,922	385	22,290	69,415	32.1
Gemfish	-	-	-	807	181	17,211	18,199	94.6
Teraglin	-	-	-	308	132	16,967	17,407	97.5
Jackass morwong	-	-	170	2,140	-	16,551	18,861	87.8
Spotted mackerel	17	-	-	-	-	10,903	10,920	99.8
Dolphinfish	-	-	-	-	-	10,478	10,478	100.0
Pearl perch	-	-	-	10	213	9,692	9,915	97.8
Hapuku	-	-	-	459	-	8,399	8,858	94.8
Bass groper	3	-	-	-	-	5,165	5,168	99.9
Black-spot pigfish	1	-	-	3	79	4,546	4,629	98.2
Narrow-barred Spanish mackerel	7	-	5	-	-	2,913	2,925	99.6
TOTAL	**329,714**	**1,009**	**84,594**	**533,376**	**92,177**	**1,677,918**	**2,718,788**	**61.7**

Table B2.23 Comparison of estimates of catches of primary and key secondary species taken by NSW and other commercial fisheries and recreational fisheries in 2001/02.

Note: figures are estimated whole weight in tonnes

	NSW Rec[A]	SEF (trawl) [C]	SEF (non-trawl) [C]	Vic [D]	Qld [C]	NSW commercial excluding OTL [E]	Ocean Trap and Line [E]	Total	OTL percentage of total
Primary Species									
Yellowtail kingfish	186[B]	*	*	*	*	5	252	443	57%
Leatherjacket (mixed species)	108[A]	*	*	30	*	147	213	498	43%
Snapper	162[B]	*	*	77	94	7	206	543	38%
Spanner crab	*	0	0	0	2182[F]	<1	150	2332	6%
Silver trevally	88[A]	144	*	93	*	214	101	639	16%
Australian bonito	57[B]	*	*	*	*	1	101	159	64%
Blue-eye trevalla	*	68	411	0	*	0	91	570	16%
Rubberlip morwong	131[B]	*	*	*	*	12	56	199	28%
Gummy shark	*	108	41	33	*	16	36	233	15%
Bream (yellowfin and black)	729[A]	*	*	200	156[G]	297	34	1412	2%
Bar cod	*	0	0	0	*	<1	29	30	97%
Key Secondary Species									
Sharks (excludes Gummy and Wobbegong)	*	*	*	*	1050	267	166	1483	11%
Wobbegong sharks	*	*	*	*	*	8	90	98	92%
Silver sweep	44[B]	*	*	*	*	15	27	86	31%
Mulloway	324[B]	*	*	*	*	47	22	393	6%
Gemfish	*	220	*	*	0	1	17	238	7%
Teraglin	40[B]	0	0	0	*	<1	17	58	29%
Jackass morwong	*	796	*	*	0	2	17	815	2%
Spotted mackerel	*	0	0	0	167	<1	11	179	6%
Dolphinfish	59[B]	0	0	*	*	0	10	69	14%
Pearl perch	44[B]	0	0	0	*	<1	10	55	18%
Hapuku	*	*	*	*	*	<1	8	9	89%
Bass groper	*	*	*	*	*	<1	5	6	83%
Black-spot pigfish	*	*	*	0	*	<1	5	6	83%
Narrow-barred Spanish mackerel	*	0	0	0	742	<1	3	746	< 1%

* denotes possibility of landings but data unavailable from published sources used.

Abbreviations: Rec = recreational; SEF = South East Fishery; Vic = Victoria; Qld = Queensland

A = Estimate from Henry and Lyle (2003) from data collected in 2000/01.

B = Estimate based on numbers of fish derived from the national recreational fishing survey (Reid and Murphy unpublished data) and median weights taken from an on-site survey recreational trailer boat anglers (Steffe *et al*. unpublished data).

C = ABARE 2004

D = Anon 2004

E = NSW Fisheries database extraction (late October 2003)

F = Estimate for calendar year 2000 (Brown *et al*. 2001)

G = Estimate includes tarwhine

Table B2.24 Total production of secondary species taken by different commercial fisheries in NSW during 2001/02.

Note: figures are estimated whole weights in kilograms

	Estuary General	Estuary Prawn Trawl	Ocean Hauling	Ocean Fish Trawl	Ocean Prawn Trawl	Ocean Trap and Line	Total NSW Commercial Production	% OTL of Total NSW Production
Tuna, Skipjack/Striped	15	-	-	-	-	19,153	19,168	99.9
Tailor	30,286	-	24,802	799	112	16,539	72,538	22.8
Fish, Ocean Mixed/Unspecified	1,002	61	3,038	24,838	17,471	14,170	60,580	23.4
Mackerel, Slimy/Common/Blue	2,091	-	473,847	1,216	274	12,623	490,051	2.6
Tuna, Mackerel	48	-	447	-	5	12,345	12,845	96.1
Yellowtail	16,685	1,075	403,426	11,911	15,350	11,508	459,955	2.5
Wrasse, mixed	126	-	-	-	214	8,723	9,063	96.2
Tarwhine	21,163	-	2,356	17,960	354	8,420	50,253	16.8
Ling	9	23	-	2,006	1,299	8,152	11,489	71.0
Samson	51	-	10	11	55	7,928	8,055	98.4
Perch Ocean/Coral Cod	50	-	-	18,560	9,531	7,096	35,237	20.1
Crab, Blue Swimmer & Sand	119,041	3,418	6	2,878	20,084	6,479	151,906	4.3
Octopus	4,082	679	-	10,767	439,182	6,378	461,088	1.4
Redfish/Nannygai	4	-	-	40,754	4,409	5,119	50,286	10.2
Tuna, Yellowfin	-	-	535	-	-	4,853	5,388	90.1
Cod, Red Rock	5	-	-	16	227	4,161	4,409	94.4
Hairtail	7,966	695	-	2,307	188	3,872	15,028	25.8
Crab, Hermit	-	-	600	-	-	3,658	4,258	85.9
Cuttlefish	1,103	117	-	59,084	178,432	3,596	242,332	1.5
Eel, Mixed/Unspecified	51	46	-	756	378	3,443	4,674	73.7
Eel, Southern Conger	265	-	-	29	69	3,336	3,699	90.2
Perch, Orange	-	-	-	118	-	2,867	2,985	96.0
Morwong, Red	337	-	-	36	6	2,526	2,905	87.0
Wirrah	50	32	-	-	1	2,381	2,464	96.6
Flathead, Sand & Blue Spotted	5,633	-	17	65,752	55,894	1,850	129,146	1.4
Salmon, Australian	82,384	-	724,734	381	-	1,618	809,117	0.2

Table B2.24 cont.

	Estuary General	Estuary Prawn Trawl	Ocean Hauling	Ocean Fish Trawl	Ocean Prawn Trawl	Ocean Trap and Line	Total NSW Commercial Production	% OTL of Total NSW Production
Wrasse, Maori	-	-	-	-	-	1,601	1,601	100.0
Stingray/Ray/Flaps Mix/Unspec	2,972	-	32	22,241	1,330	1,565	28,140	5.6
Goatfish/Red Mullet/Barbounia	168	271	4	5,043	18,477	1,452	25,415	5.7
Calamari, Southern	2,677	33	10	49,454	5,361	1,249	58,784	2.1
Oilfish	-	-	1	-	12	1,194	1,207	98.9
Trumpeter	3,486	617	-	1,335	988	1,171	7,597	15.4
Cobia/Black Kingfish	-	5	-	44	593	1,100	1,742	63.1
Ribbonfish/Southern Frostfish	21	-	-	847	46	940	1,854	50.7
Perch, longfinned	-	-	-	-	-	922	922	100.0
Albacore	-	-	-	-	-	805	805	100.0
Amberjack	9	-	-	-	3	711	723	98.3
Flathead, Tiger	-	-	-	104,792	3,274	700	108,766	0.6
Tuna, Longtail	317	-	60	-	-	575	952	60.4
Rainbow Runner	-	-	-	-	363	560	923	60.7
Catfish, Mixed	287	4	8	223	178	418	1,118	37.4
Tuna, Bigeye	6	-	-	-	-	399	405	98.5
Rosy Job Fish	-	-	-	-	8	386	394	98.0
Tuna, Mixed/Unspecified	4	-	-	-	21	366	391	93.6
Sergeant Baker	-	-	-	17	1	365	383	95.3
Pike	4,775	-	19	412	83	363	5,652	6.4
Drummer	284	-	156		8	356	804	44.3
Cod/Mixed/Unspecified	54	-		7	1,425	327	1,813	18.0
Cod, Maori	-	-	-	-	-	280	280	100.0
Trevally, Black/Happy Moments	4,441	43	66	-	-	254	4,804	5.3
Squid, Mixed/Unspecified	2,658	24,164	7	3,248	29,774	244	60,095	0.4
Emperor, Spangled	6	-	-	-	-	222	228	97.4
Mangrove Jack	17	-	75	46	-	210	348	60.3

Table B2.24 cont.

	Estuary General	Estuary Prawn Trawl	Ocean Hauling	Ocean Fish Trawl	Ocean Prawn Trawl	Ocean Trap and Line	Total NSW Commercial Production	% OTL of Total NSW Production
Perch, Mixed/Unspecified	-	-	-	-	77	200	277	72.2
Wahoo	-	-	-		-	183	183	100.0
Latchet/Sharp-beaked Gurnard	114	-	-	30,749	1,478	182	32,523	0.6
Luderick/Blackfish	449,067	10	71,103	2	-	160	520,342	<0.1
Alfonsino	4	-	-	415	-	154	573	26.9
Tuna, Southern Bluefin	8	-	-	-	-	154	162	95.1
Perch, Moses	1	-	-	-	-	152	153	99.3
Whiting, Mixed/Unspecified	-	14	-	-	3,098	115	3,227	3.6
Wrasse, Crimson Banded	-	-	-	-		115	115	100.0
Surgeon	21	-	-	-	22	108	151	71.5
Eel, Short-finned Conger	356	-	-	-	23	103	482	21.4
Trumpeter, Tasmanian	-	37	-	-	69	101	207	48.8
Trumpeter, Bastard/Moki	-	-	-	-	-	93	93	100.0
Warehou, Spotted/Silver	-	-	-	-	-	72	72	100.0
Mado	-	-	191	34	-	66	291	22.7
Swordfish, Broadbill	-	-	-	41	10	59	110	53.6
Imperador	-	-	-	-	-	53	53	100.0
Crab, Mixed/Unspecified	411	-	-	162	2,057	46	2,676	1.7
Mackerel, Other Mix/Unspecified	7	-	-	6	-	46	59	78.0
Sweet Lip	69	-	-	-	1	39	109	35.8
Emperor, Red	-	-	2	-	1	32	35	91.4
Shells	-	-	-	917	2,975	29	3,921	0.7
Dart	40	-	9,368	-	-	28	9,436	0.3
Gurnard, mixed/unspecified	3	-	-	-	-	26	29	89.7
Dory, Spiky/Spiky Oreo	-	-	-	71	-	23	94	24.5
Snapper, queen	7	-	-		-	22	29	75.9
Eel, Common Pike	6,144	-	-	10	106	19	6,279	0.3
Boarfish/Penfish	-	5	-	7,096	4,281	18	11,400	0.2

Table B2.24 cont.

	Estuary General	Estuary Prawn Trawl	Ocean Hauling	Ocean Fish Trawl	Ocean Prawn Trawl	Ocean Trap and Line	Total NSW Commercial Production	% OTL of Total NSW Production
Rudderfish	-	-	-	64	-	17	81	21.0
Flathead, Marbled	-	-	-	147	2,437	16	2,600	0.6
Flounder, Mixed	1,190	1,752	-	9,443	17,331	16	29,732	<0.1
Barracouta/Snoek	-	-	-	35	-	14	49	28.6
Dory, John	42	46	-	17,990	5,754	14	23,846	<0.1
Warehou, Blue	-	-	-	210	-	11	221	5.0
Longtom	2,565	-	614	-	126	10	3,315	0.3
Grenadier, Blue	-	-	-	93	-	9	102	8.8
Mackerel, Jack/Cowanyoung/Horse	29	-	16,879	2,324	-	9	19,241	<0.1
Morwong, Mixed/Unspecified	47	-	-	-	738	8	793	1.0
Old Maid/Butterfish	10,429	24	29	903	42	8	11,435	<0.1
Warehou, Blue & Silver Mixed	-	-	-	17	-	8	25	32.0
Catfish, Forktailed / Silver	2,589	-	12	-	19	6	2,626	0.2
Flathead, Dusky/Black/River	137,771	-	79	889	3,089	6	141,834	<0.1
Leadenall (Frigate Mackerel)	508	-	8,761	-	-	5	9,274	<0.1
Opah/Moonfish	-	-	-	-	-	5	5	100.0
Sole, Black	87	86	-	5	1,598	5	1,781	0.3
Whiting, Trumpeter	33,159	8,979	56	34	15	5	42,248	<0.1
Hussar	-	-	-	-	-	3	3	100.0
Tilefish, Pink	-	-	-	3,056	499	3	3,558	<0.1
Diamond Fish	211	-	1,964	-	-	2	2,177	<0.1
Mullet Mixed/Unspecified	5,383	49	7,646	-	81	2	13,161	<0.1
Whiting, Red Spot/School/Trawl	398	9	-	456,988	777,433	2	1,234,830	<0.1
Fusilier	-	-	-	-	-	1	1	100.0
Whiting, Rock/Grass (Wrasse)	-	-	-	-	-	1	1	100.0
TOTAL - SECONDARY SPECIES	**965,289**	**42,294**	**979,589**	**1,750,960**	**1,628,840**	**204,113**	**5,571,085**	**3.7**
TOTAL - ALL SPECIES	**1,295,003**	**43,303**	**1,835,554**	**1,512,965**	**1,721,017**	**1,882,031**	**8,289,873**	**22.7**

B2.4.3 Potential impacts of the fishery on primary, key secondary and secondary species

The main direct impact on primary, key secondary and secondary species is the potential for biological overfishing that substantially decreases exploitable mature biomass and spawning biomass of stocks. Exploitable biomass is defined as that portion of a stock's biomass that is available to the fishing gear, and spawning biomass is defined as the total weight of all sexually mature fish in the population. Indirect impacts occur through habitat damage and disruption of ecological processes, which can also result from overfishing. These aspects have been addressed in sections B2.2 and B2.3, respectively, so this section will focus on the direct impacts of the fishery on exploitable and spawning biomass.

Overfishing occurs when a high proportion of one or all age classes in a fishery are caught so as to reduce yields and drive biomass and spawning potential below safe levels (FAO glossary, website, 2002). Broadly there are two types of overfishing - growth and recruitment. Growth overfishing occurs when too many small fish are being harvested, usually because of excessive effort and/or inappropriate gear selectivity and the fish are not given the time to grow to the size at which the maximum yield-per-recruit would be obtained for the stock (FAO glossary, website, 2002). Recruitment overfishing occurs when the rate of fishing is such that annual recruitment to the exploitable stock has become significantly reduced, producing a greatly reduced spawning stock, a decreasing proportion of older fish in the catch and generally very low recruitment year after year (FAO glossary, website, 2002).

B2.4.3.1 Effects of growth overfishing

The primary effect of growth overfishing is a decrease in optimal yield from the fishery. Of the seven species within the fishery that have had stock assessments, three are considered to be growth overfished: kingfish, snapper and trevally. Too many small fish from the stock are being caught and hence larger numbers of fish need to be landed for a given catch weight than if the optimum size were fished. Slower growing fish species are more likely to suffer substantial decreases in their exploitable biomass over a short period of time if this type of overfishing is continued. In growth overfishing, larger slower growing species are reduced in number through fishing pressure and smaller fish are being caught so that very few are allowed to grow to a mature size. Lower mature biomass (i.e. smaller size of the spawning stock) means there is less weight of fish available for the same number of fishers, thereby increasing fishing pressure. As fishers increase their effort to catch fewer, smaller fish, the rate of discarding will also increase, potentially exacerbating the problem.

Another effect of growth overfishing is that lower yielding catches may result in fishers switching to target more profitable species (Orenzanz *et al.*, 1998). Depending upon the extent and magnitude of growth overfishing and the biological characteristics of targeted species, switching targets could occur for a short period while the stock replenishes, or indefinitely if biomass rebuilding is uncertain. Switching target species could produce cascading effects on other fish species possibly resulting in sequential depletion of fish stocks (Orenzanz *et al.*, 1998). Clearly, targeting additional fishing effort at other species will lead to increased fishing mortality for those populations. To what extent target switching occurs in the OTLF is unknown. It should be noted that growth overfishing, in isolation, should not cause stock collapses. However, left unchecked it can lead to recruitment overfishing which is more serious.

B2.4.3.2 Effects of recruitment overfishing

The primary effect of recruitment overfishing is collapse of the fish stock and of the fishery. Recruitment into the exploitable stock becomes so low that the adult population remains significantly depleted, leading to the possibility of commercial extinction. There have been several well documented large collapses of fish stocks around the world that have been caused by over exploitation. These include northern cod off Newfoundland and Labrador (Hutchings and Myers, 1994), anchoveta off Peru (Patterson *et al.*, 1992) and haddock in Georges Bank (Garrod, 1982). Within the OTLF, eastern gemfish has already suffered a protracted recruitment collapse, primarily due to large catches taken by demersal trawling (Rowling, 1999). Clearly, collapse of an important stock has negative consequences for both fishers and the well-being of the ecosystem.

B2.4.4 Risk assessment on primary, key secondary and secondary species

As previously stated, the risk to species of the fishery due to harvesting and discarding would be examined in finer detail by examining the available information, and in the case of harvesting primary and key secondary species, applying the risk matrix that was discussed in section B2.1.4. There is less information available about discarding (bycatch) of commercial species, but if there was sufficient, reliable information available it would be an important component of fishery impact profile used in the risk matrix. Instead, the available discarding information will be used to infer the potential risks to the commercial species of the fishery. The bycatch of non-commercial species was discussed in section B2.2.

B2.4.4.1 Risk to primary and key secondary species from harvesting

The risk matrix described in B2.1.4 uses the fishery impact profile and the biological resilience of the species to determine a species' risk of becoming unsustainable due to the activity of harvesting within the existing fishery. The overall aim is to prioritise species in terms of management changes via the draft FMS. Obviously species at greatest risk require direct and immediate action to decrease the level of the fishery impact (resilience cannot be affected by management changes), whereas those at lower levels of risk may be able to be addressed by measures that ensure that the fishery impact profile does not increase, or that any increase is considered in light of how the overall risk to that species would be affected.

Fishery impact profile

Tables B2.2 and B2.3 described the factors and the decision rules that were considered to determine the fishery impact profiles for the primary and key secondary species of the fishery. A summary of the factors and overall fishery impact profiles for those species is given in Table B2.25.

Species were spread right across the fishery impact profile spectrum, from low (bream) to high (elasmobranchs), suggesting that the factors used provide a suitable description of the fishing pressure exerted on the primary and key secondary species by the fishery. The most consistently risk-prone factors were 1 (catch levels and trends), 2 (CPUE), 3 (stock assessments) and 4 (exploitation status). Total reported landings across all commercial fisheries most of the 25 target species have been declining over the last 10 years, CPUE has been highly variable within and among species, and all key secondary species except for gemfish have not had stock assessments and thus exploitation statuses defined.

Wobbegongs have the highest fishery impact profile of 8, as all factors were considered risk-prone for that species. There were 10 other high profile species with scores of 6 or 7. In addition to the factors already discussed, those species are generally poorly understood in terms of biology, are caught in greatest numbers by the fishery, and are unlikely to have habitats beyond the reach of the fishery. Conversely, bream have a fishery impact profile of 2, reflecting their low proportion of the total commercial catch, reliable stock assessment and status, and habitats beyond the range of the fishery, namely estuaries. A high fishery impact profile may seem intuitively correct for gemfish as they are recruitment overfished, however, consideration of the other factors indicates that there is only moderately low fishing pressure due to the OTLF. This reflects the existing management arrangements for the species (50 kg trip limit), low proportional catch, its had a stock assessment albeit of overfished, it is readily identified and has some of its potential distribution beyond the fishery.

Table B2.25 Summary of fishery impact profiles for primary and key secondary species taken by the Ocean Trap and Line Fishery.

	Fishery Impact Factors								**Number of Risk-Prone Factors**	**Fishery Impact Profile**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
Primary Species										
Yellowtail kingfish	P	P	A	P	P	P	A	A	5	MH
Snapper	P	P	A	P	P	P	A	A	5	MH
Leatherjackets (mixed)	A	P	P	P	P	P	P	P	7	H
Silver trevally	P	P	A	P	P	A	A	A	4	M
Australian bonito	P	P	P	P	P	P	A	A	6	H
Blue-eye trevalla	P	P	A	A	P	A	A	P	4	M
Rubberlip morwong	P	P	P	P	P	A	A	P	6	H
Yellowfin bream	P	P	A	A	A	A	A	A	2	L
Bar cod	P	P	P	P	P	P	A	P	7	H
Gummy shark	P	P	P	P	P	A	A	P	6	H
Spanner crab	P	P	A	A	A	A	A	P	3	ML
Key Secondary Species										
Sharks (mixed)	P	P	P	P	P	A	P	P	7	H
Wobbegong sharks	P	P	P	P	P	P	P	P	8	H
Silver sweep	P	P	P	P	A	A	A	A	4	M
Mulloway	P	P	P	P	A	A	A	A	4	M
Gemfish	P	P	A	P	A	A	A	A	3	ML
Teraglin	P	P	P	P	A	A	A	P	5	MH
Jackass morwong	P	P	P	P	A	A	A	A	4	M
Dolphinfish	P	P	P	P	A	A	A	A	4	M
Spotted mackerel	P	P	P	P	A	A	A	A	4	M
Pearl perch	P	P	P	P	P	A	A	P	6	H
Hapuku	P	P	P	P	A	P	P	P	7	H
Bass groper	P	P	P	P	A	P	P	P	7	H
Black-spot pigfish	P	P	P	P	A	P	A	P	6	H
Narrow-barred Spanish mackerel	P	P	P	P	A	A	A	A	4	M

Note: Fishery Impact Factors are detailed in Table B2.2; P = Prone, A = Averse, L = Low, ML = Moderately Low, M = Moderate, MH = Moderately High, H = High

Resilience rating

Tables B2.4 and B2.5 described the categories and the decision rules that were considered to determine the resilience of the primary and key secondary species of the fishery. A summary of the factors and overall fishery impact ratings for those species is given in Table B2.26.

Like the fishery impact profiles, the outcomes for the resilience ratings suggest that the factors are a fair representation of the resilience of the primary and key secondary species. As expected, there were no species with low resilience, as the fishery does not target those species, which would generally be threatened species or some elasmobranchs that have limited distributions and have suffered severe population declines.

The three species with high resilience were all pelagic species, and are characterised by high fecundity, pelagic eggs and larvae, rapid growth rates and wide distributions. The three species with moderately low resilience were all elasmobranchs, and are characterised by low fecundity, slow growth rates and late maturity.

Table B2.26 Summary of resilience ratings for primary and key secondary species taken by the Ocean Trap and Line Fishery.

	Resilience Factors			**Number of Risk-Prone Factors**	**Resilience Rating**
	Reproductive Strategy	**Distribution and Abundance**	**Growth Rate and Longevity**		
Primary Species					
Yellowtail kingfish	A	A	P	1	MH
Snapper	A	A	P	1	MH
Leatherjackets (mixed)	P	A	A	1	MH
Silver trevally	A	A	P	1	MH
Australian bonito	A	A	A	0	H
Blue-eye trevalla	A	A	P	1	MH
Rubberlip morwong	A	A	P	1	MH
Yellowfin bream	A	A	P	1	MH
Bar cod	P	A	P	2	M
Gummy shark	2 x P	A	P	3	ML
Spanner crab	P	A	P	2	M
Key Secondary Species					
Sharks (mixed)	2 x P	A	P	3	ML
Wobbegong sharks	2 x P	A	P	3	ML
Silver sweep	A	A	P	1	MH
Mulloway	A	A	P	1	MH
Gemfish	A	P	P	2	M
Teraglin	A	A	P	1	MH
Jackass morwong	A	A	P	1	MH
Dolphinfish	A	A	A	0	H
Spotted mackerel	A	A	A	0	H
Pearl perch	A	A	P	1	MH
Hapuku	A	A	P	1	MH
Bass groper	A	A	P	1	MH
Black-spot pigfish	P	A	P	2	M
Narrow-barred Spanish mackerel	A	A	P	1	MH

Risk levels

Table B2.27 and Figure B2.7 detail the risk that the OTLF poses to the primary and key secondary species of the fishery. It is important to note the risk levels will be different in other fisheries, e.g. bar cod would be at low risk in the estuary general fishery. The risk is based on the integration of the fishery impact profile (which is specific to this fishery) and resilience of the species (which is the same for a species across all fisheries), and in the figure is presented using the risk matrix described in B2.1.4.2. Presenting the risk in this fashion allows species to be prioritised in terms of the strength of management actions that are required in the draft FMS to reduce the risk that the fishery poses to the sustainability of those species.

Clearly, the highest priority and the strongest management measures are required for species at high risk, irrespective of how many fish are caught or of their value to the fishery. That assumption has been made in the design of the fishery impact profile and needs to be carried through when determining management measures for the primary and key secondary species of the fishery.

Table B2.27 Summary of risk levels and management priorities for primary and key secondary species taken by the Ocean Trap and Line Fishery.

Species	Species Type	Fishery Impact Profile	Resilience	Risk
Wobbegong sharks	Key secondary	High	Moderately Low	High
Mixed sharks	Key secondary	High	Moderately Low	High
Bar cod	Primary	High	Moderate	High
Gummy shark	Primary	High	Moderately Low	High
Black-spot pigfish	Key secondary	High	Moderate	High
Hapuku	Key secondary	High	Moderately High	Moderately High
Bass groper	Key secondary	High	Moderately High	Moderately High
Leatherjackets (mixed)	Primary	High	Moderately High	Moderately High
Rubberlip morwong	Primary	High	Moderately High	Moderately High
Pearl perch	Key secondary	High	Moderately High	Moderately High
Australian bonito	Primary	High	High	Moderately High
Snapper	Primary	Moderately High	Moderately High	Moderately High
Yellowtail kingfish	Primary	Moderately High	Moderately High	Moderately High
Teraglin	Key secondary	Moderately High	Moderately High	Moderately High
Blue-eye trevalla	Primary	Moderate	Moderately High	Moderate
Silver trevally	Primary	Moderate	Moderately High	Moderate
Mulloway	Key secondary	Moderate	Moderately High	Moderate
Silver sweep	Key secondary	Moderate	Moderately High	Moderate
Spotted mackerel	Key secondary	Moderate	High	Moderate
Jackass morwong	Key secondary	Moderate	Moderately High	Moderate
Dolphinfish	Key secondary	Moderate	High	Moderate
Narrow-barred Spanish mackerel	Key secondary	Moderate	Moderately High	Moderate
Spanner crab	Primary	Moderately Low	Moderate	Moderately Low
Gemfish	Key secondary	Moderately Low	Moderate	Moderately Low
Yellowfin bream	Primary	Low	Moderately High	Low

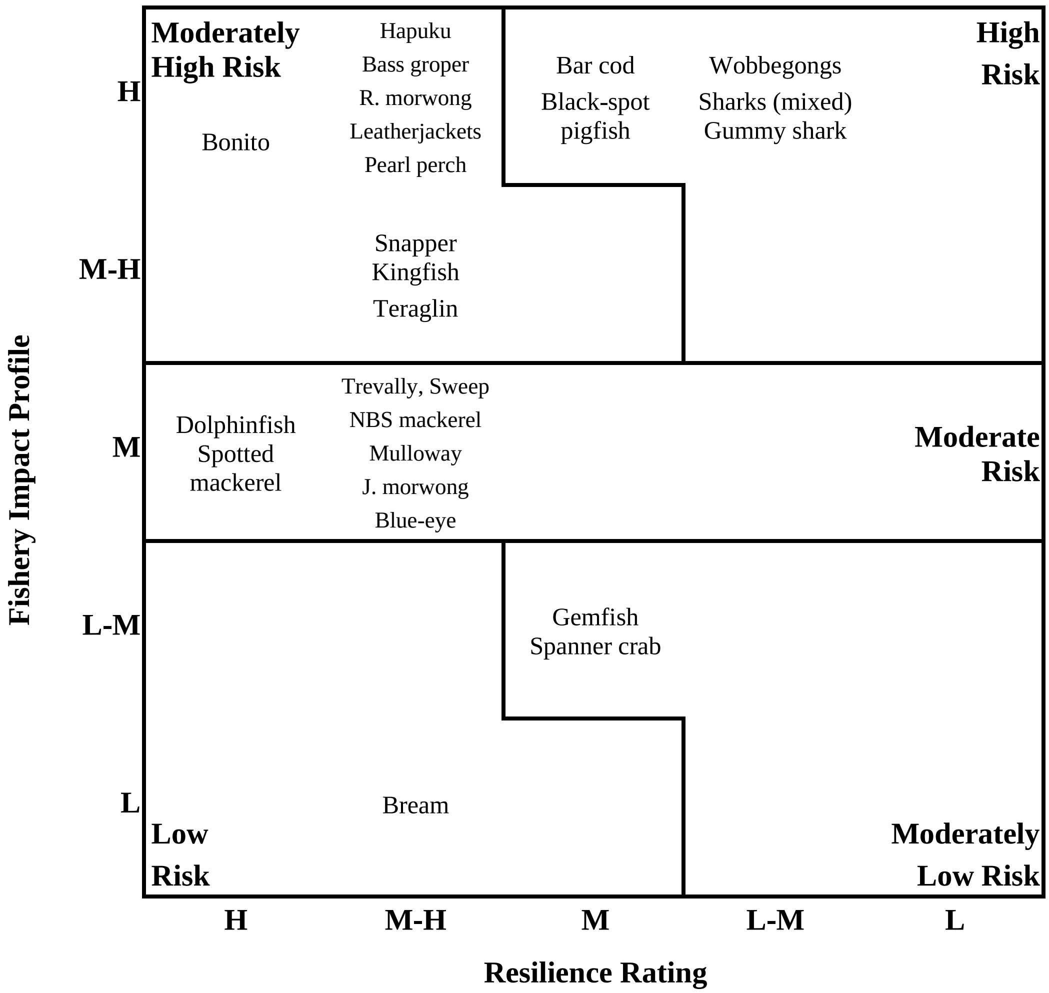


Figure B2.7 Levels of qualitative risk for primary and key secondary species taken by the Ocean Trap and Line Fishery

H – High, M-H – Moderate to High, M – Moderate, L-M – Low to Moderate, L – Low.

Five primary or key secondary taxa (20%) were determined to be at high risk due to the current operation of the fishery, two of which were primary species. Consistent with other fishery assessments and general research into elasmobranchs, the three groups of sharks targeted by this fishery are considered to be at high risk, indicating that immediate management action is needed for these taxa (Table B2.27 and Figure B2.7). The other species were bar cod and black-spot pigfish, which despite their moderate resilience, were considered high risk because of their high fishery impact profile. These species, except for pigfish, are predominantly caught using passive line methods. Bar cod are one of the few species in the fishery whose catches appear to be increasing over both the short and long-term, however, catches and CPUE are highly variable. This species was the most valuable in the fishery in terms of dollars per kilogram in 2001/02 at more than $10/kg. Anecdotal reports also indicate that it is a highly sought after recreational species, but without more accurate data it is not readily possible to determine the catch of that sector and thus its potential to influence any management measures for that species.

Nine taxa (36%) were determined to be at moderately high risk. These species all have moderately high resilience, except for bonito which has high resilience, and are caught by a variety of methods. Hapuku, bass groper and leatherjackets (mixed) represent the higher-risk end of this group, as they share seven of the eight risk-prone factors, whereas the others have six. The distinguishing factor is species identification, which is poor amongst those three species but is not a problem for rubberlip morwong, pearl perch, bonito, snapper, kingfish, or teraglin.

Eight taxa (32%) were determined to be at moderate risk, and are characterised by moderate fishery impact profile and moderately high or high resilience. Other fisheries (see Table B2.23) take the greatest proportion of the catch of these species, namely the Commonwealth's South East Fishery (blue-eye and jackass morwong), NSW Ocean Fish Trawl Fishery (trevally), NSW Estuary General Fishery (mulloway), Queensland's Northern Australian Small Mackerel Fishery (spotted mackerel and narrow-barred Spanish mackerel), and the NSW recreational fishery (mulloway, sweep, and dolphinfish). Cross-jurisdictional arrangements and monitoring of landings designed to better understand the status of these stocks should thus be the focus of management for these species.

Spanner crab and gemfish were determined to be at moderately-low risk. The stock status and structure of spanner crab has received considerable research attention and is well known, and is predominantly harvested in Queensland. Despite gemfish being overfished and have declining catches and CPUE, the other fishery impact profiles for the species were considered risk averse, resulting in a moderately-low profile and risk level.

Bream was the only species considered to be at low risk. Bream have moderately-high resilience and had only two risk-prone fishery impact factors, those of declining catches and CPUE. Short-term trends within the OTLF for these factors indicate that they have been reasonably stable or increasing, substantiating the low risk level assigned to this species.

B2.4.4.2 Risk to primary, key secondary and secondary species from discarding

As noted earlier, there is little information on the current rates of discarding of commercial species in the fishery, and the recording of in excess of 200 species suggests that species of any commercial value are retained other than those that are under MLL. Until quantitative data is gathered it is not possible to properly assess the impact of discarding on the biomass of the primary, key secondary and secondary species. However, some preliminary observations can be made based on the available information, which is limited both in its volume and its value.

Bycatch is that part of the total catch that is captured but not retained for sale (i.e. it is discarded). Catches of targeted species may also be discarded, particularly in fisheries that are managed using minimum legal lengths or output controls such as trip limits or annual quotas (Alverson *et al.*, 1994, Liggins 1996). Discarding of commercial species may also occur because some species have low economic value or there is limited market demand for that species at the time of capture (Kennelly 1995, Liggins 1996, Pascoe 1997, Cook 2001, Davis 2002).

The impacts of discarding can be serious because many fish do not survive (Liggins 1996, Jennings and Kaiser 1998, Dayton *et al.*, 1995, McLeay *et al.*, 2002, Davis 2002), thereby potentially increasing actual fishing mortality by a substantial amount. Mortalities of discards are highly variable and depend on biological, environmental and fishery operational factors (Liggins 1996, McLeay *et al.*, 2002, Davis 2002). Different fishing methods can cause different stresses to fish, which in turn, can lead to differential mortality rates for discards. For example, the three main methods used in the OTLF (spanner crab nets, fish traps and line fishing) should be expected to exert different stresses on fish and these stresses would be different to what would be expected in a trawl fishery. These different stresses may be expressed in terms of immediate or delayed mortality (caused by barotrauma, oxygen deprivation and ammonia toxicity, predation after release) or as sub-lethal effects (expressed as reduced fitness, reduced reproductive capacity, impaired immune response, behavioural change, and /or reduced growth rate).

Assessment of the impact of discarding on fish stocks requires accurate information detailing: (a) the species composition of discards; (b) the size of discards; (c) the quantity (number and/or weight) of discards for the fishery; (d) the proportion of catch discarded; and (e) the mortality rate of discards. Ideally this information would be collected for each main method used within a fishery. Discard data can only be quantified directly at sea. Some limited data on discards have been collected in the OTLF in two ways by: (1) using trained observers onboard commercial vessels to identify, count and measure the total retained and discarded catch; and (2) asking commercial fishers to record details of retained and discarded catch in voluntary logbooks. The following subsections contain descriptions of the available discard information for primary, key secondary and secondary species and the discussion has been divided according to the main methods used in the OTLF.

Spanner crab net

In 2001/02, the reported production from operations using spanner crab nets to target spanner crabs was restricted to spanner crabs, blue swimmer crabs and sand crabs (see Table B2.20). This observation suggests that either (a) this fishing method is very selective, (b) that fishers don't report other species against that method, (c) that the species that are occasionally caught are not marketable, and/or (d) a combination of these things are true. Anecdotal reports support the first scenario, that discard issues for commercial species other than the reported species of crabs are negligible, and that very few non-commercial species are caught and discarded. This is also supported by a fishery-independent monitoring program undertaken by Queensland DPI&F of their spanner crab fishery. The available data indicates that animals other than spanner crabs that are occasionally taken in the dillies include blue-swimmer crabs, juvenile flathead and flounder, as well as small gastropod and bivalve molluscs, solitary corals, sipunculids, brittle stars, sea urchins and drift algae (Brown *et al*., 2001, Dempster *et al*., 2004). The biomass of bycatch from 750 dilly lifts during the 2001 season totalled 3.226 kg (Brown *et al*., 2001), at an estimated average catch rate across all taxa of 0.0005 kg/trap lift. On the basis of the very low levels of reported bycatch, it was concluded that the risk of significant impact on bycatch populations was very low (Brown *et al*., 2001; Dempster *et al*., 2004). Further, the great majority were also considered likely to survive being caught provided they could be returned to the water within a reasonable time period (Brown *et al*., 2001; Dempster *et al*., 2004). As more than two-thirds of the catch was comprised of bivalve molluscs, this would seem to be a reasonable conclusion and given that the NSW fishery operates in adjacent waters and typically uses the same method, it is likely that the rates and composition of bycatch are similar in the spanner crab component of the OTLF.

Spanner crabs in NSW and Queensland have MLL of 9.3 and 10 cm, respectively (differences in measuring techniques means that retained crabs are in fact the same size in the two States), and the associated discard mortality of undersize spanner crabs in the relevant fisheries is a major issue (Kennelly *et al.*, 1990, Kennelly 1992, Brown *et al*., 1999). The MLL may protect a considerable proportion of the spawning population due to the estimated size at first maturity of between 60-70 mm in Australian waters (Fielding and Haley 1976; Brown *et al*., 2001), but it could be counteracted by a high discard rate, primarily of females, and high mortality rate of those discards. High mortality rates due to damage sustained when crabs were disentangled from spanner crab nets have been recorded in laboratory and field experiments (Kennelly *et al*., 1990; Brown *et al*., 1999). Crabs with one or more dactyli (parts of legs) removed during the disentanglement process had 60-70% mortality rates within 50 days, whilst 100% of crabs which lost whole limbs died after 8 days in laboratory conditions (Kennelly *et al.,* 1990). Brown *et al*. (1999) reported that 55% of crabs that lost whole limbs were likely to die after a few days. The implications of these high discard mortality rates for the spanner crab fishery are significant because the number of crabs discarded is also large. Kennelly (1992) found that about 75% of the available spanner crab population was undersize and that 69% of this discard were females. Kennelly (1992) concluded that "..handling mortality may affect (1) the availability of legal-sized crabs in the short term (the 31% of undersize crabs that are male and are caught and released), (2) the numbers of females and the fecundity of the population in the mid term, and consequently (3) the size of the exploitable stock in the long term." The response of fisheries managers to this discard problem was to implement a closure on the taking of spanner crabs during the spawning period, with the primary aim of protecting ovigerous females from discard mortality (Kennelly 1992). A similar approach has been adopted in Queensland and has been recommended for a similar fishery in Thailand for which reported landings have declined over recent years (Krajangdara and Watanabe 2005).

Blue swimmer crabs and sand crabs are important secondary species that are taken during fishing operations targeting spanner crabs. More than 6 tonnes of blue swimmer and sand crabs were harvested using spanner crab nets during 2001/02 (Table B2.20). Blue swimmer crabs have a MLL, so it is likely that some unknown quantity of these crabs are discarded, however there are no data to quantify any potential impacts due to discarding for this species.

Line fishing

In 2001/02, the reported production from operations using line fishing methods consisted of 114 taxa (see Tables B2.14 and B2.15). This observation indicates that line fishing methods are non-selective and that discard issues may be important for some commercial species. Although there have not been any targeted surveys of discarding associated with the line component of the fishery, estimates within the dropline fishery suggest that the ratio of retained to discarded catch is very high, > 50:1 (Deepwater Line Fishery Report in Kennelly and McVea, 2003). Discards are likely to comprise of gemfish (once the 50 kg trip limit has been exceeded) and small unmarketable species of sharks (Blue-eye Species Assessment in Kennelly and McVea, 2001).

Stewart *et al*., (2004) collected discard information on line-caught kingfish from 9 commercial fishers with a voluntary logbook system. The discard rates of kingfish, on a daily basis, were highly variable ranging from 0 to 97% (Stewart *et al*., 2004 and unpublished data). It was possible to calculate overall discard rates for 8 of the 9 commercial fishers that provided logbook data by pooling all data collected during the study for each fisher (Stewart *et al*., 2004). The overall discard rate from the 8 fishers was 48% (11115 of 23127 fish), and the mean discard rate was slightly higher at 57%, ranging from 26 to 76% for individual fishers. These findings indicate that for kingfish at least, the potential impacts of discarding mortality may be severe. It is not possible to quantify that potential impact, as we do not know the weights of those discarded fish, the number of fish that comprise the reported (in kilograms) landings, nor the mortality rates of discarded fish.

Demersal fish traps

In 2001/02, the reported production from operations using demersal fish traps consisted of 97 taxa (Tables B2.19 and B2.20). This observation indicates that this fishing method is non-selective and that discard issues may be important for some commercial species, although there is no indication of the spatial or temporal variability associated with discarding from fish traps. There is some indication from analyses of fisher activity and catch returns that trappers are able to target species in particular areas at certain times of the year, which is likely to minimise bycatch, however in the absence of a fishery-wide survey, it is not possible to quantify the specificity of fish traps.

Stewart and Ferrell (2001, 2002, 2003 and unpublished data) collected discard information from observers onboard commercial vessels and from a voluntary logbook system. Twenty-five taxa were documented during the observer and logbook study, and proportions of discards were recorded for some commercial species (Table B1.3). The study concluded that fish traps using standard 50 mm hexagonal mesh were inappropriate for all important species in the fishery with MLL, and that significant reductions in discards (ranging from 33-99% for snapper and tarwhine, respectively) could be achieved by using 50 x 75 mm mesh or greater (Stewart and Ferrell, 2002 and 2003). However, the use of 50 x 75 mm or larger mesh is likely to be accompanied by substantial losses of fish that currently have no MLL (e.g. ocean leatherjackets, trevally and pigfish), although they could have MLL in future.

It is important to note that the study of Stewart and Ferrell (2002) was done when the MLL for snapper was 28 cm Total Length (≅ 24 cm Fork Length) and most traps were made with 50 mm hexagonal mesh. Since the study of Stewart and Ferrell (2002) was done, the MLL of snapper has increased to and is currently 30 cm (≅ 26 cm FL), and it may be increased in future to 32 cm (≅ 27 cm FL). Assuming that the traps are currently retaining the same sized animals in the same proportions as when the study was done, the discard estimate of snapper would have increased from 30% to 52% using 50 mm hexagonal mesh, more than half the snapper caught in the traps (J. Stewart, unpublished data). The 50 mm hexagonal mesh is clearly inappropriate for use in the fishery. With the current MLL of 30 cm for snapper, which could yet be increased, the 50 x 75 mm mesh would also be inappropriate even though it would reduce discarding from 52% to 45%, and would require the use of larger mesh, such as 80 x 100 mm gabion wire (as investigated by Stewart and Ferrell, 2002, in the event of a size increases for snapper beyond 28 cm). The use of 80 x 100 mm gabion wire has its own problems, however, in that it is likely to be inappropriate for all other important species in the fishery (Stewart and Ferrell, 2002) due to loss of fish, indicating that it is not possible to use a single mesh configuration in a multi-species fishery based on the harvest of some species with MLL and many without. Further, gabion wire is heavier and more expensive than the other weldmesh products, making it a considerable logistical and financial burden to fishers, such that its widespread use in the fishery would be unlikely. The draft FMS should be investigating appropriate MLL for all primary and key secondary species of the fishery, and either use the selectivity data in Stewart and Ferrell (2002) or collect additional data to determine the necessary mesh configurations to design multiple types of fish traps to cater for the multi-species nature of the fishery.

Overall risk due to discarding

There is only limited information about discarding within the OTLF, and it does not provide a basis for determining the variability, extent, magnitude or fate of commercial bycatch. Therefore, as a precaution, a high level of risk is assigned to the threat that discarding poses to the sustainability of the commercial species and thus viability of the fishery.

B2.4.5 Issues arising from the risk analysis on primary, key secondary and secondary species

B2.4.5.1 Direct action on species at highest risk

Five taxa were determined to be at high risk, indicating that immediate and direct management action was needed for these taxa. Three of these were elasmobranchs, namely wobbegongs, gummy sharks and mixed sharks. Sharks are recognised both nationally (Shark Advisory Group and Lack, 2004) and internationally (Cavanagh *et al.*, 2003; IUCN, 2002; FAO, 2003a) as being at risk from commercial fishing. The typically slow growth rate, long life span and reproductive strategy of sharks is not conducive to rapid recovery after populations have been depleted (Walker, 1998). Specific and immediate action should be implemented to reduce the high risk on these species. Ideally, management strategies should include such things as providing adequate refuges from fishing mortality and protecting pupping and nursery areas, but as a minimum must include better identification and biological information. The National Plan of Action for the Conservation and Management of Sharks (Shark-Plan) (Shark Advisory Group and Lack, 2004) identifies 18 issues that need to be addressed in the management of sharks in Australia. Of these, nine are of direct relevance to this fishery and they are listed in Table B2.28. These issues should be considered in the draft FMS.

Table B2.28 Relevant issues from the National Plan of Action for the Conservation and Management of Sharks (Shark-Plan).

No.	Issues relevant to the Ocean Trap and Line fishery
1	The need to improve identification of shark species by all resource users.
2	The need for secure, accessible and validated data sets that are consistent over time with compatible resolution between jurisdictions over the full range of each species from all resource users.
6	The need for reliable assessments for bycatch and byproduct shark species.
7	The need for assessment of the adequacy of management for all shark species and more innovative approaches to dealing with identified shark management issues.
9	The need to reduce cryptic fishing mortality of shark species.
10	The need for an assessment of shark harvesting and handling practices.
12	The need for risk assessments for all shark species from all impacts on those species.
13	Where necessary develop strategies for the recovery of shark species and populations.
14	The need to reduce or, where necessary, eliminate shark bycatch.

Note: number denotes the issue number as listed in Shark-Plan (Shark Advisory Group and Lack, 2004).

The other species at high risk were bar cod and black-spot pigfish, which despite their moderate resilience, were considered high risk because of their high fishery impact profile. Stock assessments and information about their basic biology and ecology would remove a lot of the uncertainty associated with and reduce the overall risk to these species.

B2.4.5.2 Direct action on species at moderately high risk

Nine taxa were determined to be at moderately-high risk. They were determined as such for a variety of fishery-related factors, but particularly a lack of basic biological and ecological information and stock assessments, or for those that had assessments, they were deemed to be overfished. In addition, species identification is poor between hapuku and bass groper, and leatherjackets have been reported as mixed species. Clearly, fisher education to discriminate between species, and the ability to report as such on catch returns, is required before adequate stock assessments can be done on these species to reduce the risk. It would be prudent to initiate targeted research programs for these data-deficient species to improve the knowledge base and to make improvements to the way in which commercial catch data are reported. In the absence of better species discrimination and better biological understanding of these taxa it would be prudent to implement precautionary management strategies similar to those used for overfished species. This does not necessarily entail recovery programs, but should include the filling of the vast information gaps associated with these species. The long-term relative cost of collecting better information is expected to be far less than the costs associated with the implementation of possibly over-precautionary harvest strategies. The additional information will allow a better determination of exploitation status (and thus risk) for most species at moderately-high risk, some of which may be lower (such as bonito) and some higher (rubberlip morwong) than that assigned.

Those moderately-high risk species identified as growth overfished, namely snapper and kingfish, require appropriate management responses or recovery programs to identify ways to reduce fishing pressure with the aim of returning them to an exploitation status of fully fished. They are currently being taken at small sizes leading to below optimum yields from the fishery. It would be prudent to rebuild the stocks of these taxa and to introduce management measures that protect smaller fish, which in the medium to long term should also increase the yield to fishers. These species were identified as having significant discard issues (52 and 48%, respectively), indicating that as a minimum, any recovery program should be considering investigating the appropriateness of existing MLL, modifying the primary fishing methods for these species, investigating discard mortality rates, and the potential need for spatial, temporal or gear closures.

B2.4.5.3 Close monitoring for species at moderate risk

Eight taxa were determined to be at moderate risk, and the greatest proportion of the catch of these species is taken in other fisheries, thus reducing both the ability of and therefore strength of management responses within this fishery. These adjacent fisheries are subject to different management regimes even though the same species are often targeted and caught. This means that the effectiveness of management initiatives taken in a single jurisdiction may be undermined by the lack of complementary action in adjoining fishery areas. Ongoing consultation and complementary management arrangements with other NSW fisheries and Commonwealth fisheries will be crucial for these species. It will also be important that accurate landings and CPUE data are collected for these species, preferably as part of rudimentary stock assessments. Any increase in the fishery exploitation rating for these taxa would require immediate management action, as the result would be to increase them from moderate to moderately-high risk species. A detailed monitoring program aimed at these species is the best way of determining whether additional management actions are needed or if current management actions are sufficient.

B2.4.5.4 Lack of basic biological and ecological information and stock assessments for most primary and key secondary species

There is a paucity of basic biological and ecological information for most primary and key secondary species taken by the OTLF and most of them have not been assessed in terms of their levels of exploitation. Therefore, there is no quantitative data on which to base more effective management measures. This is a serious problem and a major obstacle to reducing the risk for primary and key secondary species. Recently within NSW DPI there has been a classification of stock assessment into five different types ranging from no information to status inferred via ecosystem indicators, or some other indirect measure, to a fully modelled assessment based on detailed data for a number of key parameters (Scandol, 2004). Together with the results of this risk assessment (see Figure B2.7), the different classes of stock assessment provide NSW DPI with valid options in prioritising species and the level of information needed to determine more accurate fishery exploitation statuses for the stocks taken by the OTLF. This should form an important part of the proposed FMS.

In addition, the draft FMS should seek in the longer term to gather similar information for some of the secondary species for which it is the primary commercial harvester in NSW, some of which are caught in larger volumes than some key secondary species, e.g. skipjack tuna, mackerel tuna and Samson fish. Many such species are also targeted by recreational fishers and owing to the uncertainty about catch volumes, although many are probably caught in greater amounts by the recreational sector, the draft FMS should develop a process by which cross-jurisdictional funding for research into those species can be achieved.

B2.4.5.5 Poor quality of commercial fishery data used in the risk assessment of primary, key secondary and secondary species

The accuracy of historical commercial fisheries data have been compromised by three major factors: (a) historical changes in form design; (b) the lack of independent validation of self-reported commercial fishery data; and (c) jurisdictional issues between the NSW and Commonwealth governments leading to the inclusion of South East Fishery data in the NSW catch records. The lack of reliable data on which to base appropriate management regimes creates a serious obstacle to identifying and mitigating the risk of unsustainable fishing-related impacts to primary, key secondary and secondary species. The draft FMS needs to address these data quality issues by making changes to the existing data collection system and by implementing a data quality assurance program. Improving the way information is recorded on the catch returns, changing from monthly to daily reporting, coupled with validation of reported landings by independent observers either on vessels and/or at local fish cooperatives would address a number of these issues and greatly increase the reliability of the database. Furthermore, appropriately designed fishery-independent surveys would also assist in improving the reliability of stock assessments (e.g. Ault *et al.*, 1999; Korsbrekke *et al.*, 2001), although such surveys may be cost prohibitive in terms of the size of this fishery. These measures would in turn allow the development and implementation of more effective management strategies.

B2.4.5.6 Discard issues

In light of the declining catches for the primary and key secondary species within the fishery, the knowledge gaps related to discarding need to be addressed to get a better understanding of fishing mortality. Some information exists about fisher activity and effort, but more information is required so that it can form the basis of designing fishery-wide studies to determine the spatial and temporal variability of discarding associated with each method. This needs to be coupled with species assessments to determine the optimal size at first capture for species of the fishery (i.e. more appropriate MLL) and in the case of the trap component of the fishery, more appropriate mesh sizes. Existing information for fish traps suggests that the current mesh size of 50 mm hexagonal mesh is totally inappropriate and needs to be changed. To mitigate losses of other commercial species, it may be necessary for fishers and managers to consider the use of more than one trap/mesh type for the fishery, as the use of a single mesh is clearly inappropriate in a multispecies fishery. If necessary, the use of such traps could be regulated spatially, temporally or by species, for example to target bream on inshore grounds or leatherjackets in offshore waters during certain times. The development of multiple trap types, however, is likely to be complicated in a move to a share-managed fishery.

Assessment of the impact of discarding on fish stocks requires accurate information detailing: (a) the species composition of discards; (b) the size of discards; (c) the quantity (number and/or weight) of discards for the fishery; (d) the proportion of catch discarded; and (e) the mortality rate of discards. Ideally this information should be collected for each main method used within a fishery. Research is urgently needed to address the information gaps that have been identified. An appropriately designed observer-based study could be used to quantify the species composition, fish sizes and quantity of discards. However, an assessment of discard mortality rates would be more difficult, probably requiring a series of well designed manipulative experiments to test various hypotheses. The draft FMS needs to adequately address these discarding issues because the unknown mortality due to discarding weakens stock assessments, increases uncertainty surrounding the determination of exploitation status for primary and key secondary species, and can lead to ineffective management choices.

B2.4.5.7 Consequences of information gaps

There are a number of substantial knowledge gaps that hinder the OTLF from being managed and fished in an ecologically sustainable manner. Evans and Grainger (2002) describe four main groups of information used in managing a fishery: fishery operations; biological and ecological; economic; and socio-cultural. With respect to the risk assessment of primary and key secondary species of the fishery, gaps exist in at least the first two groups. The paucity of basic biological and ecological information has been discussed at length in preceding sections. In the area of fishery operations, specific information is needed to describe the location of fishing grounds, the type of gear used and the site-specific frequency of fishing pressure. This information, combined with improved catch and effort returns, would provide an estimate of the spatial and temporal magnitude and variability of fishing pressure being exerted on the key species of the fishery. The location and area of fishing grounds will also provide potential information about fish habitats that would help improve our knowledge of fish ecology and may provide a better indication of the potential for impacts on habitats, which are currently thought to be low risk but also lacking information. There are many other gaps about the fishery’s operation but these highlight the main ones that could be filled relatively easily by the draft FMS. It is important that research is directed toward areas that will maximise our understanding of the biology and ecology of the primary and key secondary species and the actual fishing pressure exerted on them by this fishery.

The consequences of failing to adequately address the information gaps identified above, particularly fishery operations and biological and ecological information, needs to be understood. Information gaps lead to uncertainty in the appropriateness and/or effectiveness of management strategies instigated to reduce the risk of ecological unsustainability of fished stocks (e.g. Charles, 1998, 2001; Pitcher *et al.*, 1998; see also Humane Society International, 2004). The more uncertainty there is in a fishery the more precautionary the management measures must be to mitigate for possible long-term degradation to fish stocks and the ecosystem (FAO, 2003b). When precautionary management measures are implemented it is highly likely that they will include increased restrictions on fishers, which may in the short-term limit their revenue. Even so, when levels of uncertainty are high the introduction of precautionary measures still involves a large element of “educated guessing”. In the absence of information (and even sometimes with it), there is no guarantee that the selection of the precautionary actions will be sufficient to prevent the over-exploitation of primary, key secondary and secondary species.

The level of risk to these exploited species can only be reduced by: (a) obtaining relevant biological and fishery-related information to fill the information gaps that have been identified; and (b) using the information to make better management decisions. The ecological and economic consequences of management inaction or inability to implement appropriate research programs to fill the identified information gaps could be severe, long-term and possibly irreversible. The limited resources allocated for research dictate that careful consideration must be given to research projects that maximise our understanding of the biology of primary and key secondary species, and how and where the OTLF operates. The success of applied research done on limited budgets depends greatly on the cooperation of commercial fishers, other stakeholders and government.

B2.5 Risk Analysis of Threatened and Protected Species

The preliminary risk analysis at the broad ecosystem level indicated that most aspects of the fishery pose little or no risk to most threatened species, but that for other aspects, there was a high degree of uncertainty about the potential risk and/or which species were most at risk. The preliminary analysis indicated that it was necessary to consider 18 species of fish, 28 species of birds, seven species of mammals, four species of reptiles and one endangered population in this, the more detailed risk analysis. This section will aim to elucidate which of those species is thought to be at greatest risk due to the fishery, and the reasons for that risk.

Threatened species are protected by State and Commonwealth legislation that aims to conserve and promote their recovery. The risk ratings given below, therefore, refer to the risk that any aspect of the fishery would impede the conservation and recovery of a threatened species. The consequence of any impediment to conservation and recovery of the species would range from at best, maintenance of the existing situation, to at worst, further declines in the species.

For this assessment, 'threatened species' refers to any species, populations or ecological communities and their habitats as defined under Schedules 4 or 5 of the *Fisheries Management Act 1994* (FM Act), Schedules 1 or 2 of the *Threatened Species Conservation Act 1995* (TSC Act) or subdivisions C or D of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This assessment also includes any species of fish listed as protected under sections 19 (totally protected – not to be taken) or 20 (not to be taken by commercial fishers) of the FM Act.

B2.5.1 Risk identification

It is important to recognise that several processes may pose risks to a threatened species, population or community. In addition to the more generic potential risks posed by the operation of the fishery previously identified in Table B2.8, of which the higher risk ones are discussed below, a number of other sources of species-specific risks are identified in the species profiles (Appendix B2). In particular, various Key Threatening Processes (KTP) are listed under Schedule 6 of the *Fisheries Management Act 1994*, Schedule 3 of the *Threatened Species Conservation Act 1995* and are required by Section 183 of the *EPBC Act*. The object of listing key threatening processes under these various Acts is to manage and/or eliminate their impacts. The relevant KTP for the threatened species considered in Appendix B2 are listed below. Terrestrial-based KTP (e.g. predation by feral cat), whilst on the face of it may appear irrelevant, are relevant to the species in that these processes may affect nests, eggs, and juveniles of threatened species, compounding any potential impacts that may be exerted by the Ocean Trap and Line Fishery.

B2.5.1.1 Key Threatening Processes

Relevant KTP listed under the FM Act

Only two of the six KTP listed are likely to have any bearing on the assessments, as the other four are related to freshwater or riverine environments.

- Hook and line fishing in areas important for the survival of threatened fish species (henceforth abbreviated to "hook and line fishing").
- The current shark meshing program in NSW waters (henceforth "shark meshing").

Relevant KTP listed under the TSC Act

- Competition and grazing by the feral European rabbit, *Oryctolagus cuniculus (L.)*
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition
- Anthropogenic climate change
- Importation of red imported fire ants *Solenopsis invicta* Buren 1972
- Predation by the feral cat *Felis catus* (Linnaeus, 1758)
- Predation by the European red fox *Vulpes vulpes* (Linnaeus, 1758)
- Death or injury to marine species following capture in shark control programs on ocean beaches
- The entanglement in or ingestion of harmful marine debris by vertebrate marine life

Relevant KTP listed under the EPBC Act

- Competition and land degradation by feral goats (henceforth “feral goats”)
- Competition and land degradation by feral rabbits (henceforth “feral rabbits”)
- Incidental catch (or bycatch) of sea turtle during coastal otter-trawling operations within Australian waters north of 28 degrees south (henceforth “trawling north of 28° S”)
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations (henceforth “bycatch by longlines”)
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris (henceforth “harmful marine debris”).
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gasses (henceforth “greenhouse emissions”)
- Predation by feral cats
- Predation by the European red fox (*Vulpes vulpes*) (henceforth predation by foxes)
- Predation, habitat degradation, competition and disease transmission by feral pigs (henceforth “effects of feral pigs”)
- The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant) (henceforth “imported fire ants”).

B2.5.1.2 Other potential sources of risk

A range of other actual or potential sources of risk to particular threatened species have been identified in various publications including action plans, species recovery plans, and the general literature. These are mentioned where appropriate in each of the species profiles (see Appendix B2).

B2.5.1.3 Risks specific to the operation of the fishery

Table B2.8 identified discarding as the primary activity of the fishery that could be a potential source of risk to some threatened species. In addition, harvesting, via competition as opposed to capture, was also thought to be a threat for some marine mammals, reptiles and birds, and the potential risk posed by these activities will be assessed in finer detail below. Other activities of the fishery, such as ghost-fishing or contact without capture, were considered to be a low risk at the broad ecosystem level and will not be discussed in this section.

It is important to realise that even a very low incidence of catch of a threatened species could be above their threshold of sustainability. For example, the eastern population of Loggerhead turtles are estimated to be only able to withstand 100 human-induced deaths per year (C. Limpus, Qld EPA, pers. comm., 2003). Loggerhead turtles occur in three eastern states (Qld, NSW and Vic.) and are encountered by both State and Commonwealth fisheries. Whilst one fishery may only encounter these turtles a few times and as a result the turtles die, these deaths may push the human-induced mortality over the threshold of 100 and hence impair the recovery of this species. Therefore, it is not sufficient protection for some threatened species to rely solely on the minor incidences of encounters and conclude that no action should be taken to minimise the risks.

Harvesting

The collapse of natural prey stocks of a species can reduce the breeding success of its predators, as shown with pelagic feeding seabirds by Barrett and Krasnov (1996). Seals are commonly cited as competing with fishers harvesting activities when feeding, although the degree of overlap between seal diet and harvesting activities differs between regions (Carey, 1992; David, 1987). Interactions with seals in this fishery are likely to be restricted to the southern half of the State. Similar interactions are likely to occur for birds, sharks and dolphins, but there is very little quantitative data and none specific to the fishery. The OTLF should not interact with turtles in this way, as its harvest generally does not include the food source of turtles.

Some of the OTLF harvest includes species that may be preyed upon by seabirds. These comparatively small species can be found near the water's surface and include mackerels, tailor, yellowtail, calamari, cuttlefish, squid and dart. Any direct affects to seabirds from the harvesting of calamari, cuttlefish, squid and dart are only likely to be negligible, considering the small quantities of these species taken (i.e. around one tonne of calamari and cuttlefish and a few kilograms of squid and dart during 2001/02). Mackerels, tailor and yellowtail are secondary species in this fishery, so the size of this catch (around 16t for tailor and yellowtail and 30t for all mackerel species in 2001/02) would probably have low to minor consequences for competing seabird species. It should be noted that provisioning with discards (see below) may offset any reduction in food through capture, but it is not known to what extent this occurs for any species.

The overfishing or collapse of species that forage by herding concentrations of small baitfish to the water's surface can reduce the availability of food to seabirds. Species harvested in large numbers by the OTLF (i.e. on a primary and key secondary basis) that forage in this way include yellowtail kingfish, bonito, spotted mackerel and narrow-barred Spanish mackerel.

The removal of prey items is likely to have a similar, albeit largely unknown, impact on threatened fish, particularly the larger and relatively more cryptic species such as grey nurse shark and black cod. Snapper and kingfish (overfished species), as well as mackerels, mulloway, bonito and wrasses are likely prey of grey nurse and black cod and are targeted by this fishery. The removal of those species from the preferred feeding areas of grey nurse sharks could affect their behaviour in a multitude of ways, including but not limited to forcing them to move further afield in search of food or changing their feeding patterns and preferences. The extent and overall impact of these possible impacts is unknown.

Discarding

There are no published descriptions of the magnitude of discarding of threatened species within this fishery. Stewart and Ferrell (2002, 2003) examined discarding of commercial species of fish and of the non-commercial mado (*Atypichthys strigatus*), and these results were examined in section B2.4. Unpublished data from that same study, but from approximately 750 trap lifts from 15 fishers along the coast suggests that there is limited capture and thus discarding of threatened species within this fishery, and that most discarding that does occur is confined to undersized target species, in particular snapper. The only protected species (under section 20 of the FM Act) that was recorded was sub-adult eastern blue groper, of which 9 were caught and discarded, but it is not known what impact discarding has on those species. Further, fishing effort is poorly understood within the fishery so it is impossible to attempt to extrapolate this data for these fishers involved in the study, let alone across the fishery. It is probable that the majority of these sub-adult blue groper were captured in shallow inshore waters, where capture in a trap and associated discarding is unlikely to have a significant impact on the species. The removal of any fish from traps in deeper waters, however, would probably result in barotrauma and thus high mortalities.

In addition to the trap component of the fishery, there are also the various line methods, many of which are likely to result in the capture of either grey nurse sharks, great white sharks, black cod or blue groper. Capture and subsequent discarding by an attended method may result in less injuries or mortalities to those species, but passive methods are likely to result in much greater levels of harm, most probably death. In the case of grey nurse shark, such injuries or mortalities are likely to have a significant impact on the east coast population, which is considered endangered under the EPBC Act.

Setlining and similar unattended line methods and wire trace are currently banned within Critical Habitats and Buffer Zones for grey nurse sharks, and throughout Marine Parks, which should reduce the likelihood of capture by the fishery within those areas. Handlining (the Key Threatening Process for grey nurse sharks and black cod) and other attended line methods, however, are still permitted within both the Critical Habitats and Buffer Zones, which applies to both recreational and commercial fishers. Many commercial fishers use circle hooks when handlining, which are thought to reduce the likelihood of gut hooking based on some overseas studies of different species. Limiting the extent of the fishery and of the methods may provide some protection for grey nurse sharks and to a lesser extent blue groper and black cod whilst they are within such areas, but offer little to no protection once they move out of the Critical Habitat.

As with incidences of capture in the trap sector of the fishery, there are no quantitative data upon which to base an assessment of hook and line fishing, only anecdotal reports. Further, there are no estimates of post-release survival following hooking or capture in traps, which are necessary pieces of information in order to determine the potential impact on any of the threatened species. The extent, magnitude and degree of any interactions and potential impacts on threatened fishes are unknown, which presents a risk in and of itself that needs to be resolved in the draft FMS for the OTLF.

It is not known if seabird, seal and reptile bycatch is a significant problem in the OTLF, as no observations of the use of any gear type by this fishery have been made. The OTLF is currently not required to use any mitigating mechanisms to reduce the incidental capture of seabirds, mammals or reptiles.

The incidental capture of seabirds on both pelagic and demersal longline fishing gear has been widely documented (e.g. Brothers, 1991; Barnes *et al.*, 1997; Cherel *et al.*, 1996). Population declines of some seabird species, especially albatrosses, have been linked to this threat (e.g. Weimerskirch and

Jouventin, 1987). It is during the setting of longline gear, when seabirds forage on baited hooks at the water's surface, that most birds are hooked and ultimately drowned (Commonwealth of Australia, 2003). The likelihood of this occurring depends upon such factors as the longline type, buoyancy of the line and bait, weight on the end of the line, speed of deployment, boat speed and the use of bird capture mitigation techniques (Commonwealth of Australia, 2003). Birds can also hook up or entangle during line hauling, when they scavenge on unspent bait. These birds either escape or are released alive, and it is not known if they survive any resulting injuries (Commonwealth of Australia, 2003).

Demersal (trotlines) and mid-water (setlines) longlines can be used by the OTLF throughout its area of operation. OTLF fishers could possibly catch seabirds when using such gear types, as significant seabird bycatch on similar demersal longline gear used in South African and Antarctic waters has been recorded (Barnes *et al.*, 1997; Cherel *et al.*, 1996). However, the only significant observations of demersal longlining in Australian waters, occurring as part of the Commonwealth South-east Non Trawl Fishery, suggest that seabird bycatch may not be a significant problem for this gear type in Australian waters, as in all there were no interactions recorded on the 233,500 hooks observed (Commonwealth of Australia, 2003).

The OTLF widely uses droplines (another type of demersal longline gear) generally in deepwater areas >183 m deep. When set, this gear type drops vertically and fast, resulting in minimal likelihood of seabird bycatch (Commonwealth of Australia, 2003). Observations of dropline fishing under the Commonwealth South-east Non-trawl Fishery support this claim as there were no seabirds hooked in the 462 sets / 51640 hooks observed (Commonwealth of Australia, 2003).

Pelagic longlining occurs between 3-200 nm along the NSW coast and is a Commonwealth fishing method used to target species like tuna. This fishery overlaps with the OTLF between 3-80 nm and some fishers may have endorsements in both fisheries. While pelagic longlining does not exist as a method under the OTLF, there are no depth restrictions on the use of setlines by the OTLF, and there would only be subtle differences between the use of setlines at a pelagic level and pelagic longlining gear. While the OTLF catch statistics from 2001/02 indicate that fishers did not use their Commonwealth gear (i.e. setlines at a pelagic level) to target non-Commonwealth species, this is not an impossibility. Fishers using pelagic longline gear in the Commonwealth Domestic Tuna Longline Fishery are required to use mitigation techniques to reduce the recognised seabird bycatch problem, as prescribed in the Threat Abatement Plan for longline fishing and seabird bycatch (Environment Australia, 1998a). Commonwealth longline fishers may also use these mitigation techniques if they target non-Commonwealth species under the OTLF, especially as they minimise bait loss, any such targeting may only be occasional as indicated by the 2001/02 OTLF catch statistics.

Driftlines are another passive line fishing method that can be used in the OTLF throughout its range. Left to drift freely in ocean currents, this gear type fishes surface to mid-water pelagic waters, where the baited hooks may be within the reach of diving seabirds. Seabird bycatch from the use of driftlines is possible, especially if live bait is used, although this has never been documented.

The OTLF can use active line fishing methods (i.e. handlining, trolling, jigging and poling) throughout its area of operation. All these methods can be used near the water's surface where baited hooks may be within the reach of diving seabirds. The capture or entanglement of seabirds on this gear type is possible, especially if live bait is being used, however, due to the nature of these active gear types, any captures would be quickly retrieved and released. There is very little information on the capture of birds when using these gear types. Handlining has been identified as a method that is not likely to result in interactions with seabirds (Commonwealth of Australia, 2003), and observations of trolling off Western Australia recorded the capture of some diving seabird species (Commonwealth of Australia, 2003).

The incidental capture of other marine wildlife species on line fishing gear is not a widely documented problem. The incidental capture of turtles on longline gear has been reported in Hawaii, however the elimination of sets at the waters surface (up to 100 m depth) has reduced this capture (Polovina *et al.*, 2003). An appreciable number of turtle captures on bottom set longlines have been recorded in Malaysia, and these captures apparently had some chance of survival, although the depths and set times were not discussed (Chan *et al.*, 1988). The longlines and droplines used in the OTLF are generally set at depth and are thus likely to be beyond the more common foraging depths of turtles. Nearshore setlines, however, could be encountered by turtles and the small numbers of turtles that might be incidentally caught by these setlines are unlikely to survive, although there is no quantitative data on the actual number of mortalities associated with the gear of the fishery.

The traps used by the OTLF are generally set beyond the reach of any diving seabird and are too small to capture any cetacean. Seals may become stuck in traps when they attempt to forage on the bait (e.g. Warneke, 1975). While some Australian crab and lobster trap fisheries are known to have a bycatch impact on marine turtles (Environment Australia, 2003), this is probably largely due to entanglement in trap ropes (see below) rather than capture in the trap itself (Environment Australia, 1998b), and is reported to be the case in the Queensland Spanner Crab Fishery (Brown *et al.*, 2001).

Fishers are obliged to return any capture of threatened species to the water, whether it died in the process or has another chance at survival. The survival rate of threatened species after incidental capture is likely to differ between different animal groups and be influenced by the duration of time on deck, air temperature, handling techniques and presence of predators in the water surrounding the vessel. Animals that are returned to the water injured or suffering from trauma may not recover from this interaction, especially if they are released entangled in line and ropes or with embedded hooks. For some species, such as turtles and seabirds, simple on deck rehabilitation methods and the removal of embedded hooks and entangled line can be employed by fishers to increase their chance of survival (Ocean Watch, 2003). Handling of some threatened and protected species on deck to return them to the water can be very difficult due to their size and dangerous demeanour (e.g. sharks). Methods of releasing these species in a way that minimises harm to the fishers and increases their chance of survival are outlined in Ocean Watch 2003.

The discards from trap and line fishing, such as offal, unspent bait and bycatch, is a concentrated food source that can attract foraging seals, cetaceans and flocks of seabirds to fishing vessels (Olmos, 1997; Nitta and Hendersen, 1993; Commonwealth of Australia, 2003). By regularly feeding on fishing discards, animals provision part of their diet to this ‘unnatural’ food source. As shown with animals feeding on trawler discards, this food source can form a substantial part of the energy requirements of dependent animals, such as seabirds (Martinez-Abrain *et al.*, 2002; Oro and Ruiz, 1997; Thompson, 1992; Walter and Becker, 1997), resulting in positive benefits for some species (Blaber *et al.*, 1995). The cessation or reduction of this food source has been shown to have negative consequences for dependent species, such as seabirds (Chapdelaine and Rail, 1997; Oro, 1996; Oro *et al.*, 1996). The extent and effect of provisioning behaviour around trap and line fishing gear, including that of the OTLF, has not been studied. This is probably a reflection of the comparatively lower levels of discarding from these methods than trawling.

Restrictions to maintain offal on board during Commonwealth longline hauling and setting for seabird bycatch mitigation suggest that birds do feed on line fishing discards (Environment Australia, 1998a). The OTLF has been operating for some time and animals have probably adapted to feeding on its discards. As discussed above for seabirds, such provisioning behaviour in dependent populations appears to have positive benefits for the species and negative consequences should only be experienced if fishing activity ceased or was reduced. The species that feed from OTLF vessels, including any threatened species, have never been documented. Any species that are currently adapted to feeding on discards from the OTLF should not be experiencing any negative consequences from reduced food availability, as this fishery operates along the whole NSW coast and discards are available throughout the year and the various stages of a species breeding cycle. Provisioning species may however, become entangled or captured or ingest hooks left in unspent bait (Environment Australia 1998a). It is not known to what extent such interactions are occurring on species that may feed on OTLF discards. Research or further investigations into this matter could identify if the OTLF needs to take any mitigation actions. The OTLF is currently not required to use any techniques to reduce such seabird interactions.

B2.5.2 Risk characterisation

The approach taken to the risk assessment for threatened species will broadly follow that used for primary and key secondary species, i.e. a matrix contrasting a species resilience against the potential impact of the fishery, known as the fishery impact profile. First, aspects of the biology and distribution of the species that influence the population’s vulnerability to the fishery will be reviewed and a level of resilience will be assigned. Second, information to determine the fishery impact profile will be reviewed. The detailed information supporting the resilience levels and interaction ratings are reported in Appendix B2. Unlike the primary and key secondary species assessment, however, quantitative information necessary to determine the fishery impact profile for threatened species is not available. Reasons for this are, first, as a threatened species they are not retained or their interactions recorded, second, because these species are generally not abundant and therefore would rarely be caught, and third, because they are not marketable and therefore would be discarded. Consequently, other available information on capture of the species, along with consideration of the likely interactions based on habitat preference is used to assess a level of potential interaction with the fishery, which is given a rating of low, moderate or high. A risk level is then assigned to each species based on the risk matrix in Table B2.29, which is a modification of that used for the primary and key secondary species. It was modified because as threatened species they are highly unlikely to have high or moderately high levels of resilience, and assigning five levels of interaction would have been unnecessarily complicated (especially as those having no interaction were previously accepted as at low risk - section B2.2.3).

B2.5.2.1 Evaluation of resilience level

Biological characteristics used to determine the resilience of threatened species to disturbances caused by the fishery are the same as those used for the primary and key secondary species. The characteristics are fecundity, life history strategy, geographic distribution, habitat specificity, population size, growth rate, longevity, age at maturity and diet specificity. As threatened species, however, there is likely to be a paucity of such information. As a precautionary measure, whenever such information is lacking or non-existent, species will be considered to have low resilience.

B2.5.2.2 Evaluation of interactions with the fishery

Interaction with the fishery is based on the overlap between the species and the area in which the fishery operates (geographical and habitat), and where data are available, the frequency and/or the nature of the interaction is taken into account. The level of interaction is assigned according to the following guidelines.

Low: some contact with the fishery (including the influence of noise and light), capture or provisioning is possible, but number of individuals encountered is small enough to have a negligible impact and/or the effects of such encounters on individuals is negligible (based on survey information, other observations, geographic range).

Moderate: contact with a moderate number of individuals or relatively infrequent contact and/or effects moderate (e.g. could affect the growth or longer term survival of those individuals).

High: contact with a large number of individuals, or relatively frequent contact, such that death of the individuals, disruption of breeding, etc. is likely to occur.

B2.5.2.3 Risk matrix

The risk matrix in Table B2.29 provides a means of assigning one of five risk levels to a threatened species. The implications of, and appropriate management responses to the various risk levels are given in Tables B2.30 and B2.31, respectively.

Table B2.29 Risk matrix for the impact of the fishery on threatened species

Level of potential interaction with the fishery	**Resilience level**		
	Moderate	**Moderately low**	**Low**
Low	Low	Moderately low	Moderately low
Moderate	Moderately low	Moderate	Moderate
High	Moderate	Moderately high	High

Table B2.30 Interpretation of assigned risk levels

Risk	**Outcome for threatened species**
Low	Species unlikely to be affected
Moderately low	Possibly small effects but population unlikely to be affected
Moderate	Recovery likely to be impeded by the activity, further population declines in long term under the existing arrangements
Moderately high	Recovery impeded by the activity, further population declines in short-medium term under the existing arrangements
High	Recovery impeded by the activity, further population declines or extinctions imminent under the existing arrangements

Table B2.31 Examples of management actions required to address the various risk levels

Risk	**Management response required**
Low	None
Moderately low	None at present, but changes to the activity may require reappraisal
Moderate	Reduction in effort in the affected area(s) pending research into impacts or other indirect response that minimises risk
Moderately high	Direct response required to reduce effort in the affected area(s) pending research into impacts or other indirect response that significantly reduces risk
High	Direct response to either suspend particular fishing method or development of spatial and temporal closures pending research into impacts

B2.5.2.4 Risks to threatened species of the current activity

Risk to each species is summarised in Table B2.32, and detailed information supporting these risk assessments is provided in Appendix B2. As discussed above, the risk to species was determined using a combination of a species' biological resilience and the potential degree of overlap and interaction with the fishery. These factors and the resulting risk level calculated from the risk matrix are also summarised in the table, and discussed in detail in Appendix B2.

The detailed risk assessment (Appendix B2) found that of the 18 threatened species of fish, 15 were at low or low-moderate risk and thus considered unlikely to be affected by the current operation of the fishery. The remaining three species, namely grey nurse shark (listed as a Critically Endangered Population under the EPBC Act), black cod and great white shark were at high, moderately-high and moderate risk, respectively, and thus require indirect or direct management responses within the draft FMS to reduce the risks of the fishery to those species.

Grey nurse sharks were assessed as at high risk, suggesting that the fishery is likely to cause further population declines in the short term, and requiring direct measures in the draft FMS to reduce this risk. The high risk level was due to their low resilience and significant overlap and interaction with the fishery, even though many methods of the fishery are prohibited within Critical Habitat areas and adjacent Buffer Zones. As the draft FMS is unable to modify the resilience of the species, it will be important that measures are introduced that significantly reduce either the spatial overlap with the fishery, and/or the impact of any interaction. Mindful that some spatial closures already exist as part of the draft recovery plan within and adjacent to the Critical Habitats of grey nurse sharks, to adequately the reduce the current risk the draft FMS will need to focus on modifying the methods used in critical habitats, buffer zones and other areas utilised by grey nurse sharks. Although traps pose a lesser threat to the species than line methods, their potential for removing prey items of the shark should not be ignored when considering options for strengthening the existing restrictions on trap and line methods to protect the species. In addition, the draft FMS should consider restricting the use of unattended line methods in other important areas for the species that are not currently listed as Critical Habitat (e.g. Mermaid Reef - see Appendix B2).

Black cod were assessed as moderately-high risk, suggesting that the fishery may impede the recovery of the species over the short-medium term, and requiring direct measures in the draft FMS to reduce this risk. The moderately-high risk level was due to the species' moderately-low resilience and its potentially high degree of overlap and interaction with the fishery, although little is known about the species other than it is known to occur in many rocky reefs frequented by grey nurse sharks. Some of this potential interaction is due to the fact that serranids are difficult to identify, are invariably reported as unidentified serranids on catch returns, and that black cod have been reported on catch returns in the past. A better understanding of its distribution, abundance, and capture/release rate by the fishery would allow a far more accurate and less precautionary assessment of the risk to black cod. Any measures introduced in the draft FMS to protect grey nurse shark are also likely to reduce the risk for black cod. In addition, the draft FMS should implement measures that seek to obtain information about the actual rate of interaction with the fishery, preferably through the use of observer surveys in the short term, consistency with the recovery plan for black cod when it is written, and changes to the catch reporting forms for a longer term understanding of interactions.

Great white sharks were assessed as at moderate risk, suggesting that the fishery may impede the recovery of the species over the longer term, and requiring as a minimum indirect measures in the draft FMS to reduce this risk. The moderate risk level was due to their low resilience and moderate overlap with the fishery. It is important to note that whilst there is considerable spatial overlap between the fishery and great white sharks, there is no information about the extent of any interactions, necessitating a more precautionary estimate of overlap/interaction than is probably the case in the fishery. They are protected from fishing under s19 of the FM Act and as such are not reported on catch returns and there have not been any studies (observer or fisher recording) to determine the degree of interaction. Further, line fishing is a KTP for the species and the fishery targets many species that may otherwise be prey for great whites. As with black cod, quantitative information about interactions is likely to reduce this risk level.

Table B2.32 Summary of risks to threatened and protected species from the fishery

Common name	Legislation	Status	Resilience	Overlap and interaction	Risk level
Fish					
Australian bass	FM	P20	Mod	Low	Low
Ballina angelfish	FM	P19	Low*	Low	Low-Mod
Black cod	FM	V, P19	Low-Mod	High	**Mod-High**
Black marlin	FM	P20	Mod	Low	Low
Blue groper	FM	P20	Mod	Mod	Low-Mod
Blue marlin	FM	P20	Low	Low	Low-Mod
Eastern blue devil	FM	P19	Low*	Low	Low-Mod
Elegant wrasse	FM	P19	Mod	Low	Low-Mod
Estuary cod	FM	P19	Low-Mod	Low	Low-Mod
Estuary perch	FM	P20	Low-Mod*	Low	Low-Mod
Giant Queensland groper	FM	P19	Low-Mod	Low	Low-Mod
Great white shark	FM; EPBC	V	Low	Mod	**Moderate**
Green sawfish	FM	E	Low	Low	Low-Mod
Grey nurse shark	FM; EPBC	E; CEP	Low	High	**High**
Herbsts nurse shark	FM	P19	Low	Low	Low-Mod
Southern bluefin tuna	FM	E	Low	Low	Low-Mod
Striped marlin	FM	P20	Mod	Low	Low
Whale shark	EPBC	V	Low	Low	Low-Mod
Birds					
Antipodean albatross	EPBC & TSC	V	Low	Low	Low-Mod
Black-browed albatross	EPBC; TSC	P248; V	Low	Low	Low-Mod
Black-winged petrel	EPBC; TSC	P248; V	Low	Low	Low-Mod
Buller's albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Campbell albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Flesh-footed shearwater	EPBC; TSC	P248; V	Low	Low	Low-Mod
Gibson's albatross	EPBC & TSC	V	Low	Low	Low-Mod
Gould's petrel	EPBC & TSC	E	Low	Low	Low-Mod
Grey ternlet	EPBC; TSC	P248; V	Low	Low	Low-Mod
Indian yellow-nosed albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Kermadec petrel (western)	EPBC & TSC	V	Low	Low	Low-Mod
Little penguin population (Manly)	TSC	EP	Low	Low	Low-Mod
Little shearwater	EPBC; TSC	P248; V	Low	Low	Low-Mod
Little tern	EPBC; TSC	P248; E	Low	Low	Low-Mod
Northern giant-petrel	EPBC & TSC	V	Low	Low	Low-Mod
Northern royal albatross	EPBC	E	Low	Low	Low-Mod

Table B2.32 cont.

Common name	Legislation	Status	Resilience	Overlap and interaction	Risk level
Birds cont.					
Osprey	EPBC; TSC	P248; V	Low	Low	Low-Mod
Providence petrel	EPBC; TSC	P248; V	Low	Low	Low-Mod
Red-tailed tropicbird	EPBC; TSC	P248; V	Low	Low	Low-Mod
Salvin’s albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Shy albatross	EPBC & TSC	V	Low	Low	Low-Mod
Sooty albatross	EPBC & TSC	V	Low	Low	Low-Mod
Sooty tern	EPBC; TSC	P248; V	Low	Low	Low-Mod
Southern giant-petrel	EPBC & TSC	E	Low	Low	Low-Mod
Southern royal albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Wandering albatross	EPBC; TSC	V; E	Low	Low	Low-Mod
White tern	EPBC; TSC	P248; V	Low	Low	Low-Mod
White-bellied storm petrel	EPBC & TSC	V	Low	Low	Low-Mod
White-capped albatross	EPBC; NPW	V; P	Low	Low	Low-Mod
Mammals					
Australian fur-seal	EPBC; TSC	P248; V	Low	Low	Low-Mod
Blue whale	EPBC & TSC	E	Low	Low	Low-Mod
Dugong	EPBC; TSC	P248; E	Low	Low	Low-Mod
Humpback whale	EPBC & TSC	V	Low	Low	Low-Mod
New Zealand fur-seal	EPBC; TSC	P248; V	Low	Low	Low-Mod
Southern right whale	EPBC; TSC	E; V	Low	Low	Low-Mod
Sperm whale	EPBC; TSC	P248; V	Low	Low	Low-Mod
Reptiles					
Green turtle	EPBC & TSC	V	Low	Low	Low-Mod
Hawksbill turtle	EPBC; NPW	V; P	Low	Low	Low-Mod
Leatherback turtle	EPBC & TSC	V	Low	Low	Low-Mod
Loggerhead turtle	EPBC & TSC	E	Low	Low	Low-Mod

Where FM = Fisheries Management Act; TSC = Threatened Species Conservation Act; EPBC = Environment Protection and Biodiversity Conservation Act; NPW = National Parks and Wildlife Act; Mod-Low = moderate low; CEP = critically endangered population; E = endangered; EP = endangered population; V = vulnerable; u/c = currently under consideration for listing; P = protected; P19 = protected under Section 19 of the FM Act, P20 = protected under section 20 of the FM Act and P248 = protected under Section 248 of the EPBC Act; * = highly uncertain, limited information.

B2.5.3 Issues arising from the risk assessment for threatened species

B2.5.3.1 Grey nurse sharks and black cod

The risk assessment for grey nurse sharks and black cod indicates that these species could be at high and moderately-high risk, respectively, due to the current operation of the fishery, and as such require direct management action in the draft FMS to reduce the risk. Consistent with the NSW draft recovery plan for grey nurse, the fishery is already limited to certain methods within Marine Parks and the Critical Habitats and adjacent Buffer Zones for the species, but the draft FMS needs to consider areas beyond those areas, and/or strengthening the existing restrictions within Critical Habitats. Closing Critical Habitats and/or Buffer Zones to all OTLF fishing or high risk line fishing methods would remove or reduce risk from the fishery in these areas, but for the purposes of equity, dealing with the risk of the KTP and minimising conflict, would require similar restrictions on recreational fishers, as they are also able to conduct the KTP of hook and line fishing in those areas. Such measures are beyond the scope of the draft FMS and should be addressed in the recovery plan for the species. In particular, the removal of all hook and line fishing (the KTP for the species) from Critical Habitats, if introduced through the recovery plan, would significantly reduce both the overlap and potential for interaction between the OTLF and those species, reducing the potential risk. The selection of additional Critical Habitats may also be required, but would also have to be done through the recovery plan.

A measure that the draft FMS could impose would be to prohibit trapping from within Critical Habitats, a measure that is already used within some NSW Marine Parks to offer additional protection to the food resources of grey nurse. Trapping is relatively low risk method, however, and although it could afford some indirect benefit to the shark, the high risk methods such as handlining and setlining should be the focus of mitigative measures. These methods are KTP for these species and for great white sharks and as such are considered most likely to affect the species. Modifying line methods across the fishery means that some protection may be afforded to these species once they move outside of Marine Parks and Critical Habitats. Examples of modifications could include the use of circle hooks for all line methods other than trolling, jigging or poling; prohibiting night fishing within critical habitats; limits on the number, type and size of hooks deployed; prohibiting the use of wire trace; and recording the length of time and location of gear deployment through the use of a Vessel Monitoring System (VMS). Importantly, the draft FMS will need to be consistent with and responsive to the Threat Abatement Plan for Hook and Line Fishing in Areas Important for Threatened Species, when it is written.

B2.5.3.2 Ongoing monitoring of interaction between OTLF and threatened species

The majority of threatened species assessed are considered to be at low or moderately low risk from the operation of the fishery. Those species are not likely to be affected by the fishery and do not require further management attention in the short term, although mindful that their numbers and distributions may increase over time, the draft FMS needs to include a mechanism to review interactions in the future. There should also be better coordination of data gathering between fisheries staff of the DPI and staff of the Department of Environment and Conservation (DEC), as DEC staff are responsible for marine mammals, but do not currently have an accurate understanding of which fishing gear a mammal has interacted with. As occurred recently in August 2004, a whale was cut free of fishing gear, but it was alternately described as fishing gear and marine debris, and the headgear disposed of instead of being retained. Rather than just recording an incident, gear should be returned to a Fisheries office to allow identification, which should always be possible if floats are kept as they have to be marked with a fishers business number.

They are also likely to benefit from any measures implemented for species at higher risk levels, and there would be increased certainty in the risks assigned to these species if there was a better understanding of spatial and temporal effort distribution of the fishery. This information is likely to take a considerable time to collate and to maximise accuracy, would best be collected using VMS. This has the added advantage of allowing remote monitoring of compliance with any closures or protected areas that may apply to the fishery.

Those species at moderate to high risk require ongoing monitoring of interactions with the fishery. As a minimum, this should include some form of onboard observer program, which would include reporting on fishery interactions with threatened species, including bycatch, provisioning and disturbance. This would require observers trained in identification of marine birds, mammals and turtles, and may require additional observers to focus on these taxa from time to time. The results of the observer program and associated report should be the focus of an internal and external review, and any issues arising from the review should be the basis for determining the need for further work. The report and review should be made available to the public, and the draft FMS should include provisions for repeating the program 3-5 years after the initial survey. In between surveys, if VMS were introduced onto vessels of the fishery, it would allow future observer programs to focus into those areas of highest fishing activity and/or abundance of threatened species.

B2.5.3.3 Mechanism to incorporate future listings of threatened species into management measures

The draft FMS will need a mechanism to incorporate future listings of species and recovery plans under threatened species legislation, either immediately as they are listed or via a review of listed species during annual or biennial reporting on the fishery. For example, the fishery currently retains the endeavour dogfish and other dogfishes, gemfish, school shark and very rarely southern blue fin tuna, however, the Commonwealth's Threatened Species Scientific Committee is currently considering nominations to list those species under the EPBC Act. Many of the other dogfishes and similar types of sharks are also recognised as needing stronger conservation measures (Pogonoski *et al.*, 2002). The draft FMS for the OTLF will need to ensure that any such species that is regularly caught in the fishery can be adequately protected if required. Consequently, the draft FMS will need to include provisions to ensure consistency with any Recovery Plans developed for threatened species, as is currently the case with grey nurse sharks.

B2.5.3.4 Limited information

The assessment on birds, mammals and reptiles has been largely based on information from similar fisheries that operate in other areas where there may be considerable local differences in the use of gear types and species abundances. There have been no formal observations of the OTLF, and information on the operation of the various gear types in this fishery (for example where, how often, how deep, how long set for, how often is gear lost etc) is poor, making comparisons with the information available from other fisheries difficult. Observations of OTLF activities would remove any uncertainty that is linked to this assessment, especially for active line fishing methods as observations of the non-target bycatch from these methods are particularly sparse. We do not know which species forage on the discards from the OTLF and the degree to which they may depend upon these discards. Any future changes to fishing practices, such as the closure of some fishing areas could adversely affect threatened species that may have become dependent on this food source. More information is needed in order to quantify the importance of fishing discards in the diets of threatened species for this issue to be properly addressed in future. It is recommended that this issue be examined as part of any onboard observer program, by quantifying the frequency of feeding on discards and estimating the proportion of the diet that comes from this source.

B3 Biophysical Environment

The operations of the OTLF were assessed to determine whether they were causing a major effect on three components of the biophysical environment – water quality, noise/light regimes and greenhouse gases (including air quality). A risk assessment was done for each component to determine whether further detailed assessment was needed for any components at high risk (see Appendix A2 - DP Guidelines). Therefore, the risk assessments for these components will be presented together and then, if necessary, a more detailed assessment for each separately.

B3.1 General Background Information on Biophysical Components

B3.1.1 Water quality

The operations of the OTLF that could potentially be sources of pollutants affecting water quality are: antifouling agents, discharge of chemicals, fuel or bilge water, discharge/dumping of debris and waste from on-board processing of fish.

Antifouling agents are painted on boat hulls to reduce marine growth and the consequent loss of performance of the vessel. Over the past two decades, the active ingredient of the most effective antifouling paints, tributyltin (TBT), has been shown to harm the marine environment (Batley *et al.*, 1992; Scammell *et al.*, 1991). It accumulates in the food chain, killing and impacting sea life other than that attached to hulls. Now, under a convention passed by the International Maritime Organisation (IMO) in October 2001, antifouling paints containing TBT are not to be applied to vessels less than 25 m in length, and such coatings on vessels longer than 25 m are to be completely removed from service by the beginning of 2008 (www.cmit.csiro.au, 2003). Therefore, all the vessels in the OTLF should no longer being using TBT based paints. But it is not known whether the older vessels in the fishery still contain traces of this paint on their hulls, nor what proportion they make up. Vessels in the fishery will generally treat their hulls with antifouling paint (non-toxic) once a year in dry docks. Recently, the federal government has published a Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance (Scammell and Baker, 2004). Whilst the code of practice is not compulsory boat owners who adhere to it will further minimise pollution to the water from anti-fouling paint.

Serious accidental or deliberate discharges of chemicals, fuel or bilge water from OTLF vessels are likely to be rare because fishers are very aware of their public image and are careful not to allow discharges of this nature to occur. Modern engines and fuel systems are easily managed so individual spills are only likely to be minor. Some oil and fuel could be spilt during routine maintenance and re-fuelling at ports but these are usually handled by established oil pollution response plans for each port (NSW Waterways Authority, 2003a). In fact the NSW Environment Protection Authority (now Department of Environment and Conservation) reported no minor, moderate or major oils occurring from OTLF commercial fishing vessels from 1996-1999 (NSW EPA, 2000). All bilge water must be discharged into proper pump-out facilities available at ports from which OTLF vessels operate, so spillage of bilge water into the sea is unlikely.

Debris potentially dumped or discharged from vessels could include plastic, paper and pieces of fishing gear. Such materials are non-toxic but may injure marine wildlife (Jones, 1995). Some items, like plastic bags, can be ingested by some marine animals mistaking them for food such as jelly fish. Most studies of debris found on Australian beaches have recorded fishing related items (e.g. Slater, 1991; Haynes, 1997; Herfort, 1997; Whiting, 1998; Cunningham and Wilson, 2003; Kiessling, 2003), indicating its presence in the surrounding ocean (Jones, 1995). A study of selected ocean beaches in NSW found 13% of the debris to be fishing related, 60% of which was from commercial origins and the remaining 40% recreational (Herfort, 1997). Amongst the fishing debris recorded on NSW beaches, a noted dominance of prawn trawl debris on the state's northern beaches, fish trawl debris on the southern beaches and recreational fishing gear on beaches around urban centres, especially those on the central coast of NSW, was correlated to the distribution and intensity of these activities along the NSW coast (Herfort, 1997). The study found 134 fishing debris items/km of beach, items included recreational fishing line, floats, commercial netting and ropes (Herfort, 1997). The fishing debris found included items of both commercial and recreational origins that could entangle marine wildlife, such as intact pieces of trawl mesh and recreational fishing line (Herfort, 1997). The recorded fishing debris items that could be ingested by marine wildlife were small fragments of commercial trawl nets and recreational bait bags and lures (Herfort, 1997). However, Frost and Cullen (1997) in a study of four northern beaches of NSW found no commercial fishing gear on these beaches. Because members of the public are very conscious of gross litter commercial fishers have become increasingly conscious of obvious pollution within their environment. Therefore, deliberate incidents of dumping of debris by the OTLF would be minor.

Sources of waste discharged at sea include by products of fish processing (guts, heads), unused or uneaten bait (particularly from fish traps). Processing of some species is limited due the prohibition of finning sharks and filleting species with minimum legal lengths. Fish consume most bait, however traps may occasionally be retrieved with intact bait, which may be discarded overboard. Small, loose bait such as anchovies may also be wrapped in newspaper, which falls apart and dissolves. All of this material is readily biodegradable and may be assimilated into the marine food chain, with minimal ecological impact. Plastic bands from packaging of bait boxes were a conspicuous non-biodegradable item washed up on beaches (Hertfort, 1997), however this type of packaging is not commonly used in the fishery, and is currently being phased out of general use. Overall, the impact of dumping waste at sea is considered to be minimal.

B3.1.2 Noise and light

Noise from vessels in the OTLF come from the propeller, engine, auxiliary engines for winches and in a few cases refrigeration units. The level of noise generated by these sources for OTLF vessels is unknown and will depend upon the size of the engines. Based on similar fishing vessels overseas it is likely they contribute to the low frequency spectrum of underwater noise (Mitson and Knudsen, 2002). It is not known how far the noise from these sources penetrates the ocean during a typical day or night of fishing nor the level of noise generated.

There is a range of marine species that potentially could be affected by the noise of OTLF vessels including cetaceans, finfish and some marine birds. However, very little is known about the acoustic sensitivity of these animals for Australian waters. Whales and dolphins have been shown to have varying responses to human generated noise overseas (Clark, 1999; Croll *et al.*, 2001; Parijis and Corkeron, 2001). Impacts of noise from vessels will depend on the auditory sensitivity of the organism, the frequency level and magnitude of the noise generated by the vessel and frequency and duration of interactions between the fishing vessel and the organism. Noise from OTLF vessels could affect wildlife if fishing occurs in areas where noise-sensitive wildlife live. Given that fishing in this fishery does not usually occur immediately adjacent to land (unlike the estuary general or estuary prawn trawl fishery) no land based fauna would be affected. Very little is known about the effects of noise from vessels (including recreational and other commercial) in Australian waters on marine life.

B3.1.3 Greenhouse gases and air quality

Air quality and greenhouse gas (GHG) emissions are considered together because there is substantial overlap in the gases that contribute to them. The burning of petrol and diesel fuel to power engines (including auxiliary engines) of boats in the OTLF generates greenhouse gases, which include carbon dioxide, methane and nitrous oxide. These gases enhance the greenhouse effect of the earth's atmosphere (www.greenhouse.gov.au, 2004). Just over half the vessels in the OTLF have petrol-powered engines (292 boats or 55% of the fleet), while the remainder run diesel engines. Diesel and petrol fuels have similar CO_2 emission factors (69 kg CO_2/GJ and 65.3 kg CO_2/GJ, respectively). Therefore, they have a similar potential for greenhouse gas impacts, but would vary depending on engine efficiency and size of vessels.

B3.2 Risk Analysis of Biophysical Components

B3.2.1 Risk context

The risks being assessed for the biophysical environment can be defined as the likelihood that the components of the biophysical environment – water quality, noise and light and air quality - will be degraded, by the current activities of the Ocean Trap and Line Fishery, such that the populations of fauna, flora and humans associated with these components will become ecologically unsustainable or degraded within the next 20 years. This definition of risk explicitly describes the consequences for which risks are to be mitigated being: (a) the widespread degradation of the biophysical environment; and (b) ecologically unsustainable populations and communities of biota and humans associated with this environment.

B3.2.2 Risk identification

Table B3.1 indicates that there are two activities of the OTLF that potentially affect the components of the biophysical environment and their capacity to support ecologically sustainable populations of biota – gear loss and boat maintenance and emissions. Whilst they have some potential, the overall risk is considered to be low. Travel and disturbance due to presence in the areas are considered to have a negligible affect on the biophysical environment.

Table B3.1 Activities of the fishery that potentially contribute to impacts on components of the biophysical environment.

Biophysical Components	**Activities of the Ocean Trap and Line Fishery**			
	Loss of fishing gear	**Travel to/from grounds**	**Disturbance due to presence in the area**	**Boat maintenance and emissions**
Water quality	L	-	-	L
Noise/Light		-	-	L
Air quality & greenhouse gasses		-	-	L

B3.2.3 Risk characterisation

B3.2.3.1 Loss of gear

Water quality can be degraded by fishing gear debris. Occasionally, due to snagging and breaking of lines, fishers can loose parts of traps, ropes or lines at sea. The quantity of fishing debris washed up on beaches in northern Australia (Kiessling, 2003), south-eastern Australia (Slater, 1991) and NSW beaches (Herfort, 1997) has been documented. These studies found substantial amounts of fishing gear lost from vessels. Debris specific to the trap and line fishery on NSW beaches was rope from traps and pots, which made up 2.7% of all debris. (Hertfort 1997). The other main source of commercial fishing debris was trawl netting, which comprised 3.1% of all debris and strapping from bait boxes, which comprised 1%. This type of bait packaging is not commonly used in the fishery (K. Rowling, pers comm. 2004). Overall, it is considered that the risk of poorer water quality as a result of gear loss in the OTLF is low.

B3.2.3.2 Boat maintenance and emissions

Boat maintenance, both major and minor, would usually be done at the vessel's home port. Consequently, any oil or fuel spills are contained within the waters of the port, usually small to medium sized harbours. The likelihood of accidental spillages of small amounts of oil and fuel is very low. The EPA (2000) reported no major oil spills from fishing vessels in NSW causing pollution either at ports or out to sea in the period of 1996-1999. Therefore, the risk of boat maintenance contributing to degraded water quality is low.

Table B3.2 shows the estimated contribution of vessels to the national greenhouse gas emissions. According to the Australian Greenhouse Office (2004), domestic navigation (made up of pleasure craft, ferries, fishing boats and coastal shipping) contributed 1.58 Mt or 0.3% of total national GHG emissions in 2002. The contribution of pleasure craft was based on an estimate of 1% of domestic automotive gasoline sales being consumed by pleasure craft (National Greenhouse Gas Inventory Committee, 2003). It was assumed that commercial vessels made up the remainder of the contribution from domestic navigation. It was further assumed that NSW commercial domestic navigation makes up 25% of the national figure, and therefore contributes 25% of the national GHG emissions or 0.22 Mt of CO_2 equivalent per year. Finally, trap and line vessels comprise 7% of the total NSW commercial fleet (calculated from figures given by NSW Waterways Authority, 2003b and ABARE, 2004), thus contributing 0.0154 Mt or 0.003% of total GHG emissions.

Clearly this figure is based on several assumptions and should be used as a guide only. The main assumptions (other than those already mentioned) are that: 1) the composition of the NSW domestic commercial fleet (in terms of the size and fuel consumption of vessels) in NSW is representative of the national domestic commercial fleet; and 2) trap and line vessels are a representative sample of NSW commercial vessels (in terms of size and fuel consumption). Due to entry restrictions and restrictions on size of replacement vessels, it is unlikely that greenhouse emissions from the Ocean Trap and Line Fishery will increase significantly in the future.

Table B3.2 Estimated contribution to national GHG emissions from vessels in the fishery.

GHG Source	Mt CO2/yr	% of total	Comment	Data Source
Total GHG in 2002 (national)	550	100		a
Contribution from transport sector	79	14		a
Contribution of domestic navigation to total GHG emissions	1.58	0.3		a
Contribution of pleasure craft	0.7	0.12	Derived from information given in b (see text)	b
Contribution of commercial vessels	0.88	0.16	Subtraction of 4 from 3	Calculation
Assumed contribution of NSW commercial domestic navigation to national total	0.22	0.04	For the purpose of the argument, this is assumed to be 25% of the national figure	Assumption
Contribution of trap and line vessels	0.0154	0.003	Trap and line make up 7% of commercial fleet in NSW	c & d

Data sources: a) Australian Greenhouse Office, 2004; b) National Greenhouse Gas Inventory Committee, 2003; c) NSW Waterways Authority, 2003b; d) ABARE, 2004.

B3.3 Summary and Justification of Low Risk to the Biophysical Environment

The assessment found that all components of the biophysical environment were at low risk from the operations of the OTLF. The primary reasons for this are set out below:

i) regulations control and define certain activities that minimise or eliminate the potential for contamination of the environment e.g. disposing of bilge water, types of antifouling paint

ii) heightened awareness of fishers of gross pollution from their vessels including debris, noise and light. There is also high motivation by fishers to improve the image of their fishery to the general public resulting in diligent self-regulation of behaviour among fishers

iii) small number of boats operating in the fishery compared to other types of craft including recreational, other commercial and larger foreign vessels. Furthermore, because vessels in OTLF are not concentrated in any one port, do not always operate at exactly the same time of the day or year and primarily operate away from the coast, greenhouse gas emissions, light and noise disturbance are more dissipated than other fisheries, such as those operating within estuaries.

Therefore, there is no need for further detailed assessment of the risk to the biophysical environment as per DP Guidelines Section B3(b) and there are no issues arising that the need to be addressed by the draft FMS.

B4 Economic Issues

This section was prepared by Dominion Consulting Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Appendix B3.

This section has been compiled from a limited amount of existing information augmented by economic and social surveys by Roy Morgan Research, a number of reports prepared by NSW DPI and access to ABS data.

This section summarises the existing information on:

- investment in the fishery and businesses associated with it
- employment
- economic performance of the fishery
- economic multiplier effects, economic rents and community contributions
- markets for species harvested in the fishery, and
- overall risks to the economic viability of the fishery.

Existing information for the economic assessment was obtained from the following sources:

- NSW DPI - licensing and catch records
- results of the economic and social survey, and
- other publications with relevant material.

The OTLF is based all along the NSW coast and has a diverse range of fishing methods (Line, Demersal Fish Trap and Spanner Crab nets). In 2001/02, out of 624 Fishing Businesses (FB) endorsed to fish in the OTLF, only 354 (57%) FB were actively involved in OTL fishing and 89 (14%) FB fished only in other commercial fisheries (note: these figures are likely to be inconsistent with others previously presented in this report due to different dates of database extraction). The remaining 181 (29%) FB were not involved in fishing and are considered to be latent effort (see glossary for definitions of active and latent effort).

B4.1 Capital Investment in the Fishery

Capital investment in the fishery by fishers is in the form of vessels, equipment and licences. The available data comes from commercial boat brokers and indicates that capital investment in the Ocean Trap and Line Fishery ranges from approximately $50,000 to $250,000 and the average capital investment is approximately $110,000. Based on this information, the total capital investment in the 443 active OTL FB is estimated at approximately $48.7m. These are conservative capital investment estimates and should be treated with caution as more accurate information is needed on fishery licence and investment values. Information on investment in processing facilities and value adding in the seafood sector is not available, however information on Fish Receivers can provide some guidance as to the number of licensed processing facilities. On the basis of this information it is estimated that around 62 Fish Receivers with processing capability work with OTL species.

B4.2 Employment in the Fishery

The NSW fishing industry has direct and indirect employment. Current information is available for direct fisher employment only, with the social survey giving new employment estimates. There are between 991 and 1925 persons employed full-time (49%) and part-time (51%) in FB that hold an OTLF endorsement. In the survey sample, 34% of fishers had their marital partners involved in their fishing business, of which 46% were employed full-time. The estimates of employment need to be seen in the context of all fishing activity state-wide, rather than for each administered fishery and requires further investigation.

B4.3 Economic Performance of the Fishery

The economic survey enabled the economic performance of businesses in the OTLF to be appraised and gave an indication of the position of fishers to pay additional management costs and purchase shares under the draft FMS. Results from the economic survey were analysed to measure economic profit and to estimate the contribution of the fishery to individual, state and regional income. Estimates of economic profit were made using data collected through the survey. As many operators did not include owner's payment from fishing, or the cost of unpaid labour including family labour, an imputed wage rate was calculated. The economic costs included in the calculation of economic profit were: operating costs, - including the opportunity cost of capital; labour and economic depreciation.

In the 1997/98 to 2001/02 period, the fishery had annual average revenues of $9.8m, which was approximately 14% of the total annual fishery revenue from production in NSW.

In businesses with an OTL endorsement, the top 50% of fishing businesses take 92% of the fishery revenue and the lower 50% take only 8% of revenue. The economic survey of OTL fishing businesses for year 1999-2000 indicated that 28% of OTL business respondents are earning an economic surplus under the levels of opportunity costs and economic depreciation assumed for long-term viability. The remaining 72% of OTL fishing businesses were operating below long-term viability. The OTL businesses fishing in other fisheries had an average economic rate of return to capital of 5%. The OTL and OTL/Other businesses had a negative net economic return of -11% and -18% respectively. The average net return was -4%, with 50% of all OTL businesses having less than -23% net return. This is an indicator that existing arrangements are not achieving sufficient profitability in the fishery.

B4.4 Economic Multiplier Effects, Economic Rents and Community Contributions

The long term economic benefit of OTLF resources to society can only be realised through effective management of the fishery in a manner that generates resource rent. The currently low level of economic viability and depletion of fish stocks represent a loss to society. In addition, OTL fishers are currently only paying a portion of total management costs and the remaining costs are paid from public funds.

Economic multipliers come from input-output modelling of economies and relate to the flow-on impacts of expenditure within a closed local economy and the revolving benefits of this. The economic significance of an industry, such as commercial fishing, can be measured in terms of direct and indirect effects. The available literature is dated, but enables some discussion of multipliers in four fishing communities in NSW. Expenditure multipliers for non trawling sectors in both the southern and northern studies indicate that the ratio of all effects to direct fishing effects, is between 1.4 and 1.9. Income multipliers are 1.5, and employment multipliers are between 1.3 and 1.6. The available data indicates indirect effects are relatively low for the 3 categories of multipliers examined, reflecting the limited expenditure on inputs.

B4.5 Markets for Species Harvested in the Fishery

The OTLF supplied between 1,473 and 2,296 tonnes of fish during 1997/98-2001/02. The main species landed by the fishery in 2001/02 were snapper, spanner crabs, yellowtail kingfish, leatherjackets, bonito and silver trevally. Other key species include rubberlip morwong, blue-eye, gummy shark, bar cod and yellowfin bream. The economic survey revealed that the OTL fishers exported 7.4% of their product (by value).

The price of species in the OTLF depends on the method of capture, the handling of the species and the market examined. In the case of blue-eye and spanner crab, there has been a notable increase in average prices. The price per kg of blue-eye increased from $6.70 in 1992 to $9.90 in 2002. The price of spanner crab more than doubled in four years (1998-2002). These price increases reflect improved handling techniques and marketing strategies by fishers.

B4.6 Overall Risks to the Economic Viability of the Fishery

The review of the existing information on the OTLF and existing management arrangements indicates that the following are major risks to the economic viability of the fishery.

B4.6.1 Overfishing of the primary and key secondary species

Available information indicates that some of the primary and key secondary species taken by trap and line fishing in ocean waters off NSW show signs of being overfished. Most of them have not been assessed, and it is possible that when assessments on all species of the fishery are complete, that more of them will be assessed as overfished. This overfishing appears in two forms:

- recruitment overfishing, where there is a reduction in the spawning stocks of some species (e.g. eastern gemfish) and
- growth overfishing (a form of 'economic overfishing'), due to some species being harvested before they reach optimum size (e.g. silver trevally, kingfish and snapper). As a result, fishers forgo possible higher prices and yield, compared to harvest at the optimum size.

Biological information is inadequate to determine if the other species are overfished, although the available fishery information indicates that as a minimum, they are fully fished. Declining stock levels of both the primary and key secondary species on which the fishery is based, is a major risk to the economic viability of the fishery. Depleting a stock of a key species will reduce current and future revenues and may lead to fishing effort being increased on an alternative species, which can be undesirable, particularly if that new fishing pressure results in the depletion of the alternative species.

B4.6.2 Current levels of fishing effort

The currently active fishing effort in the fishery exceeds a level that would support commercially viable fishing businesses. The results of the economic survey support this finding, as only 28% of OTL fishing businesses report an economic surplus. Active effort may continue to increase due to increased efficiency of fishing techniques as a result of new technology and increased fishing time. If there is no reduction in active effort levels, the risk of declining economic returns in the fishery will increase.

B4.6.3 The potential for activation of latent fishing effort

Approximately 37% of all endorsements are latent and there is a potential for activation of this effort if there is an improvement in the current situation in the fishery. Activation of latent effort would increase total active effort in the fishery potentially eroding positive steps taken to improve the economic viability of the fishery.

B4.6.4 Ineffective management controls and lack of economic incentives

Current management arrangements are predominantly input based and have been insufficiently effective in containing total levels of fishing effort. Current management arrangements do not provide sufficient economic incentives to fishers, such as security in access rights, and an economic framework for effort adjustment through trading of fishing rights, although category 1 is being implemented and should lead to an improvement. There are currently too many fishers competing for a share of the resource. Because there are not sufficient long term, secure and well defined access rights in the fishery, no one can exclude anyone else from accessing the resource, and no one derives benefits from restraint.

B4.6.5 Loss of economic rent

Currently the Ocean Trap and Line Fishery is under performing by not generating sufficient sustainable resource rent. However, there is insufficient information to estimate the level of economic rent that could accrue in the fishery under different effort levels. There is a need to develop a bio-economic model which relates the production of vessels, prices and costs of operation, to the biological production available in the fishery. From this, estimates of long term sustainable catch, the maximum economic rent and the optimum level of effort can be recommended for the fishery.

B4.6.6 Increasing management and restructuring costs

A number of management fees are currently payable by OTL fishers, but these are only a small percentage of the true costs of managing the fishery. Approximately 72% of fishing businesses are economically under performing and their ability to pay full management costs is questioned, as is their capacity to sustain the increased debt servicing required in restructuring programs. As part of the move to sustainability, the payment of the true cost of management by users is required. This will lead to less efficient fishers choosing to exit the fishery as part of an adjustment process.

B4.6.7 Inadequate information to monitor the economic viability of the fishery

The economic and social aspects of the fishery have been insufficiently addressed, but most pressing problems in the OTLF are economic in nature. There is currently no framework to monitor the economic performance of the fishery.

B5 Social Issues

B5.1 Fishers Social Capital

This section (B5.1) was prepared by Dominion Consulting Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Appendix B3.

This section summarises the existing information on fishers and their communities associated with the OTLF, focussing on:

- the community values associated with the commercial fishery;
- the community views and perceptions of the fishery;
- the importance of social identity and job satisfaction; and
- the overall social risk to fishers from the current operational arrangements.

B5.1.1 Community values associated with the commercial fishery

Fishing communities tend to focus around key coastal towns, though a significant number of fishers reside in smaller communities. The ocean trap and line fishers are based all along the coast of NSW, using approximately 62 home ports. OTL fishers are most numerous in the Clarence, Coffs Harbour, Wallis Lake and Port Stephens regions in the north and Shoalhaven, Batemans Bay, Montague and Far South Coast in the south.

Employment associated with OTL endorsed fishing businesses was examined in the social survey. It was estimated that between 991 and 1,925 persons are employed full-time and part-time in fishing businesses which hold an OTL endorsement. OTL fishers are highly dependent on fishing for their income. Approximately 78% of OTL fishers have 90-100% of their income from fishing and another 10% have over 50% of their income from fishing. Part-time fishing involvement among OTL fishers is limited (9%). Approximately 34% of OTL fishers have financial dependents.

B5.1.2 Community views and perceptions of the fishery

There is little independent opinion on community perceptions of fishing activities. In a community telephone survey in 1999, there was general concern among a random selection of the population for the well being of the fishery environment and for the need to manage and conserve fish stocks. Other community opinion about fishers is less formal and is an area requiring development. Most commercial fishing activity in the OTLF is offshore and is not observed by the public.

B5.1.3 Social identity and job satisfaction

OTL fishers were found to be an aged, highly resident population, with substantial fishing experience and strong family involvement with fishing. Approximately 15% of OTL fishers are aged greater than 60 years and will be entitled to the age pension within the lifetime of the FMS. There are 43% of fishers with two or more generations of involvement in fishing. Approximately 60% of OTL fishers were insistent about their identity as fishers and were unable, or unwilling, to consider re-training. Age was the major reason for not considering starting alternative employment or businesses, followed by only having experience in the fishing industry, fishers' lifestyle and investment in the fishing business.

The capacity and willingness of fishers to undertake full-time job in non-fishing sectors were examined through the social survey. Only 20% of fishers have worked outside of fishing and 15% have the skills and willingness to work in another occupation full-time. Regional unemployment in NSW is higher on the north coast of NSW which is a significant issue for fishers considering alternative employment to fishing.

B5.1.4 Overall social risks

The economic survey indicated that 72% of OTL fishing businesses may not be economically viable in the long run. As a result, it is expected that some fishers will choose to exit the fishery. There is a lack of alternative employment opportunities and the risk of increased unemployment in regional areas are major concerns for fishing families in regional NSW. Fishery adjustment to improve profitability is required to enable fewer fishers than at present to have a future in the fishery.

Fishing is a way of life for most fishers and displacement of fishing communities means loss of fishing lifestyle and tradition. Uncertainty and lack of secure, well developed access rights fishers are impediments to develop long-term businesses plans and encourage families members to become involved or to remain in the fishing industry.

Many fishers believe that they have not been adequately involved in the management of the fishery. This lack of ownership of decisions may increase the risk of non-compliance in the fishery. There is also a lack of consistency in policies with the Commonwealth and other states. OTL fishers face a range of conflicts with other fishers and major stakeholder groups over access to fishing grounds, gear interaction with more active fishing methods such as trawling, and disputes related to the sharing of fish stocks.

There is currently no framework to monitor social issues in the fishery and insufficient information is collected to provide socio-economic advice to policy makers and policy analysts.

B5.2 Health and Safety

The Seafood Safety Scheme, implemented by The NSW Food Authority, is based on the premise that some species and/or activities represent a potentially higher food safety risk than others. The highest food safety risk is associated with bivalve molluscan shellfish because they can readily accumulate harmful contaminants (bacteria, viruses, algal toxins and heavy metals) from their environment and transmit these to the consumer. Bivalve molluscs are not retained in the OTLF and the species that are targeted in the fishery do not need any special management arrangements. With the introduction of the Seafood Safety Scheme Regulation, responsibility for this fishery in terms of food safety will pass to The NSW Food Authority.

B5.2.1 Health risks to fishers

There are a variety of occupational health and safety (OH&S) risks associated with any fishing activity and the OTLF is no different in this respect. These risks are related to the use of boats, fishing gear, baiting hooks, powered winches, etc. Work Cover Authority NSW administers the legislation, which controls these activities and protects workers' health. The fishing businesses are required by law to operate in a manner consistent with the OH&S legislation.

B5.2.2 Health risks to consumers

As food producers, the provisions of current NSW food legislation, namely the *Food Act 1989* and the *Food Regulations 2001*, bind participants in the fishery. Vessels are included in the definition of "vehicles" in the *Food Act 1989*. There are no specific provisions relating to seafood specifically in the context of this fishery but general requirements about hygiene and cleanliness, keeping good records and keeping products cool apply to the handling of all foods including fish.

The *Food Production (Seafood Safety Scheme) Regulation 2001* requires all seafood businesses including those in the catching/harvest sector to be licensed with The NSW Food Authority and prepare a Food Safety Program in respect of their activities.

With respect to the fishery, this will apply from the point at which the catch is brought on board the vessel. Where the same business or individual further processes or handles products on shore (after landing) the Food Safety Program will have to encompass each and all of those other activities.

For most participants who simply catch fish and transport them to land, the basic requirements would already be understood and met since they involve good handling and hygienic practices. Given the range of scale and sophistication of vessels and businesses engaged in the fishery, however, some improvements may need to be made, primarily of a minor nature.

Essentially the major food safety requirements on all participants in the fishery are to keep the catch clean, keep it cold and keep good records. The current level of compliance is largely unknown but with the introduction of the Seafood Safety Scheme all participants will be licensed and subject to audit and inspection.

B5.2.3 Overall risk to health and safety

The risks to the health and safety of fishers, their crew and consumers is low due the highly regulated nature of the industry from both Work Cover Authority and the Seafood Safety Scheme. The draft FMS is not required to provide additional specific management responses to these issues.

B5.3 Indigenous Peoples

The following summaries are based on the detailed report prepared by Umwelt (Australia) Pty Ltd and presented in full in Appendix B4.

B5.3.1 The interests of Aboriginal people in the resources and habitats targeted by the Ocean Trap and Line Fishery

Many Aboriginal people in regional coastal communities of NSW express the view that ocean fishing is part of their cultural identity. Most often, the fishing that is described is inshore fishing, based on beaches or rock platforms, although there is no doubt that some people also traditionally fished the ocean from canoes and continued this tradition as ocean fishing from small boats in contemporary times. This fishing is for subsistence and socio-cultural purposes. People fish to feed their families, but also to meet obligations for looking after other people in their community, either as part of daily routines, or for special events such as funerals. Aboriginal Elders still pass on stories and information about places and species of traditional importance to their children and grandchildren.

During consultation that has been conducted for this project and other recent research on Indigenous fishing, Aboriginal people have consistently reported:

- strong interests in rights to access ocean resources (including a sense of 'ownership' of the seas and their products);
- strong interests in the sustainability of ocean fisheries, drawing on a belief that in the past, Aboriginal people fished for what their families needed, but always left some to ensure that they could come back again in the future;
- that transfer of traditional ecological knowledge from one generation to another is culturally important and is dependent on access to fishery resources extending beyond the concept of recreational fishing; and
- interests in the well being of particular species.

When discussing commercial fishery management, Aboriginal community respondents did not differentiate clearly between one commercial fishery and another, and there was a tendency to bundle all commercial fishery issues up together (e.g. people commented on pipi restrictions, oysters, abalone and estuarine fishery species as well as ocean species).

B5.3.2 Sites and places of value to Aboriginal communities

The physical evidence of past ocean fishing practices is (poorly) preserved in midden sites on headlands and behind ocean beaches along the NSW coast. There is minimal risk that the operation of the commercial OTLF will impact on these archaeological sites. Some Aboriginal communities (such as Yarrawarra) have documented places of contemporary value, where social activities associated with fishing have occurred within memory and continue to occur. The documentation of these places helps to understand the relationship of local communities to the natural landscape. As with archaeological sites, there is minimal risk that these places of value will be impacted by the operation of the commercial OTLF.

There are stories from communities right along the coast of Aboriginal people having a special relationship with dolphins; of women and men calling to (sometimes singing) dolphins from beaches and headlands. On the south coast, this extends to historical accounts of collaboration of Aboriginal people and dolphins in whale hunting and driving fish species close to shore where they could be caught. The operation of the OTLF will not impact on these values.

B5.3.3 Potential impacts on traditional fishing practices and access

Schnierer and Faulkner (2002) document the results of consultation with Aboriginal people in coastal communities in NSW, about species targeted by Aboriginal fishers, and the ways in which they utilise aquatic resources for food, medicines and other parts of their daily lives. The research also provides information about the reasons for fishing. It is these reasons, and particularly the cultural identity of Aboriginal fishing, which separate the fishing activities reported by Indigenous people from other fishing in the general community.

Eighty-one per cent of respondents noted that they fished either to supplement their family's diet or to share with their extended family (especially Elders). However, whilst these subsistence/dietary reasons for fishing are clearly important and continue traditional practices, other reasons for fishing indicate particular characteristics of Indigenous fishing that distinguish it from fishing by other groups in the community. These reasons are directly linked to community ties to the land and water 'country' and the passing on of traditional cultural knowledge. No other groups have the cultural ties to the land and water that Aboriginal people express.

The existence of commercial ocean fisheries does not in itself detract from Aboriginal access to traditional fisheries. Community members believe, however, that the low representation of Aboriginal people in the commercial sector, the regulation of the commercial fishery and the imposition of strict bag limits for non commercial fishers disadvantages them and conflicts with traditional fishing customs.

B5.3.4 Aboriginal participation in the OTLF

No Aboriginal people currently appear to hold a commercial licence in the OTLF and there appears to be little direct engagement between Aboriginal people and the commercial Ocean Trap and Line Fishery. People state that they do not participate because they do not have the capital to invest in commercial vessels and equipment and traditional skills have been lost over generations of disadvantage.

During consultation, Aboriginal people have expressed strong views that the wealth generated from use of marine resources (including, but not restricted to the OTLF) does not accrue fairly and that Aboriginal people have been disadvantaged in their participation in the commercial sector. Some people argue that there has been a cumulative loss of rights as licensing requirements have changed.

B5.3.5 Interaction of the OTLF and the Indigenous Fisheries Strategy

The Indigenous Fisheries Strategy (IFS) was released in 2002 after consultation with Aboriginal communities at several regional meetings. The Implementation Plan that accompanies the Strategy identified actions for 2003 and 2004, and the progress towards priority actions is monitored by the Indigenous Fisheries Advisory Committee.

The development of mechanisms to maintain and enhance Indigenous participation in the commercial fishing sector generally is a very high priority for the Indigenous Fisheries Advisory Committee, and was the subject of a workshop to develop an action plan during 2003 (see Callaghan and Associates 2003).

Whilst it should not be anticipated that the issue of Aboriginal employment and Aboriginal ownership in the commercial sector can be resolved through the Ocean Trap and Line FMS alone, commercial fishers and the Indigenous community should both participate in discussions about potential changes to the *Fisheries Management Act* and the potential introduction of programs to enhance Indigenous capacity to enjoy their rights to economic independence.

Potential actions, that are still being refined through further consultation within and by the Indigenous Fisheries Advisory Group include:

- filling a number of positions for Indigenous people on Fishery Management Advisory Committees (note for instance that there is currently no Aboriginal person on the Ocean Trap and Line Management Advisory Committee);
- consultation with Aboriginal people about the concept of identification of Indigenous commercial fishers on their licences (and whether Indigenous fishing licences could have special conditions attached to them);
- endorse the goal of retaining Indigenous people in commercial fishing and demonstrate this through investigating options for licence transfers, sub leasing of licences, and assistance with gaining new licences;
- training for Aboriginal fishers, both to enhance employment prospects as crew and to support operations as licensed fishers; and
- consider new structures and any special training for involving Aboriginal people in Management Advisory Committees, potentially using the models described in the Boomanulla Statement.

B5.3.6 Overall risks to Indigenous values associated with the operation of the OTLF

Table B5.1 presents a simple qualitative assessment and ranking of risks to Aboriginal values that are associated with the existing operation of the OTLF. For simplicity, this table will be presented again in Chapter E showing how these risks have been addressed by the draft FMS, where necessary.

Table B5.1 Summary of risks to Indigenous values due to existing fishery management

Broad Issue/Value	**Risk – Existing Management**
Aboriginal sites – the physical evidence of past Aboriginal land use	Low (low probability and low consequence)
Aboriginal places – the locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world	Low
Aboriginal marine totem species	Moderate
Aboriginal cultural landscapes – the places and species in the landscape that are important to Aboriginal people. As a separate issue from Aboriginal places, this refers to the presence and distribution of Aboriginal foods and medicines in the marine landscape	Low to moderate
Aboriginal socio-economic participation in the commercial fishing sector	Moderate – currently very low participation

B5.4 European Heritage Sites

The following summaries are based on the detailed report prepared by Umwelt (Australia) Pty Ltd and presented in full in Appendix B4.

B5.4.1 Sites of historic heritage

Approximately 1100 shipwrecks appear to be located within New South Wales non-estuarine coastal waters. Of these approximately 260 are recorded offshore of the coastlines of the Northern Rivers, Mid North Coast, Illawarra and South East regions of the total New South Wales coastline.

A key constraint to the accurate assessment of risk is that details about the locations and condition of many shipwrecks are poor. It is difficult to pinpoint the locations of these wrecks, or the amount of wreckage that may still remain, with any certainty. For many wrecks, only limited, broadly descriptive information is available, and the extent to which parts of the wreck may be exposed to snagging on nets etc is difficult to determine. The condition of a shipwreck will depend on the nature of the vessel (size and type of construction), depth of water, circumstances that caused the wreck, subsequent disturbance, and marine processes such as waves, currents and sediment transport. For many shipwrecks, little of this information is known directly.

Almost all the shipwrecks along the NSW coast are protected by either the Commonwealth heritage legislation (*Historic Shipwrecks Act 1976*) or by the *NSW Heritage Act 1977*. For example, of the 260 or so shipwrecks identified in the Northern Rivers, Mid North Coast, Illawarra and South East regions of the coast, less than twenty shipwrecks do not have protection under either the Historic Shipwrecks or Heritage Acts.

B5.4.2 Summarise the overall risk to European heritage sites from the current fishery

In broad terms, the potential risks to historic heritage derive from the following aspects of the operation of the fishery:

- direct impacts by vessels on shipwrecks; and
- fishing gear becoming snared or entangled on parts of shipwrecks and affecting the integrity of the heritage structure. In this case, there is also a risk to the safety of licensed fishers and their crew if gear is not easily disentangled from the shipwreck. There are a number of instances of damage to or sinking of vessels after nets became snared on shipwrecks.

These risks are qualitatively assessed in Table B5.2.

Table B5.2 Qualitative risk assessment considerations

Aspect	Likelihood	Consequence	Risk
Vessel navigation – collision with shipwrecks	Unlikely to rare	Moderate	Low
Entanglement of lines in shipwrecks	Possible	Very Low	Low

The risk presented to historic shipwrecks by the activities of the Ocean Trap and Line Fishery is low. In this context, the types of response that are appropriate in the Fishery Management Strategy relate to procedures for monitoring (for instance locations, frequency and consequence) and reporting incidents.

Volume 2

Chapters C - G

This is the second of three volumes of the Environmental Impact Statement on the OTLF in NSW

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CHAPTER C ALTERNATIVE MANAGEMENT REGIMES

This chapter highlights a range of high-level alternatives to the existing operation of the fishery described in Chapter B.

C1 Alternative: No OTLF

This section presents the consequences of not having a commercial OTLF in NSW waters. The size and scale of the fishery is outlined in Part 1 of Chapter B.

Not having an OTLF would prevent the capture of the primary, key secondary and secondary species by trap and line fishing methods, which would improve the biomass levels of those stocks and might improve catches of some species by recreational and Indigenous fishers and in other commercial fisheries.

However, the above potential benefits need to be balanced against the negative impacts of not having an OTLF. It is clear that the fishery forms a significant component of the economy of coastal NSW, and provides a significant quantity of fresh seafood to mainly local but also export markets. The fishery produces about 1,800 tonnes of seafood annually, valued at about $10 million at the first point of sale. This value is considerably increased if the assessment considers supply of goods and services to the fishery, and the value-adding of seafood products through wholesale, retail and restaurant outlets. Not having an OTLF would have considerable social and economic impacts, not only on the fishing businesses that are endorsed to operate in the fishery, but also on the local and regional economies of some areas of coastal NSW (see below).

C1.1 Supply of Seafood to the Community

Fresh seafood enjoys a reputation as a healthy source of high-quality protein and beneficial nutrients (e.g. Omega-3 fatty acids). The major products of the OTLF, such as snapper, kingfish and blue-eye trevalla have a prominent place in the Australian lifestyle. The importance of ‘local’ seafood to the catering and tourism industries has now been well established (Ruello, 1996; Ruello and Associates, 2000). There is an increasingly strong local demand for most of the products of the OTLF, and the rapid increase in this demand is unlikely to slow in the foreseeable future.

Products provided by the operation of the OTLF range from large quantities of relatively low value species (e.g. leatherjacket), large quantities of relatively high value species (e.g. snapper, kingfish), to small quantities of high value species (e.g. bar cod and pigfish). For most of the species taken by the OTLF, it is likely that the local market could not be effectively supplied from other NSW commercial fisheries that have an equivalent or lesser impact on the environment if trap and line fishing ceased.

It is also unclear if other commercial fisheries in adjoining jurisdictions (such as the Commonwealth South East Fishery or trap and line fisheries in other states) would be able to supply the market currently supplied by NSW ocean trap and line fishers. These other fisheries may already have lucrative markets for their product, and in the case of the South East Fishery increases in catch of the primary species are restricted by the application of Total Allowable Catches in the management of that fishery.

The supply of some key species taken in the OTLF, particularly snapper and kingfish may be wholly or partly replaced by imports of fish from other countries or by the future development of aquaculture in NSW and other Australian States. Such influences on seafood supply are already occurring (e.g. aquaculture kingfish from South Australia) and can have a direct affect on market prices for the species concerned. There is potential for other supply sources to substitute for any loss of catches of key species if the OTLF did not exist, although many of the smaller quantity, higher value species or fish being supplied to small niche markets (e.g. fresh line caught product supplied to select Sydney restaurants) are unlikely to be able to be readily substituted.

C1.2 Employment Considerations

In 2001/02, 624 fishing businesses in NSW held one or more endorsements to fish in the OTLF. Taking into account direct and indirect employment, approximately 991 to 1925 people are estimated to be employed in ocean trap and line fishing businesses (see Chapter B). The OTLF also supports considerable infrastructure ashore for supply of fuel, ice, electronic aids, vessel maintenance, and for unloading, handling and marketing of product. The available studies relating to employment flow-on effects for the OTLF in NSW indicate a multiplier factor of 0.4 times the direct effect (Tamblyn and Powell, 1988; Powell *et al.*, 1989).

Based on the NSW DPI catch and effort records, of the 354 fishing businesses participated in the OTLF in 2001/02, 24% also operated in other NSW commercial fisheries. It is not known how fishers would change their business structure if there was no longer a commercial OTLF in NSW. However, it is reasonable to expect that trap and line fishers with endorsements to fish in other fisheries would put more fishing effort into these other fisheries to compensate for any lost income. This may increase the risk of conflict between fishers as they compete for a share of the stocks and may result in the need to implement additional effort controls in those other fisheries.

It is also reasonable to expect that a number of people would have to find alternative employment. It is estimated that this would be between 991 and 1925 fishers, though a considerable number of fishers are at or nearing retirement age. A social survey found that 67% of trap and line fishers responding to the survey believe they would be unable to gain employment outside of fishing, and 73% of these people state that they would not consider retraining (refer to Chapter B/E).

C1.3 Economic Considerations

In 2000/01, revenue at first point of sale for seafood caught from NSW waters by ocean trap and line fishers was approximately $10 million. The results of the economic survey, done as part of this EIS (see Chapter B), found that 28% of businesses surveyed were earning an economic surplus and contributed to the Gross Domestic Product (GDP). All businesses contributed to the local economy through the purchase on inputs and factors of production. This revenue for the fishery provides an important source of employment for fishers and has multiplier effects in regional communities. Economic multipliers in the fishing industry are, however, low and total effects are generally between 1.5 and 2 times the direct effect (Tamblyn and Powell, 1988; Powell *et al.*, 1989).

If there were to be no OTLF, the loss of such a significant level of economic activity would be keenly felt by the fishing and associated industries in coastal NSW. A large proportion of the catch from the OTLF is sold through the Sydney Fish Market, and there may also be a significant negative effect on the financial position of this company if the OTLF ceased operations.

C2 No Changes to Existing Management Arrangements

The existing management arrangements for trap and line fishing in NSW ocean waters are outlined in Part 1 of Chapter B, and Part 2 of that chapter identifies the risks associated with the current operation of the OTLF.

Should there be no change to the existing management arrangements in the fishery, the risks would remain unaddressed, and the fishery will almost certainly become unsustainable and experience a reduction in economic viability in the long term.

C3 Alternative Management Responses to Address Significant Areas of Risk

The key significant risks identified by the environmental assessment of the OTLF include:

- overfishing of primary or key secondary species, including all elasmobranchs
- bycatch,
- impacts on grey nurse sharks (and other threatened species),
- loss of economic viability.

The following discussion examines broad level alternative management regimes for addressing each of these key risks.

C3.1 Alternate Regimes to Prevent Overfishing of Primary and Key Secondary Species

Current management of the OTLF is based on a range of input controls including limiting the number of endorsed operators, gear controls, closures, size limits, and some minor output controls such as daily trip limits. There is no direct control on the amount of fishing effort that may be exerted by individual operators, however in practice there is an upper limit (albeit variable) due to the above factors and limited fishing opportunities due to weather conditions.

Two feasible alternatives to the existing management of the fishery that may be used to prevent overfishing of primary and key secondary species include:

1. using a different suite of input controls (i.e. alternative effort regimes)
2. managing the fishery using output controls, specifically total allowable catches (TAC).

C3.1.1 Alternative input (effort) controls

Alternate management regimes to prevent overfishing of primary and key secondary species using a different suite of input controls could involve the following:

C3.1.1.1 Significant reduction in the number of currently active fishers

There is a substantial problem with the level of latent (unused or seldom used) effort within the majority of endorsement types in the OTLF with only 354 of 624 endorsed fishing businesses actively participating in the fishery[3]. Accordingly, there would be little point in developing a regime that reduces active fisher numbers without first addressing the issue of latent effort. To have any impact on the number of active fishers through limits on business numbers, the total number of fishing businesses with ocean trap and line endorsements would need to be reduced by at least 44% and a major adjustment program would be required.

Benefits to stock sustainability from a reduction in active fisher numbers would only become apparent if they were complimented by measures to prevent the remaining stocks from simply being caught by other users of the resource. The benefits of such a change however, need to be weighed

[3] Using the 2001/02 figures provided in the economic assessment in Chapter E of this EIS.

against the likely economic and social costs, which would vary depending on the scale of the reduction but be significant on the individual businesses removed from the fishery.

C3.1.1.2 Enhancing the range of existing effort controls and fishery restructuring

A feasible and perhaps the most beneficial alternative would be to enhance the current set of effort controls applicable to the fishery, and introduce a restructuring scheme to cap the number of operators in the fishery to currently active levels. This would require slight modifications to a range of the existing input controls (e.g. gear limits, gear design, minimum legal lengths) to reduce the mortality of juvenile or mature primary and key secondary species, along with a general effort reduction program that sought to prevent the activation of the latent entitlements. The level of fishing effort necessary to achieve a commercially viable and ecologically sustainable fishery would need to be identified.

C3.1.1.3 Use of minimum legal lengths

The minimum legal length (or size limit) is a management tool that can be used to protect the juvenile fish in a population, thereby increasing the chance of fish reaching spawning size. Size limits are already used on selected primary and key secondary species in the OTLF and new size limits appear necessary for some other species, such as wobbegong sharks. The effectiveness of size limits in the OTLF can be beneficial in terms of their ability to prevent the intentional targeting of young fish, but can result in significant discarding problems if the selectivity of the gear fails to exclude fish that are smaller than the minimum legal length. As such, a feasible alternative to the existing fishery arrangements is to implement size limits on species where there are problems of overfishing, while at the same time adjusting the selectivity of the fishing gear in an attempt to avoid the capture of undersize fish. It is also necessary to consider the economic and social impacts of introducing or modifying size limits as size based controls on key species can have significant regional effects on the amount of product available to the fishery, and there may be consumer preferences that affect the market price of fish at different sizes.

C3.1.1.4 Implementation of widespread closures

With the large diversity and distribution of species, closures designed to protect the primary and key secondary species would probably need to be extensive to be effective. The selection of closure areas would necessarily be based on very limited information, and could lead to major economic and social costs as outlined in section 1 above, with no real assurance of meaningful ecological benefits. The effectiveness of such closures would also rely on the implementation of corresponding closures to other fisheries (including recreational and trawl fisheries) and the early installation of a vessel monitoring system (VMS) at considerable cost to enable effective enforcement.

C3.1.1.5 Limiting the number of days fished

Another alternative would involve the introduction of a direct control on the number of days or nights fished by individual fishers or boats. Such a system would be feasible to apply to line methods within the fishery, as the number of days fished is directly linked to the level of fishing effort. However, it would be problematic to apply the system to the trap sector because the successful operation of the gear involves soak time and effort is more distantly related to the number of days fished. Limits on the number of hooks and traps able to be used is likely to be a more effective effort control than this alternative.

C3.1.2 Alternative output controls

The other alternative to the existing management arrangements involves the use of output controls to manage the key species in the fishery, predominantly through a TAC. Quota management is best suited to fisheries that have the following characteristics: simple jurisdictional arrangements, single method, single species, relatively high value, small number of participants, small number of ports of landing, good stock assessment information, and general industry support. Apart from the spanner crab, kingfish and school and gummy shark sectors, there are no species in the OTLF exhibiting the range of characteristics that would make them suitable for management under a TAC regime.

Indeed, there are several examples of mixed-species fisheries where management by catch quotas has not prevented the overfishing of some of the important species in the fishery (e.g. the Commonwealth's South East Trawl Fishery). The failure of some quota-managed fisheries has most often occurred because catch quotas only control what is landed by the fishery, not what is actually caught, and do not by themselves address impacts of the gear on broader ecosystem components. Quota management systems do not provide a direct control over fishing effort and in some instances have been criticised for allowing uncontrolled increases in fishing effort (Smith and Wayte, 2002; BRS, 2003). Supporting regulations on the selectivity of fishing gear and appropriate closed times or areas are still often necessary to underpin management using catch quotas.

C3.2 Alternate Regimes for Minimising Bycatch

An alternative approach to minimising bycatch to that currently used (see Chapter B) is to require the key gear types to have appropriate bycatch reduction devices. For example, the exclusive use of circle hooks for unattended line fishing methods can minimise incidences of gut hooking in fish and increase the post-release survival of bycatch. The use of escape panels in fish traps has also been demonstrated to reduce the bycatch of undersize fish with minimal loss of other commercially valuable species (Stewart and Ferrell, 2001). Stewart and Ferrell (2002, 2003) concluded that an escape panel with 50 x 75 mm mesh was appropriate for widespread use in the fishery, but that larger mesh sizes (which were even more effective in reducing the capture of small fish) should be trialled by fishers on a voluntary basis as there were implications for losses of commercial valuable species and increased incidences of fish being damaged in the mesh of the trap.

Another alternative is to substantially increase the use of temporal and/or spatial fishing closures to reduce levels of bycatch. With the large diversity and distribution of species, the additional closures required would most likely incur significant economic and social costs to the fishery that would outweigh the biological benefits of this option. The effectiveness of these closures would also rely on the ability for them to operate in real-time as bycatch composition changes on spatial and temporal scales, and on the implementation of corresponding closures to other fisheries (including recreational and trawl fisheries).

C3.2.1 Kingfish

Kingfish was identified in Chapter B as a species with a particular discard issue. The discarding is predominantly a result of the existing MLL of 60 cm applied to the species. Fishers are legally required to return undersize fish to the water.

An alternate approach to reducing the bycatch of kingfish is to remove or lower the size limit so that fishers could retain smaller fish. Removing the size limit would prevent the discarding of juveniles, however this is not considered a feasible alternative as removing the size limit would reduce the yield per recruit by approximately one third (Stewart *et al*., 2004) as more of the total catch would be made of smaller fish. Aggregations of fish below the current size limit commonly occur in waters between Sydney and Tuncurry and are currently protected from harvesting, although they are likely to be caught and released by both commercial and recreational fishers. Removing or reducing the size limit would create new opportunities for recreational and commercial fishers and have the effect of reducing the chances of juvenile kingfish from reaching spawning age. Additionally, because the total commercial catch would be likely to increase, an over-supply of small, low value, kingfish to the market is probable with a corresponding decrease in market price. Furthermore, while the study by Stewart *et al*., (2004) found that at times the ratio of discarded to retained catch of kingfish was up to 30:1, they are robust individuals and the recaptures from a co-operative tagging program suggest good survival rates (Gillanders *et al.*, 2001).

A further alternative to reducing the discarding of small kingfish is to introduce total fishing closures in areas and at times when juvenile fish are present. This alternative is problematic however, as kingfish is a highly mobile species with a wide distribution and real-time adaptive closures would be difficult and costly to define, monitor and practicably enforce in ocean waters.

C3.3 Alternate Regimes for Conserving Grey Nurse Sharks and other Threatened Species

An alternative management approach for conserving grey nurse sharks is to modify gear including the exclusive use of circle hooks for all unattended line fishing methods, and prohibiting the use of wire trace on bottom setlines. The prohibition of wire trace on bottom setlines would reduce the chance of incidentally capturing grey nurse sharks as sharks are generally unable to free themselves from wire traces with the same ease that they can from monofilament material.

Another management approach may be to increase the protection of grey nurse shark critical habitat areas in NSW waters with associated regulations to control fishing and diving activities. NSW DPI is currently reviewing the protection of grey nurse sharks in critical habitat areas. A discussion paper for grey nurse shark protection was released in July 2003. Options for increased protection outlined in the paper included enhancements that could be made to the current critical habitat and buffer zone provisions, and practical ways of providing increased protection for grey nurse sharks when they are foraging or travelling away from their critical habitat areas. The management regime for fishing activities within the OTLF should be adaptive to the outcomes of the specific plans for threatened species protection.

An alternative approach for conserving other threatened species including black cod and great white sharks is to obtain information on distribution, abundance and capture/release rate by the fishery through a scientific observer program.

C3.4 Alternate Regimes for Preventing Loss of Economic Viability

The *Fisheries Management Act 1994* aims to promote the economic viability of commercial fishing, within the context of the foundation objectives of conserving fish stocks and promoting ecologically sustainable development. Accordingly, any alternative management regimes proposed to maintain the economic viability of the OTLF must not compromise the conservation of fish stocks and ecological sustainability. This approach is consistent with sustaining the resource 'asset' base so that it may continue to be harvested over the longer term, as against 'mining' the resource for a short term return.

Currently, the economic viability of fishers in the OTLF is assisted by a subsidy provided by the NSW government to help cover the costs of management. Under the principles of ESD a cost-recovery framework should be established, to move towards a situation where the 'attributable' costs of management are borne by those who benefit from the management strategy. One alternative would be for the NSW Government to continue subsidising the costs of management of the fishery, however some studies suggest that such subsidies may encourage and aggravate problems of over-capitalization and over-capacity (Greboval and Munro, 1999; Ibsen, 1999; Porter, 1998) and some subsidies may also act against the interests of the environment in the short term or the fishery in the longer term (Pimm, 2001).

An alternative to the existing situation would be to reduce the number of operators in the fishery to a level at which the remaining operators can make a reasonable profit from the available trap and line fishery resources. Not enough is currently known about the economics of individual fishing businesses to be able to identify a target number, however, a program of determining a realistic indicator for fishing business viability and a long term restructuring program to reduce the number of fishing entitlements is a feasible and highly recommended approach to resolving this issue. This restructuring could be undertaken through the use of a range of adjustment tools, including minimum shareholdings in the share management plan, higher requirements for new entrants or business transfers, voluntary surrender of entitlements or through targeted buy-backs of fishing entitlements.

C4 Alternative Performance Indicators and Monitoring Programs

The Fishery Management Strategy for the OTLF presented in Chapter D contains seven broad goals, each with a number of objectives and a much larger number of individual management responses, many of which are new actions. The extensive set of responses is necessary to manage the risks identified in the environmental assessment of the OTLF (Part 2 of Chapter B).

Changes in the sustainability and viability of the fishery will be affected by the continuation of existing management arrangements and the introduction of new actions under the fishery management strategy, as well as a significant range of factors external to the fishery (e.g. oceanic environmental conditions and market conditions). Additionally, as cost recovery is progressively introduced in the OTLF, the more extensive and costly performance monitoring is, the greater the costs will be to industry. Considering that economic viability has been identified as a significant issue in the future management of this fishery, it is desirable that cost increases be kept to the lowest feasible level.

The seven goals proposed in the draft FMS address the major areas of risk identified for the fishery, and monitoring the performance of the fishery against each goal is therefore considered the most cost effective way of measuring performance of the strategy.

The performance indicators outlined in the draft FMS (section 5 of Chapter D) have been identified as the preferred indicators, taking into account both the major issues or risks associated with the fishery, and the general costs of monitoring. A number of performance indicators proposed in the strategy will act as surrogate indicators until more appropriate alternatives can be developed. For instance, a performance indicator that seeks to measure the impact of the fishery on marine biodiversity cannot currently be specified due to the (generally world-wide) lack of knowledge regarding the dynamics of aquatic ecosystems. Similarly, it is difficult to identify a single performance indicator to monitor trends in the commercial viability of typical fishing businesses (development of such indicator(s) is to be discussed with the Ocean Trap and Line MAC under management response 5.4a). Alternatives to the proposed indicators would be those that produce a meaningful outcome, and could be monitored without causing significant increases in cost of management, research or administration.

‘Adaptive management’ is increasingly accepted as the ideal framework for management and policy development. However, it can be an expensive process (i.e. in terms of both the experimental design and the necessary data collection and analysis) depending on how it is applied. Adaptive management can be broadly defined as “*a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs*” (Bennett and Lawrence, 2002). In an active sense, the design and implementation of a cost effective adaptive management system should take account of the natural and anthropogenic characteristics, variables, interrelationships, scale and risks relevant to the use of a specific natural resource, as well as the way in which the monitoring results can be used to inform ongoing management decisions. The limited availability of knowledge and information for many natural systems demands that management decisions typically need to be refined over time as knowledge and information progressively improve (Healthy Rivers Commission, 2000). Adaptive management can be applied in a ‘responsive’ way by using readily available and broad indicators to monitor performance and adjust management against set goals. Alternatively, this can be done through a robust experimental design that drives the monitoring program to determine whether the aims of each management action (i.e. response) are being/have been achieved.

It would be problematic to successfully introduce a system based on a robust experimental design in the OTLF, which captures a large number of different species, and where individual management actions generally assist in achieving more than one goal or objective (or address more than one hypothesis). Application of active adaptive management in the fishery would, in most cases, require a large number of variables to be monitored, leading to significant costs that would need to be borne by the fishery participants. It would also be difficult to determine the cumulative effects of the multiple management responses in achieving each goal or objective.

The management regime outlined in the draft FMS is a ‘responsive’ program that enables the regime to be changed in response to new information or if the trigger points are tripped over time. It incorporates the principles of adaptive management.

C5 Alternative Arrangements for Cost-Effective Delivery of Management

Following the risk assessment in Part 2 of Chapter B, a number of management responses and research programs have been proposed in the draft fishery management strategy (see Chapter D) to address major issues and reduce the significant risks that have been identified in the assessment. Many of these are actions or programs that are already underway, or are new responses that will require little, if any, additional resources to implement. Some, however, may require additional resources to implement and alternative cost recovery arrangements and/or sources of funding need to be considered.

There are three broad alternatives to fund the existing management programs or the management responses and/or research programs proposed in the draft management strategy:

1. *All costs subsidised by government* **-** One option is for government to fund the complete costs of management, compliance and research attributable to the OTLF. However, cost recovery is a common principle among Australian commercial fisheries and an important component of ecologically sustainable development. The concept of users pays (or ‘beneficiary pays’ as per the IPART findings) aims to internalise the environmental costs by the proponents whose activities have detrimental impacts on natural resources. To have full government funding would be contrary to contemporary competition policy and natural resource management principles and is not recommended.

2. *All costs funded by ocean trap and line shareholders* – This option would see shareholders paying for the full cost of management, compliance and research associated with the fishery, even those services that benefit other fishing sectors or fisheries in other jurisdictions. For the reasons outlined in the report prepared by IPART (see IPART, 1998), this option would be inequitable for ocean trap and line shareholders and is not recommended.

3. *Funding from external sources (i.e. other than industry or Government)* – This option entails relying on externally sourced funds to pay for all management, compliance and research costs attributable to the fishery. While an ideal prospect, there can be no guarantee that such funding would be forthcoming and indeed most externally funded projects are discreet projects that have a flow of benefits to other user groups or jurisdictions. For these reasons, this option is not feasible or recommended.

Given that the options described above are not feasible, the best approach to cost recovery is to continue to develop a fair and transparent cost recovery policy, taking into account all relevant issues. However, there will be additional costs associated with addressing the risks identified through the environmental assessment of the fishery, through the implementation of new programs and actions. Immediately increasing charges to individual trap and line fishers to cover these costs may place a high financial burden on individual fishing businesses. Taking into account the economic state of the OTLF as identified in this environmental assessment a progressive cost recovery scheme should be implemented so that charges are passed on to industry in a way that enables commercial fishers to plan their businesses. Applications should continue to be made to the Fisheries Research and Development Corporation or other funding providers for any research projects identified as eligible for external funding.

In terms of who undertakes the delivery of services for commercial fisheries, a number of alternatives to the current practice are possible. They range from all services being provided by the government to all services being outsourced and managed by the industry, with a number of possible combinations for service provision in between.

A detailed independent study investigating the potential alternative service delivery arrangements for the future management of commercial fisheries in NSW has recently been finalised. The study, conducted by Marsden Jacob Associates, identifies the potential for models that provide for a higher level of involvement by commercial fishing industry in fisheries management, whilst enabling government to fulfil its responsibilities for ensuring the long-term sustainability of commercial fisheries and providing equitable sharing of a community-owned resource. The feasibility of this approach to service delivery, including industry's ability to fund such a model, is currently being investigated. Whatever the outcome of this process, the draft FMS should be sufficiently broad and adaptive such that it can be implemented using any service delivery model.

CHAPTER D THE DRAFT FISHERY MANAGEMENT STRATEGY FOR THE ACTIVITY

D1 Introduction to the OTLF

The OTLF is one of nine major commercial fisheries in New South Wales. It is a multi-method, multi-species fishery using demersal fish traps and numerous line methods to target demersal and pelagic fish in ocean waters along the length of the NSW coast. The fishery also includes the taking of spanner crabs by nets (dillies) north of Korogoro Point (near Hat Head).

There is a variation in the levels of participation of fishers with some fishers operating in the OTLF on a full time basis while others work in a number of commercial fisheries reducing their participation in the OTLF to a part-time or seasonal basis. Table D1.1 shows the relationship between the OTLF and other commercial fisheries in NSW.

Table D1.1 Snapshot of the major marine commercial fisheries in NSW

(Source: NSW DPI licensing database extraction October 2004)

	Ocean trap and line	**Estuary general**	**Ocean trawl**	**Ocean hauling**	**Lobster**	**Abalone**	**Estuary prawn trawl**
Methods	Fish trap, Spanner crab net, Setline, Trotline, Driftline, Poling Handline, Jigging, Dropline, Trolling	Handline, Trap, Hauling net, Mesh net, Hand collecting	Otter trawl net	General purpose haul net, Garfish haul net, Purse seine net	Trap/pot	Diving (hookah)	Otter trawl net
Key species	Snapper, Kingfish, Morwong, Spanner crabs, Silver trevally	Yellowfin bream, Dusky flathead, Sand whiting, Longfinned eels, Sea mullet, Pipis	King prawn, School prawn, Royal red prawn, Balmain bugs, Octopus, Silver trevally, Tiger flathead, Redfish, Calamari, School whiting	Sea mullet, Sea garfish, Luderick, Yellowtail, Pilchards	Rock lobster (eastern)	Black lip abalone	School prawn, King prawn
Total catch in 2001/02 (t)	1882	5023	4883	4607	102	305	322
Est. value in 2001/02 (A$m)	10.7	19.3	38.4	7.8	4.4	15.2	2.3
No. of fishing businesses in March 2003	528	703	411	323	166	49	218
Standard boat length (m)	6-8	5	14	4	6-8	6	9
General no. of unlicensed crew	0-1	0*	2-3	0**	0-1	1	1

D2 Relevant Legislation

D2.1 Ecologically Sustainable Development

Ecologically sustainable development (ESD) was defined under the National Strategy for ESD as "development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends". It can be achieved through the implementation of the following principles and programs[4]:

- precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- intra-generational equity – the benefits and costs of pursuing ESD strategies should be distributed as evenly as practicable within each generation
- inter-generational equity – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations
- conservation of biological diversity and ecological integrity – conservation of biological diversity and ecological integrity should be a fundamental consideration
- improved valuation, pricing and incentive mechanisms – such as user pays and the use of incentive structures to promote efficiency in achieving environmental goals.

D2.2 The Fisheries Management Act

The *Fisheries Management Act 1994* (FM Act) seeks to achieve ecologically sustainable development for the fisheries of NSW through the achievement of its stated objectives, which are:

(1) To conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

(2) In particular the objects of the Act include:

(a) to conserve fish stocks and key fish habitats, and

(b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and

(c) to promote ecological sustainable development, including the conservation of biological diversity,

and, consistently with those objects:

(d) to promote viable commercial fishing and aquaculture industries,

(e) to promote quality recreational fishing opportunities, and

(f) to appropriately share fisheries resources between the users of those resources, and

(g) to provide social and economic benefits for the wider community of New South Wales.

[4] Adapted from section 6 (2) of the NSW *Protection of the Environmental Administration Act 1991*.

D2.3 Arrangements with the Commonwealth and other States

The extent and scope of the NSW OTLF and any entitlements issued therein are subject to arrangements made from time to time between the State of NSW and the Commonwealth and other State governments over the management of particular fisheries. Section 135 of the FM Act enables the State of NSW to make arrangements with the Commonwealth under the powers of the Commonwealth *Fisheries Management Act 1991* and section 141A of the FM Act gives the power to enter into agreements with other States. Refer to Part 5 of the FM Act and sections 71-78 of the Commonwealth Act for further information on the power to make (and terminate) arrangements.

Arrangements made under the Act can effectively modify the waters and the fishing methods that fall under the jurisdiction and law of NSW. At the commencement of this management strategy, a series of significant arrangements known as the ‘Offshore Constitutional Settlement’ (initially made in 1991) are in place that cede jurisdiction of trap and line fishing for certain species in certain waters beyond 3 nm to the State of NSW – refer to section 4.1.2 of this management strategy for a description of the effect of the existing arrangements on the OTLF.

The FMS will apply to all waters under NSW jurisdiction following any changes to the arrangements made between NSW and the Commonwealth or other states.

D2.4 Fishery Management Framework

The OTLF is included in Schedule 1 the FM Act and is a share management fishery. The FM Act requires that a share management plan be developed and implemented for all share management fisheries. A share management plan for the OTLF will be prepared as part of the transition of the fishery to a full share management regime and can only occur once the draft fishery management strategy has been subject to an environmental assessment and subsequently approved by the NSW Minister for Primary Industries.

The primary role of a share management plan is to provide a legislative framework for the fishery and the rights of shareholders in a share management fishery. The share management plan provides for a range of fishery specific controls to be formalised into a regulation. Examples of these include the species that may be taken, the areas for taking fish, the times or periods during which the fishery may operate, the protection of fish habitat, and the use of boats, fishing gear and bait in the fishery.

The share management plan for the OTLF may also bring into operation a number of controls in the fishery that are described in this management strategy. One example of this is the penalty points scheme referred to in the management strategy. Whilst the management strategy relies on the penalty points scheme as a compliance mechanism for creating an effective deterrent, the workings and provisions of the scheme will be included in the share management plan for the fishery.

A share management plan must include objectives and performance indicators, which, for the OTLF, will be consistent with the goals and objectives of this management strategy. The share management plan must also specify at what point a review of the plan is required when a performance indicator is not being met. The review process to be included in the share management plan will complement the review process outlined in this management strategy. This will ensure that there is a robust review and reporting framework for the fishery that is underpinned by the provisions of the share management plan. In addition to this capacity for 'performance-based' reviews, a share management plan must also be subject to scheduled periodic review.

D2.5 The NSW Environmental Planning and Assessment Act

Division 5 of Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) requires an environmental impact statement to be prepared for each designated fishing activity described in Schedule 1A of the FM Act, for the purposes of an environmental assessment.

Prior to the environmental impact statement being prepared, a draft fishery management strategy must be prepared under the FM Act. The environmental impact statement assesses the likely impact of implementing the draft FMS on the biophysical, economic and social environments.

Once a management strategy and environmental impact statement has been prepared and subject to a determination by the Minister for Primary Industries (under s.115O(4) of the EP&A Act), the requirement to undertake an environmental assessment for each individual fisher's licence approval or renewal does not apply.

D2.6 The Commonwealth Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) makes it an offence for a person to undertake an action that has the potential to significantly impact on a matter of 'national environmental significance' without first obtaining a permit from the Commonwealth Minister for Environment and Heritage. Matters of national environmental significance include: declared World Heritage areas; declared Ramsar wetlands; listed threatened species and ecological communities; listed migratory species; listed marine species; nuclear actions; and the environment of Commonwealth marine areas.

The EPBC Act was amended in January 2002 to incorporate the provisions of the Wildlife Protection Act (which was repealed at the same time). The new Part 13A of the EPBC Act has the effect of removing the previous blanket exemption from export control for marine species. As a result, the export of all marine organisms will come under the controls of the EPBC Act and be subject to ecological sustainability assessments based on guidelines established by the Commonwealth. To give time in which those assessments may be made, the exemption will continue until 1 December 2005. Until then, current arrangements regarding export of marine species will remain in effect, that is, the export of most marine fish and the bulk of marine invertebrates will continue to be exempt from export controls under the Act.

If a fishery is not assessed as exempt, it will more than likely be able to continue to supply product for export through an approved wildlife trade operation (section 303FN) under the EPBC Act. These declarations will have conditions attached that will bring the management and operations of the fishery in line with the Commonwealth guidelines. Once declarations are made, exporters will need to apply for and obtain a permit from the Department of the Environment and Heritage (DEH) to export.

D2.7 The NSW Marine Parks Act

The NSW Government is using a systematic approach to identify sites for marine protected areas and to prioritise new areas for marine biodiversity conservation in NSW waters. There are three types of marine protected areas in NSW - large multiple-use marine parks, small aquatic reserves and the marine and estuarine components of national parks and nature reserves.

Marine Parks aim to conserve biodiversity by protecting representative samples of the habitats in defined 'bioregions'. Zoning and operational plans are used to guide the protection of conservation values and manage activities that occur within the marine park. Four zones are used in marine parks - sanctuary zones, habitat protection zones, general use zones and special purpose zones.

Consultation occurs with the community prior to the declaration of marine parks. It is also important that the Ocean Trap and Line MAC participate in the consultation over the selection of marine protected areas, as declaration of such areas can be beneficial to all sectors of the community, including the commercial fishing sector. However, such declarations can also impact on the operations of ocean trap and line fishers.

The *Marine Parks Act 1997* was introduced to provide for the declaration of marine parks in NSW. The objects of the Act are as follows:

(*a*) *to conserve marine biological diversity and marine habitats by declaring and providing for the management of a comprehensive system of marine parks*

(b) to maintain ecological processes in marine parks

(c) where consistent with the preceding objects:

(i) to provide for ecologically sustainable use of fish (including commercial and recreational fishing) and marine vegetation in marine parks, and

(ii) to provide opportunities for public appreciation, understanding and enjoyment of marine parks.

This fishery management strategy has been prepared taking into account, and ensuring consistency with, the objects of the *Marine Parks Act 1997*.

Up to date information on the creation and zoning of marine parks in NSW waters is available on the Marine Park Authority website: www.mpa.nsw.gov.au

D2.8 Changes to Regulations

Most of the regulations that currently apply to the OTLF appear in the *Fisheries Management (General) Regulation 2002* (FM Regulation). The FM Regulation sets out the working arrangements that underpin the provisions of the FM Act, and are made pursuant to that Act. For example, an offence appears in the Act for possessing prohibited size fish (section 16), however it is the FM Regulation that prescribes the fish species subject to size limits and what those size limits are (clause 9).

This management strategy includes a number of actions that will impact on the current regulations that apply to the fishery. Where it is necessary to introduce or change controls prior to the development and implementation of a share management plan for the fishery, regulatory changes will be made.

D2.9 Indigenous Fisheries Strategy

Fishing has been an integral part of the cultural and economic life of Aboriginal communities since they have been in this land. Fishing has been an important source of food, a basis for trade and an important part of cultural and ceremonial life. Traditionally, Aboriginal fishers had responsibility for providing not just themselves but for family and community. These cultural expectations continue in Aboriginal communities today, particularly in regard to improved access to fisheries resources.

In December 2002, the NSW Indigenous Fisheries Strategy and Implementation Plan (IFS) was released. The IFS seeks to protect and enhance the traditional cultural fishing activities of Aboriginal communities, and ensure Aboriginal involvement in the stewardship of fisheries resources. There are some issues that will be addressed immediately by the IFS and others that will only be resolved after lengthy negotiation involving Aboriginal communities, the broader community, fishing groups and government agencies. The IFS puts in place a process which will ensure discussion and negotiation can continue with progressive resolution of problems and challenges (see NSW Indigenous Fisheries Strategy and Implementation Plan, 2002).

While the relationship between Indigenous fishing and the OTLF is probably not as direct as with the inland, estuarine or beach-based fisheries, there are possible linkages with many of the species caught by the OTLF which spend part of their life cycle in estuaries or nearshore waters. To better understand the linkages between this and other fishing activities to Indigenous issues, a substantial research study has been proposed through the IFS which seeks, among other things, to identify the species, areas and harvesting techniques of cultural importance to Aboriginal people in NSW.

Furthermore, although Aboriginal participation in the OTLF is limited, Aboriginal people have aspirations of becoming more involved in commercial fisheries. Such aspirations were identified as recently as June 2003 during an Indigenous Fisheries Strategy workshop. The workshop identified fishing closures, licence transfer rules, market value of entitlements and the gradual decline of Aboriginal commercial fishers in the industry as constraints for Indigenous involvement in commercial fisheries.

D3 Goals, Objectives and Management Responses

This section sets out the long term vision, goals, objectives and management responses for the Ocean Trap and Line Fishery.

D3.1 Fishery Vision

The vision for the Ocean Trap and Line Fishery is:

A profitable fishery that provides the community with fresh local seafood and carries out fishing in an ecologically sustainable manner.

D3.2 A Model Framework

Figure D3.1 A model of the framework for a fishery management strategy.

The link between the goals, objectives and management responses is not as simple as that portrayed in Figure D3.1. The reality is that most management responses assist in achieving more than one goal.

A fishing closure is one example of the complex relationships that exist in a multi-method multi-species fishery. Some closures were originally put in place to protect spawning aggregations of fish. A closure to protect spawning fish fits into the "maintaining sustainable populations" goal, however, it can have other benefits, and assist the fishery to meet other objectives. For example, a closure can also provide greater protection to habitat and biodiversity. This outcome provides a range of benefits for the fishery over and above maintaining sustainable populations (see Figure D3.2).

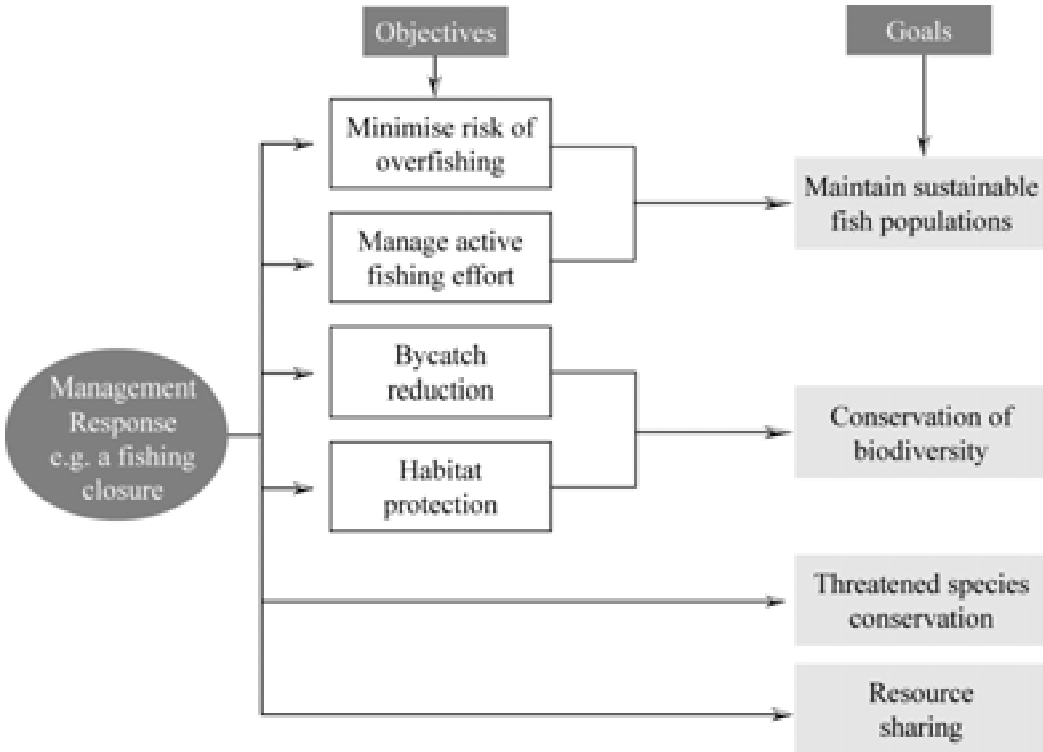

Figure D3.2 Example of how a management response affects multiple goals and objectives

This complex structure has been dealt with in the following section by listing each of the management responses once only, under the objective that the response contributes most towards achieving. Management responses with an asterisk (*) indicate new management actions that are to be implemented to address the outcomes of the risk assessment completed in Chapter B.

Information relating to the implementation of management responses is provided in a table located in Appendix D1. The implementation table outlines the time periods within which each management response is scheduled to be implemented, as well as information relating to the head of power for implementation and the group who has the lead responsibility for carrying out the actions.

The management responses listed in the following section relate to specific actions that directly contribute to meeting the goals and associated objectives defined for the OTLF. Some of these responses have been identified to address specific environmental risks identified in Chapter B. The overall management regime for the OTLF includes the management responses (below), the principles and guidelines contained within the harvest strategy (see section 4), as well as the general requirements of the FM Act and associated Regulations.

D3.3 Goals, Objectives and Management Responses

GOAL 1 Manage the OTLF in a manner that promotes the conservation of biological diversity in the marine environment

Objective 1.1 Mitigate the impact of trap and line fishing in NSW ocean waters on ecosystem integrity (species, populations, and ecological communities)

*1.1(a) Map major trap and line fishing grounds (including available information on associated geological features), assess the level of use of the OTLF on each ground and identify the areas in NSW ocean waters where trap and line fishing occurs (taking account of marine protected areas)

Background: As major trapping grounds are identified, their broad location will be entered on maps. The maps will include relevant geological features and provide information on the level of ocean trap and line fishing that occurs in each area (taking into account the different gear types and seasonal variations where known). The purpose of such maps is to graphically demonstrate the areas where trap and line fishing currently occurs and does not occur to allow an assessment of the impact of trap and line fishing on each ground to be made. The maps will also assist in managing the cross-fishery interactions between trap and line fishing, ocean trawling and lobster trapping activities, as foreshadowed under Objective 4.2, and would also be helpful when considering area closures (such as for Marine Parks).

1.1(b) Collect information on the number of fish traps in the fishery that are lost during fishing operations and implement, in consultation with the MAC, appropriate management actions if necessary

Background: The quantity of traps that are lost each season due to various reasons such as weather, ocean currents, entanglement with gear used in other fisheries, ships breaking head gear, etc is unknown. In order to determine the numbers of traps lost, and ultimately whether there is any potential risk of 'ghost-fishing' from lost fish traps, the catch reporting system has been amended to collect data on the number of traps lost and recovered. The 'Comments' section on the catch return form could be used by fishers to report such things as partial trap retrieval which would indicate that some lost traps were destroyed and unable to ghost-fish. 'Ghost-fishing' is the term given when an item of fishing gear is unable to be retrieved and continues to have the ability to capture or entangle animals. The scientific observer program may also provide estimates of trap loss, depending on the level of coverage of the trap fishery. An example of an appropriate management action is time release mechanisms for fish traps.

1.1(c) Use fishing closures to control fishing activities within the OTLF

Background: This is an adaptive provision of the strategy to allow the modification of fishing practices from time to time. The response itself does not require any immediate action upon implementation of the management strategy.

Fishing closures may by used to protect key fish habitat and minimise impact on sensitive ocean habitat, avoid direct interactions with marine and terrestrial threatened species, populations or ecological communities, equitably share the resource between ocean trap and line fishers and other stakeholders or minimise conflict between resource users. Fishing closures may be gear specific, so that only the relevant gear type/s are affected by such a closure. Closures are periodically reviewed and modified to take account of changing fishing patterns and/or environmental conditions. Any new fishing closures should take account of areas closed to trap and line fishing through marine protected areas.

Fishing closures prohibit fishing over an area either absolutely or conditionally. In this management strategy the term "fishing closure" has a broad meaning encompassing any legally enforceable prohibition or restriction on fishing activity. This includes: fishing closures made under Division 1, Part 2 of the FM Act; aquatic reserve notifications made under Subdivision 3, Division 2, Part 7 of the FM Act; regulations under section 20 of the FM Act (as amended by the Fisheries Management Amendment Act 2001*); regulations under section 220ZE of the FM Act; and regulations under section 205B of the FM Act. Examples of fishing closures include restriction or prohibition of inappropriate gear, may specify fishing seasons for particular species or may set aside closed areas for some or all fishers.*

Objective 1.2 Mitigate the impact of ocean trap and line fishing activities on bycatch (i.e. non-retained catch including prohibited species and unwanted catch)

*1.2(a) Design and implement an industry funded scientific observer program to document the degree of interaction of commercial designated fishing activities, including the OTLF, with non-retained and threatened species

Background: There are limited quantitative data in the NSW OTLF on discard rates and interactions of the fishery with threatened and protected species. Previous studies have demonstrated that the most cost-effective way of obtaining rigorous estimates of incidental catches of a fishery is through a properly designed onboard observer study. The observer program will involve observations on the rate and species composition of bycatch for each gear type in the fishery, document any interactions with threatened and protected species, and estimate the accuracy of catch returns in terms of the quantity caught and species identification. The program will identify, during the design phase, the areas of highest risk to bycatch, and will be able to record the effectiveness of bycatch reduction devices implemented through the management strategy. The program will be designed and costed in consultation with the Ocean Trap and Line MAC.

The environmental performance of the NSW Category 1 Share Managed fisheries, excluding Lobster and Abalone, will be reviewed every two years under the fishery management strategies to determine whether the monitoring program (including the observer program) is needed in future years and, if so, to set priorities and the level of work.

*1.2(b) Implement fish escape panels in fish traps to minimise bycatch and the retention of juvenile and small fish

Background: A FRDC funded study into the mesh selectivity of fish traps used in New South Wales (Stewart & Ferrell 2001) was completed. The study found that the selectivity of 50 mm hexagonal wire mesh was inappropriate for important species with minimum legal size limits in the fishery (e.g. snapper, bream, rubberlip morwong) and smaller fish of other species (e.g. silver trevally). Trials using escape panel mesh of 50 x 75 millimetres showed that it was *effective at reducing the bycatch of undersized fish with minimal loss of other commercially valuable species. This research was done when the minimum legal length (MLL) for snapper was 28 cm. Escape panels with even larger mesh were tried and found to be more effective in reducing bycatch. An escape panel with 50 x 87 mm or 60 x 80 mm mesh would be compatible with the new MLL for snapper of 30 cm, and selecting for rubberlip morwong. However, there was a loss of other marketable species (e.g. bream and pigfish). Fishers also advise that the meshing of fish was greater with the larger mesh size.*

Under this response, an escape panel with 50 x 75 mm mesh will be implemented at the entire back panel of the trap with a short (i.e. one year) phase-in period. The observer program will collect information on the effectiveness of the escape panel with 50 x 75 mm mesh under normal fishing operations. The appropriateness of the escape panel mesh will be reviewed after the term of the first share management plan (i.e. 5 years after the commencement of the plan) unless otherwise specified in the plan, in a recovery program for an overfished species developed under Management Response 2.2(a) or if the MLL for snapper is further increased (referred to in Management Response 2.1(h). Any further advances in the size of mesh contemplated in the future will only be introduced after consultation with the Ocean Trap and Line MAC and an analysis of the economic impacts of the changes and meshing rates of fish. Larger escape mesh panels can be implemented in specific regions, where necessary, to accommodate for the regional variation in the size of the target species.

*1.2(c) Use best-practice handling techniques, including the prohibition on the use of fish spikes, clubs or any other such implement that could unduly harm non-retained organisms

Background: Some techniques used to return unwanted animals to the water unduly injure animals. Such techniques are used to hasten the sorting process or to avoid handling dangerous animals. Fishers should adopt alternative techniques for returning animals to the water which avoid injuring those animals, taking into account occupational health and safety issues. In 1999, Ocean Watch (a non-profit company sponsored by the NSW seafood industry) produced a publication outlining bycatch solutions for non-trawl fisheries proposing better handling techniques. The prohibition of spikes and clubs is a specific action, however, the use of best handling techniques is an ongoing aim for the fishery.

1.2(d) Prohibit the finning of sharks and discarding carcasses

Background: A prohibition currently applies on the taking and landing of all shark species mutilated in any manner other than by heading, gutting or removing gills, and on the possession of any shark fins (alone) in any boat in all waters of NSW. The finning of sharks and the discarding of carcasses is prohibited because it is a wasteful practice.

*1.2(e) Develop a code of practice for the OTLF to:

i) promote best practice handling of bycatch (particularly with the removal of undersize spanner crabs from dillies) and to achieve a premium quality product for the retained catch

ii) promote slow lifting rates for traps to reduce pressure trauma and therefore maximise the likelihood of survival of bycatch

iii) use the shortest rope possible for the head gear to avoid entanglement by marine life or marine craft

iv) discourage the unnecessary deployment of unattended gear for the purpose of ‘holding ground’, and

v) encourage the responsible use of fishing gear around other commercial and recreational fishers and other user groups e.g. scuba divers, whale watchers and swimmers

Background: A code of practice will provide a guide to fishers concerning socially and environmentally acceptable behaviour, and is especially useful for encouraging such behaviour in cases where ensuring compliance with regulations is not possible or overly expensive. A code of practice which has the support of surrounding communities can go a long way to improving the relations between the commercial fishing industry and other stakeholders. The code may contain both mandatory and voluntary requirements.

*1.2(f) Implement the exclusive use of circle hooks for all unattended line fishing methods to reduce gut hooking of prohibited size and other non-retained fish.

Background: Studies have shown that the use of circle hooks on unattended lines reduces gut hooked fish and increases post release survival of bycatch. Circle hooks are designed to prevent the exposed point and barb from puncturing internal organs if the hook is swallowed. As fish swallow the baited hook and begin to move away, the movement pulls the hook from the throat, thereby decreasing the chance of gut hooking.

A circle hook is defined as a hook where a straight line drawn from the point of the hook, and following the trajectory of the point of the hook, crosses and is not offset from the eye or shank of the hook. This means that generally, although not exclusively, that the point of the hook is oriented perpendicular to the shank, whereas in J-style hooks the trajectory of the point is generally parallel to the shank. When laid on a flat surface, non-offset circle hooks to be used in the fishery would lay in the same dimensional plane (i.e. flat), whereas offset hooks would appear uneven in that the point or some other part of the hook would be raised off the flat surface. Circle hooks are already in common use by NSW setline and dropline fishers. Management response 3.1(c) is closely related to this response, and focuses on mitigating the impact of the fishery on grey nurse sharks.

Objective 1.3 Mitigate the impact of the OTLF on ocean habitats and their associated biota

*1.3(a) Modify the use of trap and line fishing methods in areas where their use is identified as having a detrimental impact on fish habitat

Background: While the impact of the OTLF on fish habitat is thought to be low, a management response is needed to reduce any unacceptable impacts should they be identified or occur in future. Where fishing methods are known or believed to be having detrimental impacts on fish habitat or threatened species, their use should be modified so as to avoid or minimise those impacts. These impacts may be identified through research programs proposed in this management strategy or through consultation with the Ocean Trap and Line MAC or Ministerial Advisory Councils. Other than the specific changes to fishing gear described elsewhere in this management strategy, this management response does not propose any immediate actions.

Objective 1.4 Prevent the introduction and translocation of marine pests and diseases by fishing activities

1.4(a) Implement, in consultation with the MAC, measures required in accordance with any marine pest or disease management plans

Background: The Minister for Primary Industries or other authorities may alter management arrangements from time to time to minimise or mitigate the impact of marine pests and diseases. Recent examples of outbreaks were the suspected incidence of white spot disease in NSW prawns and the mass mortality of pilchards across southern Australia. There are concerns of the use of imported bait that potentially carry disease that could impact on wild fish stocks. At times it may be a requirement for the commercial fishing industry to respond to outbreaks by modifying fishing practices. Proposed measures will be discussed with the Ocean Trap and Line MAC prior to implementation.

GOAL 2 Maintain stocks of primary and key secondary species harvested by the OTLF at sustainable levels

Objective 2.1 Prevent overfishing of the stocks of primary and key secondary species by ocean trap and line fishers

*2.1(a) Monitor the quantity, length, and/or age and sex composition of the primary and key secondary species taken by commercial designated fishing activities, including the OTLF, as part of the overall resource assessment system

Background: In addition to the collection of information about activities in the fishery, it is necessary to collect relevant information about the composition of the catch of the important species exploited by the fishery. During the development of this strategy a total of 25 species and species groups are identified as primary or key secondary species for ocean trap and line fishing in NSW. For many of these species there is currently little or no information available about the size or age composition of the exploited population. A catch monitoring program will be established as part of the management strategy, to provide sufficient information to support an assessment of the status of the stocks of the primary and key secondary species taken in the fishery.

The type of information gathered within the monitoring programs for the 25 primary and key secondary species is based on the classes for resource assessment (FMS Appendix 4). This information, in conjunction with the framework set out in Scandol (2004), will be used to determine the stock-status of these species. Note that the status of some stocks may remain uncertain even after additional data have been collected and analysed, given the limited contrast in the data available. The environmental performance of the NSW Category 1 Share Managed fisheries, excluding Lobster and Abalone, will be reviewed every two years under the fishery management strategies to determine whether the monitoring programs should be revised and, if so, to set priorities and the level of work. These reviews are necessary to ensure the ongoing effectiveness and efficiency of the monitoring program and the use of industry funds for this purpose.

*2.1(b) Using the approved resource assessment framework, conduct resource assessments of the primary and key secondary species taken by commercial designated fishing activities, including the OTLF, where necessary, and review the assessments at least every three years thereafter with an external review of the assessment framework at least every four years

Background: The quantity of information available to assess fish stocks varies for each primary species, ranging from having completed major projects to having little information to include in an assessment beyond catch and effort information. For the primary and key-secondary species, the monitoring program will change from the use of commercial landings to the use of catch-per-unit-effort data, length-composition data and, in some cases, age- composition data. Within statistical constraints, these data will be used to confirm that the stock remains stable; and, if possible, used to determine the stock-status of these species. For the key secondary species the short term aim will be to gather and analyse information which will enable an initial assessment of the status of the stock to be completed (often for the first time). More details about the methods to be used to develop and undertake these resource assessments can be found in Scandol (2004).

It is important to note that resource assessments are done on a species basis and are therefore reliant on harvest estimates from all sectors and adjacent jurisdictions. Furthermore, the scope and reliability of the assessments will vary for each species depending on its life history, biological characteristics and availability of research and monitoring information. In the short term, an important part of the process for reviewing the status of each species will include reviewing the trigger catch levels for each species (see management response 2.1c and Appendix D3). The results of resource assessments will be fed into decision making processes about sustainable levels of catch and/or effort. A periodic review of resource assessments is important for ensuring ongoing improvement in the assessments and the programs providing information for them.

*2.1(c) Monitor the annual landings of primary and key secondary species for comparison against "reference" levels set out in FMS Appendix 2, as part of the overall resource assessment system

Background: As a cautionary measure, annual landings of primary and key secondary species will be monitored to detect unusual trends in catches. Both increases and declines in catches will be assessed in relation to pre-determined 'trigger catch' levels set with regard to historical annual landings by the OTLF. Primary and key secondary species will be monitored at the individual species (or species group) level. The results from this monitoring will be used in the determination of a species status as part of the overall resource assessment system (see FMS Appendix 2).

*2.1(d) Monitor commercial landings of all secondary species (other than the key secondary species) taken in the fishery annually for comparison against an historical range for each of those species or groups of species, as part of the overall resource assessment system

Background: It is important that available resources for resource assessment are directed towards assessing the primary and key secondary species (note that resource assessments may be undertaken for some species that are considered 'secondary' in the OTLF because they are 'primary' species in another designated fishery).

The catch of secondary species (other than the key secondary species) will be monitored to determine whether they are outside the historical range of catches (i.e. the lowest and highest catches) within the period 1984/85 to 2001/02. This ensures species that are less widespread in the fishery will still be monitored at a broad scale. The monitoring will aim to detect unprecedented changes in landings of the species taken in very small quantities by the OTLF. Given the number of species involved, the secondary species may be monitored in groups as appropriate.

*2.1(e) Investigate the cost effectiveness of using fishery independent surveys to provide abundance indices and other information for resource assessment of the primary species taken in the OTLF

Background: One of the key pieces of information needed to develop quantitative resource assessments is a time series of relative abundance estimates. This can be difficult to obtain from commercial landings data due to changes in fishing practices, varying catchability of different fishing gears and problems of misreporting. Fishery independent surveys can be designed to reduce biases due to the above factors, however such studies are expensive to implement and need long-term commitment to funding. It is important to assess the potential usefulness of such studies for the resource assessment of ocean trap and line species, and whether the fishery independent surveys being conducted in estuaries will be likely to provide sufficient information *for some of the primary species in the OTLF. The cost effectiveness of using a fishery independent survey will be reviewed at the request of the OTL MAC*

*2.1(f) Review and where appropriate implement minimum legal lengths for the primary and key secondary species to give a high probability that at least 50% of the fish of each particular species landed have reached reproductive maturity (unless alternative strategies apply to individual species)

Background: This response aims to prevent incidences of recruitment overfishing. Size limits are designed to allow a sufficient proportion of the population to survive to maturity and thereby breed at a rate necessary to sustain the population in the long term. It is important however, to maintain the natural sex ratio in the population. As noted in the proposed response, there may be exceptions for some species.

Size limits are already in place for several of the primary species. A review of all size limits, involving community consultation, is conducted as required. If in the interim, additional information becomes available indicating that a size limit needs to be introduced or changed prior to the periodic review, this response enables the appropriate action to be taken. Rubberlip morwong is one species that needs specific attention because there have been large declines in the commercial catches and the average size composition of landings since the mid-1980s.

*2.1(g) Implement minimum size limits for wobbegong sharks (initially at 130 cm total length), and adjust the size limits based on research results

Background: The majority of commercial wobbegong catches occur in the OTLF, where they are taken as both a target species by setline methods and as byproduct by other methods. Little is known about the biology of wobbegong sharks, and the commercial landing of wobbegong sharks have steadily declined from about 120 tonnes in 1990/91 to about 40 tonnes in 1999/00, however the commercial landings have been relatively stable in recent years. This may signal reduced abundance of the species in NSW. In January 2002, NSW Fisheries released a discussion paper 'Management of Wobbegong Sharks in NSW' which sought community and stakeholder submissions on possible management options for wobbegong sharks. There was strong support from the consultation process for maximum and minimum size limits, proposed at 100 cm as a minimum and 200 cm as a maximum. Discussions with commercial fishers suggest that a maximum size limit for wobbegong sharks is not practical due to the difficulties in measuring large wobbegong sharks.

The minimum size limit for wobbegong sharks is an interim measure pending the outcome of scientific research that is currently underway and will be specifically reviewed in the next statutory review of the Regulation in 2007. An identification card will also be developed and distributed to fishers, highlighting the distinguishing features of wobbegong species. The catch reporting system will also be amended to include the two species (see management response 7.3b).

*2.1(h) Assess the economic impacts of increasing the size limit for snapper to 32 cm

Background: On 1 July 2001, the minimum legal length for snapper increased from 28 cm to 30 cm. The scientific data suggests that yield would be further increased with an additional increase to 32 cm, however, the commercial fishery is concerned about the impact of such an increase on the economic viability of snapper fishing. Before any further increase in the *snapper size limit, an economic study will be undertaken to determine whether the longer term biological and economic benefits of increasing the limit outweigh the short term economic costs.*

*2.1(i) Cap the NSW catch of school and gummy sharks and participate in the development of a multi-jurisdictional quota scheme with the Commonwealth and southern States

Background: The school and gummy shark resources have been identified as being heavily overfished and fully fished, respectively, and the Australian Fisheries Management Authority, in conjunction with the southern States, has implemented a quota scheme to limit the total harvest. While the catch of school and gummy sharks is small in NSW compared to that in other jurisdictions, there is a need to cap the NSW catch to prevent it from increasing. NSW will also participate in the global quota scheme to assist in the rebuilding of stocks. The NSW harvest is largely restricted by the gear able to be used in ocean waters, in comparison to the waters in other jurisdictions where mesh nets are still authorised. The use of mesh nets in NSW ocean waters was prohibited over 20 years ago.

*2.1(j) Modify the gear controls applicable to the spanner crab fishery and investigate the feasibility of a quota system to manage the harvest of spanner crabs in the longer term

Background: A range of input controls currently exists for the spanner crab fishery. Several of these controls need to be modified to ensure sustainability of the fishery. The modifications to the management controls for the spanner crab sector are outlined in FMS Appendix 3 and include changes to the dimensions of the gear, number of dillies permitted on board a boat and the mesh size of the netting.

The spanner crab stock is shared with Queensland where the fishery is managed predominantly by output controls (quota), though several input controls remain. The characteristics of the NSW spanner crab fishery makes it well suited to management by quota and full complementary management arrangements between States is therefore possible. However, the volume and value of the NSW fishery is substantially smaller than the fishery in Queensland (i.e. approximately 10% of the Queensland catch) and the cost of managing the NSW catch through a quota scheme may be excessive given the value of the fishery.

An investigation into the feasibility of a quota system will be undertaken to examine the cost and benefits of implementing a quota scheme in the longer term.

*2.1(k) Utilise onboard observers to collect additional biological information, including size at maturity and fecundity/brood size data, for the important elasmobranch species taken by the fishery

Background: A public consultation draft of an Australian National Plan of Action for the Conservation and Management of Sharks was released in July 2002. This document sets out the need for concerted national action to reduce the risks of commercial and recreational fishing to the variety of shark species found in Australian waters. Two of the primary recommendations found in the plan involve improving the identification of captured sharks and thereby increasing the accuracy of reported catch data, and undertaking targeted research on shark species.

In addition to the size and sex composition data collected for primary and key secondary species under management response 2.1a it is necessary that data be obtained on the important *biological characteristics governing maturation and fecundity for those elasmobranch species which are significant in trap and line catches. The generally slow growth rates and low reproductive rates of elasmobranchs make them particularly susceptible to overfishing. The paucity of relevant biological data for the main species taken in the OTLF needs to be addressed in order to determine if any of these species require more targeted management actions to prevent overfishing of the stocks. This work is best done by onboard observers as shark species are generally cleaned aboard the catching vessel prior to landing.*

2.1(l) Prohibit the taking of all female spanner crabs carrying ova

Background: In order to protect spawning females, the taking of any female carrying ova is prohibited under the FM Act.

2.1(m) Prohibit the taking of male spanner crabs from 20 November to 20 December and female spanner crabs from 20 October until 20 January

Background: Seasonal spawning closures are in place to protect spawning aggregations and migrating male and female spanner crabs.

Objective 2.2 Promote the recovery of overfished species

*2.2(a) Where the OTLF is a major harvester of a species determined as overfished in NSW (recruitment or growth overfished) develop and implement a recovery program for that species, including those listed in the harvest strategy, in particular:

i) develop and implement a recovery program for gemfish (recruitment overfished)

ii) develop and implement a recovery program for snapper (growth overfished)

iii) determine if a recovery program is required for any other species through the management strategy or subsequent research, and implement necessary actions.

Background: There are two recognised types of overfishing, recruitment overfishing and growth overfishing. Recruitment overfishing occurs where insufficient spawning stock remains to ensure adequate recruitment of young fish into the stock. Recruitment overfishing requires urgent attention, usually in the form of fishery closures to allow the mature population to rebuild. Growth overfishing occurs when fish are harvested at a size much smaller than the optimum size for maximising biological and economic yield. Addressing this problem generally requires an adjustment of the selectivity of the fishing gear used to take that species, and the setting or adjustment of a minimum legal size for the species. It should be noted that development of a recovery program may not be required for all species determined as growth overfished, providing certain circumstances apply – refer section D4.2.7 of the harvest strategy for details.

As the OTLF has been a major harvester of gemfish in NSW, a recovery program for gemfish will be developed as part of the OTLF Management Strategy, and will specify: (1) the continuation of a NSW 'daily trip limit' of 50 kg which applies to all commercial methods; and (2) the assessment by scientific observers of any discarded catch. The trip limit for gemfish was reduced from 150 kg to 50 kg in May 2000 in response to overfishing concerns and acts to discourage NSW fishers from targeting gemfish.

The OTLF is also a major harvester of snapper in NSW, the recovery program for snapper will be developed as part of the OTLF Management Strategy, and will specify: (1) assessing the economic impacts of increasing the size limit for snapper to 32 cm; and (2) the assessment by scientific observers of any discarded catch.

Yellowtail kingfish have been identified as being growth overfished but a recovery program is not being recommended for kingfish at this time. Updated length composition data of yellowtail kingfish collected in 2004/05 will enable a clearer assessment of this species and a review of the stock-status will be completed in early 2006. If the overfished status of this species remains, then a recovery program will be developed and implemented within a timeframe commensurate with the assessed risks.

*2.2(b) Where the fishery is a minor harvester of an overfished species, contribute to the development of any recovery program for the species and adopt any measures required by a program. In particular, implement the provisions of the recovery program for silver trevally to be developed under the Ocean Trawl Fishery Management Strategy

Background: The Ocean Trawl Fishery Management Strategy is developing a recovery program for silver trevally and will include a minimum legal length for silver trevally (30 cm total length). The OTLF will need to comply with the provisions contained within that recovery program.

Objective 2.3 To conserve fish stocks by managing levels of active fishing capacity in the fishery

2.3(a) Implement the following limits on gear use in the fishery:

*i) a maximum number of 30 fish traps to be used by an endorsement holder at any one time

ii) maximum use at any one time of 10 set lines with 6 hooks each line inside 3 nm (except when shark fishing south of Moruya when hooks of size 9/0 or greater are being used)

iii) maximum use at any one time of 30 driftlines with 1 hook (or 1 gang of hooks comprising no more than 5 hooks) attached to each line

*iv) a maximum use at any one time of 1,200 hooks by an endorsement holder using any line fishing methods outside 3 nm

*v) a maximum of 6 single or 3 double poles able to be used at any one time during poling operations

Background: Limiting the number of traps, rods and lines that may be used by ocean trap and line fishers is a means of controlling the fishing capacity in the fishery and reduces the risk associated with the existing management arrangements. Fishing effort will be controlled through limits on the number of endorsements available. Management response 5.3a will establish a level of total fishing effort over a 10 year period to achieve a fishery that is commercial viable and ecologically sustainable. Once effort levels established under 5.3a are achieved, these gear limits could be adjusted in response to further changes in effort levels.

The Fisheries Management (General) Regulation 2002 *provides a description of fish trap, spanner crab net and line methods. Because the fishery environmental assessments must consider possible use of gear, as well as common use, explicit definitions of the gear should make the assessment easier.*

*2.3(b) Prohibit the use of on-board automatic baiting machines in the fishery

Background: An automated baiting mechanism allows fishers to set and bait a greater number of hooks by a single vessel and enables faster deployment of the gear. Prohibiting the use of these machines is a means of controlling the level of active effort that can be applied in the fishery at any one time. Few, if any, automated baiting machines are currently used in the NSW fishery and this response will ensure that they do not become commonplace. Automatic baiting machines are permitted to be used in the Commonwealth Gillnet, Hook and Trap fishery, where the key species taken are subject to individual catch quotas.

GOAL 3 Promote the conservation of threatened species, populations and ecological communities and protected species of fish likely to be impacted by the operation of the OTLF

Objective 3.1 Identify and minimise or eliminate any impacts of fishing activities on threatened species, populations and ecological communities (including mammals, birds, reptiles, fish, invertebrates and vegetation), and protected species of fish and where required promote their recovery

*3.1(a) Modify, in consultation with Ocean Trap and Line MAC, the mandatory reporting arrangements to enable the collection of information on interactions with or sightings of threatened or protected marine species and interactions with other threatened or protected species

Background: The guidelines for 'ecological sustainable' fisheries approved by the Commonwealth under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 *include a requirement to collect information on interactions with endangered, threatened or protected species and threatened ecological communities. These species, populations and communities are listed in the FM Act*, Threatened Species Conservation Act 1995 *and the EPBC Act. Information on interactions with threatened species will come from the modified reporting arrangements, the scientific observer survey and any other verifiable interactions on threatened or protected species.*

It is important that fishers are able to distinguish threatened and protected species from similar species in order to correctly identify and where possible avoid interactions with them. An example of this type of information is the grey nurse shark identification material. For this purpose, information will be disseminated to endorsement holders to assist them in identifying and avoiding protected and threatened species.

3.1(b) Implement, in consultation with the Ocean Trap and Line MAC, the provisions of any relevant threatened species recovery plans, threat abatement plans, or other similar management arrangements designed to protect critical habitat areas

Background: Once a species, population or ecological community has been listed as endangered, a recovery plan must be developed. These plans are designed to return the species, population or ecological community to a point where its survival in nature is assured. The recovery plans referred to in this response could include those being developed under the Fisheries Management Act 1994*, the* Threatened Species Conservation Act 1995 *or other State or Commonwealth legislation.*

Additionally, threatened species legislation requires the development of a threat abatement plan for any listed key threatening processes. A threat abatement plan outlines actions to eliminate or manage the key threatening process, and identifies the authorities responsible for carrying out those actions.

This response recognises that the statutory provisions of a threatened species recovery plan or threat abatement plan, or an arrangement necessary to protect a critical habitat area, must be implemented and given precedence over the provisions of this management strategy.

*3.1(c) Implement changes to reduce or prevent the impact of the OTLF on grey nurse sharks, including:

i) the exclusive use of circle hooks for all unattended line fishing methods

ii) prohibiting the use of wire trace on bottom setlines

iii) investigating the effectiveness of the use of circle hooks for all attended line fishing methods, and

iv) working with Ocean Trap and Line fishers to develop appropriate arrangements to close key grey nurse shark areas to commercial fishing, including any shift in effort, consistent with broader management arrangements for grey nurse sharks

Background: The grey nurse shark Carcharias taurus *is listed as an endangered species under the NSW* Fisheries Management Act 1994*. The east coast population of grey nurse sharks is listed as critically endangered under the Commonwealth* Environment Protection and Biodiversity Conservation Act 1999*.*

The grey nurse shark population in eastern Australia is under serious threat. Its abundance in NSW and Queensland waters declined dramatically prior to 1984 because it was killed in large numbers by hook and line, and spear fishing. Since then numbers have not recovered despite being protected and they have continued to die mainly as a result of accidental catch by hook and line fishers, in bather protection nets, and due to illegal fishing and spear fishing.

Since the introduction of the grey nurse shark critical habitat areas in 2002, grey nurse sharks are still being observed with hooks and line in their mouths within these locations. The exclusive use of circle hooks for all unattended line fishing methods and the prohibition of wire trace on bottom setlines reduces the chance of incidental capture of grey nurse sharks (Note: the definition of a circle hook is included in the background text to Management Response 1.2(f)). The effectiveness of circle hooks when used on all attended line fishing methods will be reviewed to determine if the benefits warrant this additional change to the operation of the fishery. NSW DPI will also work with OTL fishers to develop arrangements to close key grey nurse shark areas to trap and line fishing.

Note: In February 2006, in response to a condition placed on the fishery by the Commonwealth Government under the EPBC Act, the OTLMAC supported the early implementation of several initiatives proposed in the draft FMS, as follows:

- *the exclusive use of circle hooks for all unattended line methods;*
- *a prohibition on the use of wire traces used on bottom setlines in all ocean waters within 3 nm from the coastline, and in ocean waters beyond 3 nm in buffer zones surrounding known grey nurse shark aggregation sites.*

The MAC expressed concern about the proposed prohibition of wire traces in all ocean waters impacting unnecessarily on fishers who target large sharks (e.g. tiger sharks, black-tip sharks, makos, etc.) using setlines in deep waters or other areas where grey nurse shark are not likely to frequent. Further advice from industry is needed with respect to the concerns raised by the Ocean Trap and Line MAC.

*3.1(d) Using the code of practice, promote the use of fishing techniques that avoid the capture of or interaction with protected fish and fish protected from commercial fishing

Background: 'Protected fish' refers to species of fish that are protected from all forms of fishing and are listed in section 19 of the FM Act. 'Fish protected from commercial fishing' as the name suggests, refers to species of fish that are protected from commercial fishing only and are listed in section 20 of the FM Act. There are a range of measures that could be included in the code of practice that may minimise the interactions or impacts on protected fish and fish protected from commercial fishing such as using different bait or not using whole fish bait to avoid capture of certain species, and promoting best practice handling techniques. It is already unlawful for any person to retain a protected species and as such the focus of this response is to encourage fishers to avoid interactions with species that have 'protected' status.

GOAL 4 Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts

Objective 4.1 Provide for appropriate access to the fisheries resource by other stakeholders (e.g. recreational, Indigenous), acknowledging the need of seafood consumers to access fresh quality fish

*4.1(a) Estimate the total catch of primary and key secondary species in the OTLF, taking account of the recorded commercial catch and estimates of recreational, Indigenous and illegal catch

Background: Estimates of harvest rates from all sectors are vital for resource assessments and to ensure access to resources is appropriately shared. Information on the recreational and Indigenous catch will be drawn from the results of the National Recreational and Indigenous Fishing Survey, related studies to be undertaken in NSW and information obtained from other sources such as charter boat logbooks. Information on illegal catches will come mainly from the results of compliance actions and associated intelligence.

Objective 4.2 Provide for fair and equitable sharing of the fisheries resource with other commercial fisheries (NSW, interstate and Commonwealth)

*4.2(a) Monitor management arrangements and the annual landings of key ocean trap and line species in fisheries that are outside NSW jurisdiction but which impact on stocks shared with the NSW OTLF, as part of the resource assessment system

Background: Many of the primary and key secondary species in the OTLF are also significant in landings of fisheries under other jurisdictions. Increased targeting or harvesting of particular species can have implications for sustainability and sharing of access to that stock. Observing changes in harvest levels by other fisheries can allow implications arising from increased targeting or landing to be detected early and appropriate action to be taken.

*4.2(b) Monitor the annual landings of secondary species (other than the ‘key secondary’ species) in the OTLF

Background: A large number of species are taken incidentally but retained in the OTLF and while quantities landed are small, this response seeks to identify and limit any unusual increases in landings of any of these species. Many of these species are significant in landings of other commercial or recreational fisheries.

4.2(c) Use cross-fishery and cross jurisdictional consultation to discuss and manage issues relating to, but not limited to, the multiple use of specific fishing grounds, collaborative research, fair and equitable access to stocks, complementary management arrangements and other interactions between fishing sectors

Background: There have been recent examples of interactions between the OTLF and the trawl and lobster fisheries where cross-fishery consultation provided a useful mechanism to resolve *conflicts. There will be times when direct consultation between fishers within NSW and/or with other jurisdictions such as Queensland and the Commonwealth is required. Cross-fishery consultation and the management tools in this strategy will be used to provide for fair and equitable access to fisheries resources.*

The existing Management Advisory Committee (MAC) and Advisory Council processes are typically used for cross-fishery consultation, however the Minister may at times establish working groups to address specific issues. An example of this is the Juvenile Prawn Summit Working Group that was formed during 2000 to provide advice on harvesting the State's prawn stocks.

*4.2(d) Participate in the development and implementation of a policy (including reporting procedures) to manage the use of the lift net for collection of 'live' bait by NSW ocean trap and line fishers

Background: In 1985 a concession was introduced to allow licensed commercial fishers in NSW to use lift nets for taking bait (pilchards, yellowtail and blue mackerel) for own use for tuna fishing. In 1995 the lift net was prescribed in the Regulations. The lift net does not form a part of any restricted fishery and was included in the Ocean Hauling Fishery Management Strategy to enable its use to continue within an appropriate framework. The Ocean Hauling Fishery is the primary harvester of these bait species and it is appropriate that this activity is managed in direct association with ocean hauling.

The Ocean Hauling Fishery Management Strategy provides for the development of a policy to manage the taking of baitfish by NSW line fishers. The policy must be developed in consultation with the Ocean Trap and Line MAC, particularly with regard to eligibility criteria for access to permits. Development of the policy will allow for the consideration of the use of lift nets to take bait for taking species other than tuna (e.g. kingfish).

*4.2(e) Implement a policy to manage the impact of dual endorsed Commonwealth tuna boats in NSW waters, in particular to regulate boat length and/or catches taken by larger than standard size boats, such as through amending the existing policy that allows tuna boats to upgrade in length whilst retaining State entitlements

Background: The NSW licensing policy allows licensed fishing vessels over 6 metres to be replaced by a new vessel that is within 1 metre or 10% of the original vessel length (on a once only basis). An exemption applies to vessels with Commonwealth tuna longline permits. Those vessels are able to upgrade no longer than the maximum boat length applying in the East Coast Tuna Longline Fishery (providing the longline permit was attached to the vessel before 16 January 1991) and retain State entitlements provided that there is no increase in effort or catch in fisheries other than the East Coast Tuna Longline Fishery. This policy has been in place to allow NSW endorsed vessels to compete in quota managed Commonwealth fisheries where there are pressures to increase capacity in order to remain competitive. Vessel owners are made aware of the requirement that they should not increase their effort in State managed fisheries, however no formal system of monitoring currently exists to ensure that effort is not increased. This management response aims to eliminate the risk under the current policy associated with larger upgraded tuna vessels be able to continue to operate in the smaller scale State fishery. The new policy will take account of any new management arrangements implemented under the Commonwealth's Eastern Tuna and Billfish Fishery Management Plan.

Objective 4.3 Provide for the fair and equitable sharing of the fisheries resource within the OTLF

*4.3(a) Respond to information about significant changes in the relative catches of the primary and key secondary species taken by different endorsement types within the OTLF

Background: The primary and key secondary species are of major importance to the fishery. It is important to monitor the relative catch levels across fishing methods to detect any changes that may occur within the fishery.

Objective 4.4 Identify and mitigate any negative impacts of the OTLF on Aboriginal, cultural or other heritage

4.4(a) Manage the OTLF in a manner consistent with the Indigenous Fisheries Strategy and Implementation Plan.

Background: The Indigenous Fisheries Strategy and Implementation Plan (IFS) was released during December 2002. The IFS puts in place a process that will ensure discussion and negotiation to resolve problems and challenges in relation to indigenous involvement in the fisheries of NSW. A funding application is being developed to conduct a significant research program that would determine the fish species, areas and/or harvest techniques of cultural importance to Aboriginal people so that any interactions with the OTLF may be identified. Such a program may identify species that are taken in ocean based commercial fisheries but spend part of their life cycle within estuaries or near-shore waters where cultural fishing practices are more common.

4.4(b) Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from ocean trap and line fishing activities

Background: Fishers in the OTLF must respond appropriately to new information about items or locations of Aboriginal and other cultural significance (e.g. a recently discovered shipwreck), and this management response seeks to reinforce that intention.

Objective 4.5 To promote harmony between the commercial fishery and other resource users, including recreational fishers, Indigenous fishers and local communities, through fair and equitable sharing of the resource

4.5(a) In consultation with the Ocean Trap and Line MAC, identify areas of high interaction between the OTLF and other resource users and respond appropriately to resolve any conflicts

Background: It is important, when promoting harmony amongst resource users, to identify areas of potential conflict and determine the most appropriate use of commercial fishing gear in areas where more than one resource user group is apparent. Issues over access to fishery resources or locations often arise in areas where there is high interaction between multiple user groups. The maps developed under management response 1.1a will be crucial to the effective implementation of this management response. This response provides a means of resolving any conflicts identified by measures such as improving communications or small spatial or temporal closures.

GOAL 5 Promote a viable commercial fishery, consistent with ecological sustainability

Objective 5.1 Provide secure fishing entitlements for ocean trap and line fishers

5.1(a) Implement the share management provisions of the *Fisheries Management Act 1994*

Background: The category 1 share management provisions allow for the allocation of shares in perpetuity, with the payment of statutory compensation for the market value of the shares if the Government decided to close the fishery and cancel the shares. Category 1 share management provides a secure property right and a stronger incentive for business investment and resource husbandry.

Objective 5.2 Manage the harvesting of the primary and key secondary species by size to achieve optimal biological yield and economic return in the longer term

*5.2(a) Determine and implement strategies for harvesting fish at a size that provides optimum balance between biological yield and economic return for the primary and key secondary species in the longer term

Background: Determination of the size of fish harvested that optimise both biological yield and economic return needs to take into account the available information on reproductive biology (e.g. size at maturity), growth and natural and fishing mortality rates for the species mix taken, as well as information on gear technology, discard mortality, input costs and market prices. The results of such analyses will be used to make informed decisions on the size limits imposed on certain species, selectivity of fishing gear used and other harvest strategies associated with the fishery.

Objective 5.3 Establish a level of fishing effort to achieve a fishery that is commercially viable (and ecologically sustainable) over the longer term

*5.3(a) Manage fishing effort in the OTLF by:

- i) capping the number of each endorsement type at currently active levels
- ii) establishing a maximum level of fishing effort for each sector of the OTLF to be achieved within 10 years of the commencement of the share management plan

Background: The current total level of effort (active and latent) in the OTLF is greater than the level that would provide a positive economic return from the fishery. In particular, there is currently a high level of latent fishing effort in each sector of the OTLF that, if activated, could have a significant adverse impact on the commercial viability of fishing businesses reliant on the fishery. (Latent fishing effort/capacity is defined as those endorsements never used or used at very low levels.)

Careful planning is required to facilitate an orderly process of structural adjustment, including setting achievable targets for effort levels, selecting adjustment tools and setting *implementation timelines. Adjustment tools may include the use of minimum shareholding requirements under the share management plan, and may be supplemented by a range of other adjustment tools and controls to manage fishing capacity. Modelling will be undertaken to make informed decisions on the most appropriate way to apply minimum shareholdings and any other restructuring tools. This process will be undertaken in consultation with the Ocean Trap and Line MAC.*

Point (i) of this response will prevent the risks to commercial viability and the biological environment that might otherwise result if latent effort was activated. The criteria for determining the current level of active endorsements will be determined with reference to the time of commencement of the strategy and in consultation with the Ocean Trap and Line MAC.

Point (ii) will include consideration of the number of entitlements, how often they are used and the capacity of those operators (i.e. a measure of the capability to catch fish).

Objective 5.4 Promote the economic viability of the OTLF and assess the economic benefits of the fishery to the community

*5.4(a) Refine the performance indicator for monitoring trends in the commercial viability of typical fishing businesses within each designated commercial fishing activity, so as to be based on net returns

Background: This management strategy includes a performance indicator for monitoring economic viability of fishing business with trap and line endorsements, using gross returns. However, net return rather than gross return is a better indicator of economic performance as it accounts for changes in fishers' costs over time. An understanding of the average net return across fishing businesses requires data on seafood prices, as well as the cost of inputs such as fishing gear, fuel and bait. A process will be developed in consultation with the MAC to determine how best to collect data on the costs of going fishing, taking into account confidentiality/privacy concerns and the cost-effectiveness of the data collection methods. Once this process is developed, the performance indicator can be modified accordingly.

*5.4(b) Investigate the data available to assess the economic multiplier (flow-on) effects of commercial fishing, including the OTLF, to the broader community, and develop strategies to improve the quality/usefulness of such data

Background: There have been few detailed assessments of the economic benefits of commercial fishing in terms of flow-on effects for local and regional economies, or returns to the broader community for access to a community owned resource. Fishing activities (and in this case expenditure and income associated with the activity of trap and line fishing in ocean waters) are believed to be important to many local economies. There is little doubt that some coastal communities derive substantial economic benefits from trap and line fishing in ocean waters, not only from direct employment but also from the provision of ancillary services. There may be some areas where the economic impacts of management changes need to be directly assessed, taking account of the actions in this strategy. Advice will be sought from the Ocean Trap and Line MAC and experts in economic analysis on the best data to use to describe the multiplier effects of the commercial fisheries, and to assess any significant impacts.

*5.4(c) Identify and promote post-harvest practices which will ensure the best return in dollars per kilogram for product of the fishery

Background: The economic viability of the fishery is dependent on obtaining the best return possible for the product landed. Opportunities are likely to arise where the economic return to the fishery could be increased by improving handling practices or value adding, and it is in the interests of the fishery to widely promote such practices. Good post-harvest practices can be promoted through the Code of practice to be prepared for the fishery.

5.4(d) Develop a cost recovery framework, in consultation with the MAC and the Ministerial advisory body relating to commercial fishing

Background: A cost recovery framework is currently being developed and will be subject to consultation with industry advisory bodies. The framework will allow for the fair charging of the costs of management and access rights and give industry a greater ability to plan. See section D4.3.12 for further information on the cost recovery policy.

Objective 5.5 Manage food safety risks in the harvesting of fish in the fishery

5.5(a) Co-operate with NSW Food Authority in the development and implementation of food safety programs relevant to the fishery

Background: Food safety plans covering the production and distribution of seafood in NSW are currently being developed and implemented by NSW Food Authority . These plans may impose statutory requirements on fishers to comply with the approved standards. Supporting food safety programs is an effective way of promoting consumer confidence in products harvested by the fishery and contributing to the future viability of the industry.

GOAL 6 Facilitate effective and efficient compliance, research and management of the OTLF

Objective 6.1 Promote and maximise compliance with the provisions contained in the OTLF Management Strategy

*6.1(a) Develop, implement and monitor a compliance plan for commercial designated fishing activities, including the OTLF

Background: Currently, compliance plans are developed by NSW DPI compliance officers at the district level. Relevant aspects of these plans will be reviewed and combined into a compliance plan for commercial designated fishing activities, including the OTLF, on a state-wide basis. The Ocean Trap and Line MAC will periodically review the operation of the parts of the compliance plan relevant to each of the fishery sectors.

Compliance with the management strategy can be encouraged through participation of fishers in decision-making. The cost of compliance with provisions in the FMS will be minimised if fishers are involved in the development of those provisions and understand the potential benefits. Such participation should seek to encourage the flow of information between fishery operators and their representatives on the MAC, and an appropriate level of explanation to all endorsed fishers about the reasons for decisions regarding management of the fishery. This could be assisted by holding MAC meetings in relevant ports, and continuing the policy of making MAC meetings open to the attendance of endorsed fishers.

*6.1(b) Investigate the feasibility of the vessel monitoring system (VMS) with a view to implementing the system if it is found to be a cost-effective alternative to existing compliance and/or catch reporting methods

Background: NSW DPI has been monitoring developments in Vessel Monitoring Systems (VMS) in other States and countries over the last few years and has been examining the possibility of introducing a cost effective system in NSW. A VMS uses satellite technology to report the position, speed and other information on commercial fishing vessels. An electronic catch and effort recording system (i.e. log book system) can be integrated into the VMS, allowing fishers the option to report catches via a computer on the boat or at home. VMS systems are currently relatively expensive to implement and maintain, though they appear to be getting less expensive through time as the technology improves.

The introduction of VMS could result in savings of fees, such as compliance fees, under the full cost recovery framework, and would allow for a more complete understanding of fishery operations and how fishing businesses would be affected by management decisions, such as area closures. A VMS could enhance management flexibility and compliance with regard to jurisdictional boundaries, inter-fishery boundaries, grey nurse shark critical habitats, Marine Park zoning, aquatic reserves and any other spatial closures.

*6.1(c) Implement a penalty points scheme (incorporating endorsement suspension and share forfeiture for serious offences and habitual offenders)

Background: It is crucial that effective deterrents are in place to discourage illegal activity in the fishery, especially given the difficulty in enforcing compliance at sea. The penalty points scheme will be similar to the demerit points scheme used by the RTA for driver's licences and will be applied across fisheries. The detail of the scheme will be developed in consultation with industry and implemented through regulation or in the share management plan.

6.1(d) Develop strategies to support appropriate practices and behaviour in commercial fisheries, including development of training and accreditation courses in core competencies and the introduction of fit and proper person requirements

Background: The minimum qualifications will aim to ensure that skippers have a sound understanding of the fishery and the rules that apply, including the need for provision of accurate data. Increasing the professionalism of operators can provide long term benefits to the industry.

Some fisheries currently have fit and proper person requirements to ensure that reputable persons continue to operate in those fisheries. The Ocean Trap and Line Fishery can benefit from similar requirements.

Objective 6.2 Identify research priorities required to provide for the sustainable operation of the OTLF

*6.2(a) Develop and implement a Research Strategic Plan for designated fishing activities, including the OTLF, taking account of the priorities for research outlined in the harvest strategy

Background: Draft research plans have previously been prepared and discussed with the Ocean Trap and Line MAC, along with the assignment of priorities to research proposals. Such plans will be reviewed, in consultation with the MAC, to ensure their relevance and efficacy in relation to the goals and objectives of the approved Fishery Management Strategy and the priorities outlined in the harvest strategy. A new Research Strategic Plan for the fishery, detailing the priorities and possible sources of funding, would then be developed. Development of the plan will benefit from the risk assessment and identification of knowledge gaps in the Environmental Impact Statement.

Objective 6.3 Ensure effective and efficient management of the OTLF

*6.3(a) Develop and implement a fishing business card system

Background: Only one person may be nominated to hold endorsements in respect of a fishing business. The FM Act limits the number of people able to hold endorsements in respect of a fishing business to one, except in the case of skipper endorsements where multiple endorsements can be issued although they are often linked to the boats attached to a specific business. Under current circumstances, for a skipper to work another boat, a new licence with endorsements must be issued; a process that can take several weeks to complete.

To increase the flexibility for business owners to acquire a skipper at short notice a new system will be developed; the fishing business card system. Under this system the owner of a fishing *business with entitlements in the OTLF will be issued a Fishing Business Card. The fishing business owner can then register a pool of appropriately licensed fishers associated with their business. A registered person is deemed to be endorsed with respect to that business when they are in possession of the card. They may operate in all fisheries specified on the card. The fisher may also be restricted to the vessel specified on the card. In the event that a business owned in partnership by two licensed fishers has two sets of endorsements, two fishing business cards could be issued. All registered persons and those in possession of the card must abide by all rules and regulations that would normally apply to the endorsed fishing business owner.*

Objective 6.4 Provide effective and efficient communication and consultation mechanisms in relation to management of the OTLF

6.4(a) Utilise a key consultative body, such as the Ocean Trap and Line Management Advisory Committee (MAC), when undertaking industry consultation on all aspects of the OTLF

Background: The Ocean Trap and Line MAC provides advice to the Minister for Primary Industries on a broad range of issues relating to the management of the OTLF. The MAC includes endorsed commercial fishers elected to represent the interests of those in the OTLF and non-industry members, appointed by the Minister for Primary Industries, to represent other interest groups such as indigenous, recreational and conservation groups. The MAC provides a forum for discussion on issues relating to the fishery.

Objective 6.5 Implement this Strategy in a manner consistent with related Commonwealth and State endorsed programs aimed at protecting aquatic environments and achieving the objectives of ecological sustainable development

6.5(a) Manage the OTLF consistently with other jurisdictional or natural resource management requirements, such as the marine parks program, aquatic biodiversity strategy**,** threatened species program, Indigenous Fisheries Strategy and other relevant strategies

Background: The management strategy will be operating alongside other programs relating to the management of marine resources, and in most instances must be consistent with those programs. The management strategy must be adaptive if inconsistencies between the programs become apparent. This response enables a whole of Government approach to management of the marine environment.

6.5(b) Provide for the issue of permits under Section 37 of the FM Act authorising the use of modified fishing practices to assist research programs or for purposes consistent with the vision and goals of this management strategy

Background: Permits are required to use fishing gear in a manner that is different to that specified in this management strategy, or the associated regulations. This response allows approval to be given to industry members who are participating in research programs to trial new approaches to fishing gear design.

GOAL 7 Improve knowledge about the OTLF and the resources on which it relies

Objective 7.1 Improve the community's understanding and perception of the OTLF

*7.1(a) Promote awareness of the OTLF as part of the overall communication strategy across all commercial designated fishing activities by implementing issue-focused education programs

Background: The Management Advisory Committee and NSW DPI will develop and monitor these programs to ensure they are cost-effective. As an initial step, the Fishery Management Strategy and the Environmental Impact Statement and any resulting reports will be made available to the public by placing them on the NSW DPI website and providing copies at NSW DPI Offices.

Objective 7.2 Promote scientific research to collect relevant information about the biology of the primary and key secondary species, the impacts of fishing on other species and the environment, and the status of the fishery as a whole, including economic and social factors

*7.2(a) Promote and support targeted research projects, which are relevant to:

i) the biology or resource assessment of the primary and key secondary species in the OTLF

ii) the impacts of ocean trap and line fishing on biodiversity and the environment

iii) economic and social factors affecting the fishery, and the effects of management changes on fishing businesses and communities

Background: The current level of knowledge about most of these proposed areas of research is less than desired to properly understand the functioning of this fishery. The MAC, through the FMS and contributing to a Research Strategic Plan, should identify and promote relevant research projects, and offer whatever assistance can be practically provided by fishers or others connected with the fishery. Ideally, the MAC will also be pro-active in the development of necessary research projects, and in supporting such projects to obtain competitive funding.

Objective 7.3 Improve the quality of the catch and effort information collected from endorsement holders

7.3(a) Periodically review the mandatory catch and effort return forms submitted by ocean trap and line fishers and implement changes if:

i) the data are insufficient for the purpose of conducting resource assessments or an environmental assessment

ii) the forms are found to be exceedingly complex for fishers to complete, ensuring an emphasis on quality rather than quantity of information collected.

Background: Ocean trap and line fishers submit a catch and effort return form to NSW DPI each month and the information is used to increase understanding of the fishery and the resources upon which it relies. An informal working group involving commercial fishers and NSW DPI staff has been established to periodically review the current catch and effort return forms. The working group will make recommendations for changes that are considered necessary to improve the quality of data collected. Any recommendations of this working group will be discussed with the Ocean Trap and Line MAC.

*7.3(b) Assess the accuracy of the current catch recording system, and species identification in catch records, and provide advice to industry to make needed changes

Background: Correct species identification is critical to the performance of many areas of the management strategy. Most species in the fishery are accurately reported, however some species are not (e.g. the different species of sharks and leatherjackets,). The onboard observer program may provide first hand information on local names for fish. This information will be used to ensure that industry education is appropriately targeted.

*7.3(c) Modify the reporting system to remove lobster trap as a method on the ocean trap and line catch returns

Background: Some fishers, who are also endorsed in the Lobster Fishery, enter their other catch from lobster traps on their ocean trap and line catch returns. However, the catch taken out of lobster traps is not part of the OTLF and needs to be recorded separately. This issue is also being addressed within in the fishery management strategy for the Lobster Fishery.

D4 The Harvest Strategy

D4.1 Extent of the Fishery

D4.1.1 Number of fishers

At March 2003, NSW DPI licensing database showed that 528 fishing businesses held entitlements to operate in the OTLF, with some businesses holding multiple endorsements within this fishery or in other fisheries. The number of fishers entitled to operate in the fishery varies over time, due to a number of factors including the transfer and amalgamation of fishing businesses and late payments on renewal of fishing licences.

D4.1.2 Area of operation

The OTLF extends from NSW coastal baseline seaward to the 4,000 metre isobath (approx. 60 to 80 nm offshore) (Figure D4.1). The ocean waters from the NSW coastal baseline to 3 nm offshore are state waters and fall under the jurisdiction of NSW. The waters from 3 nm to the 4,000 metre isobath are Commonwealth waters, however an Offshore Constitutional Settlement (OCS) established in 1991 allows NSW to manage some of the fishing activities in those waters (see below).

Ocean waters are defined under Schedule 1 of the FM Regulation as waters east of the natural coastline of NSW, which is defined by a line drawn along the high water mark of the sea. In general, where an estuary meets the coast, the natural coastline is defined as follows:

- a line drawn across the eastern most extremity of two breakwalls
- a line drawn from the eastern most extremity of the one breakwall to the northern or southern extremity of the high water mark on the opposite bank
- a line drawn across the entrance between the eastern most high water mark of the two banks.

Additional areas of ocean waters may be closed to the OTLF through the declaration of marine protected areas, such as marine parks, aquatic reserves, intertidal protected areas and national park or reserve extension areas.

Before 1991, the Commonwealth Government controlled all fishing in waters greater than 3 nm from shore. In January 1991 the Commonwealth and NSW Governments signed the OCS which gave jurisdiction of all ocean trap and line fishing activities within the 4,000 metre isobath (about 60 to 80 nm offshore) to NSW. The Commonwealth retained jurisdiction of the tuna and oceanic squid fisheries beyond 3 nm.

Resolution of the OCS meant that many fishers who previously held both NSW and Commonwealth licences needed only to renew their State licence each year, resulting in significant licence fee savings. Under OCS agreements, fishing boats that were previously licensed to fish outside 3 nm under Commonwealth jurisdiction were automatically issued an authority on their State boat licence (called an 'OG1') to continue to work in offshore waters.

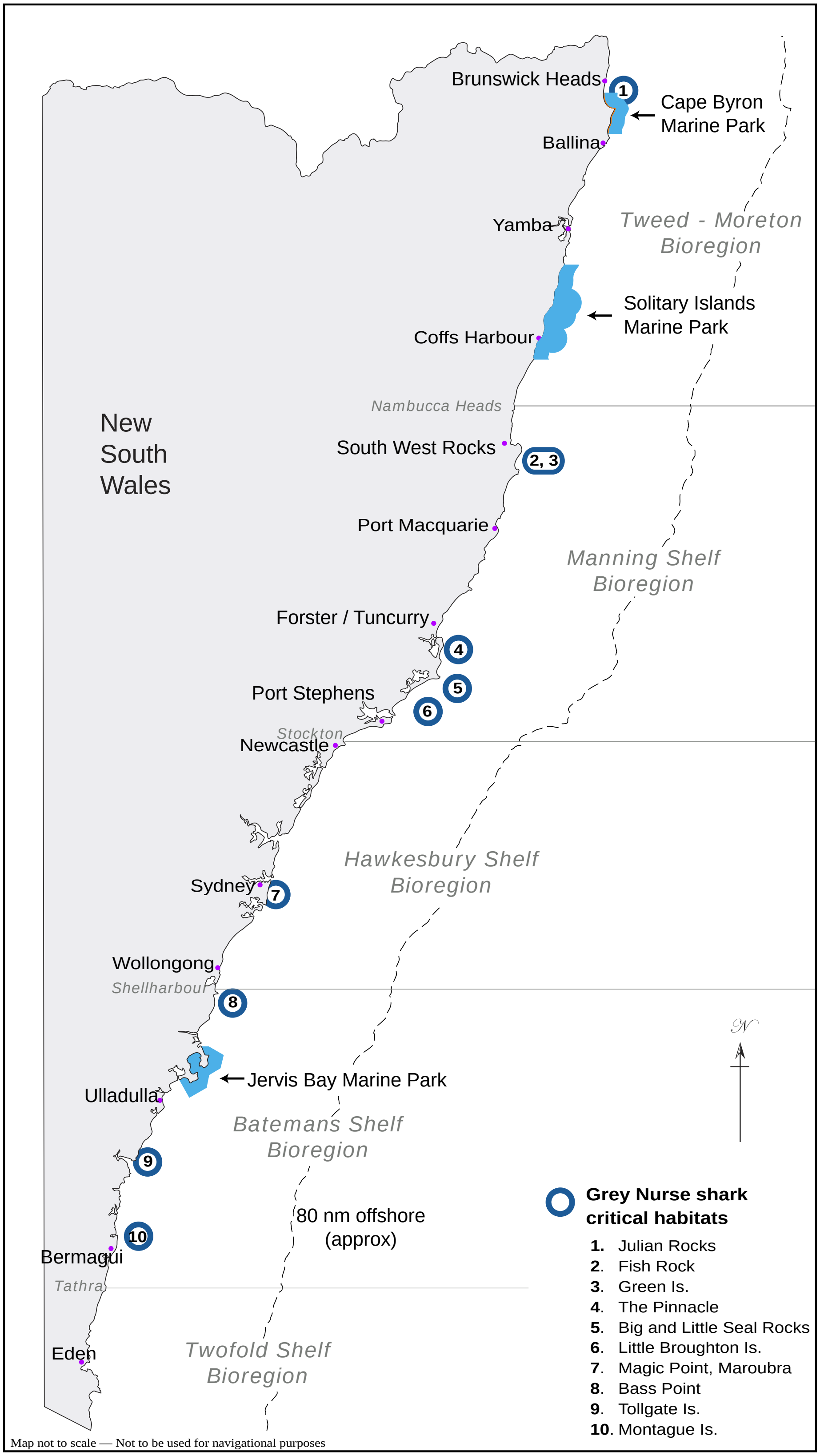

Figure D4.1 Map of the area of the OTLF including major ports, marine bioregions, marine parks and grey nurse shark critical habitats (as of March 2006 Batemans and Port Stephens / Great Lakes marine parks had been declared but zoning was not finalised).

D4.1.2.1 Habitat management

Habitat management guidelines and plans have been and will continue to be prepared under the FM Act to prevent or minimise the impact of all types of activities on fish habitat. Habitat management plans can potentially close areas to commercial fishing and other activities. The Ocean Trap and Line MAC will provide advice and contribute to any reviews of NSW DPI habitat management policy and guidelines or habitat protection plans, where they relate to areas fished by ocean trap and line fishers.

Commercial fishers are often aware of the key habitat areas for fishery production. This knowledge can assist NSW DPI to identify and prioritise sites that may benefit from rehabilitation and potentially contribute to increased fishery production.

D4.1.3 Activities endorsed in the fishery

The fishery is categorised into a number of endorsement types that determine the types of fishing gear each fisher is allowed to use. Table D4.1 lists the endorsement types available in the fishery and details the activity that is authorised by each endorsement. For example, only fishers with a demersal fish trap endorsement on their fishing licence are permitted to use fish traps.

Table D4.1 Endorsements in the OTLF.

Endorsement type	Endorsement description
Spanner crab (northern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are north of a line drawn east from the southern breakwall at Yamba.
Spanner crab (southern zone)	Authorises use of a spanner crab net to take spanner crab for sale from ocean waters that are south of a line drawn east from the southern breakwall at Yamba
Line fishing (western zone)	Authorises use of line methods to take fish from ocean waters that are west of the 100 fathom (183 metres) depth contour. This endorsement does not authorise the holder to take school or gummy shark from waters that are south of a line drawn east from the northern point of the entrance to Moruya River. The endorsement does not authorise the taking of the deeper water species blue eye trevalla, ling, gemfish, hapuku and bass groper.
Line fishing (eastern zone)	Authorises use of line methods to take fish from ocean waters that are east of the 100 fathom (183 metres) depth contour. This endorsement does not authorise the holder to take school or gummy shark from waters that are south of a line drawn east from the northern point of the entrance to Moruya River.
Demersal fish trap	Authorises the taking of fish for sale from ocean waters by bottom set fish traps.
School and gummy shark	Authorises the taking of school shark and gummy shark by line methods south of a line drawn east from the northern point of the entrance to the Moruya River

Note: fishers may hold more than one endorsement. Additionally, any vessels operating outside 3 nm must have an OG1 authorisation.

D4.1.4 Fishing gear used in the fishery

Fishing gear used in the fishery consists mostly of trap and line methods used to target finfish, as well as spanner crab nets designed to specifically target spanner crabs.

The following sections describe the fishing gear able to be used in the fishery and provide details relating to the standard dimensions of that gear. The use of these gear types is subject to a range of time and area closures and other controls as outlined in the management responses in this strategy.

D4.1.4.1 Fish trap (bottom/demersal)

Fish traps are generally timber framed with a wire mesh covering (not less than 50 mm mesh size), which are baited and set on or adjacent to reefs at depths of 10 to 150 metres. Fish traps have maximum dimensions of 2 metres x 2 metres x 2 metres, although most traps used in the fishery measure approximately 2 metres x 1.5 metres x 1 metre. Fish traps must be marked with a buoy (> 150 mm diameter) and must rest on the seabed not less than 5 metres apart. Fish traps are set with bait secured in the middle to lure fish through wire funnels into the trap.

D4.1.4.2 Spanner crab net (dilly)

Spanner crab nets or dillies are flat, rectangular steel frames which have a net over the frame and bait in the centre of the net. A dilly must have an area within its frame of no more than 1.6 m^2.

Baited traps are generally left for approximately one hour before they are lifted into the boat by a line hauler. Multiple spanner crab nets are often set along one line to assist in retrieving the nets.

D4.1.4.3 Line methods

The regulations set out controls that apply to the number of lines and hooks used in commercial line methods within 3 nm. Variations to the controls inside 3 nm apply to fishers with a school and gummy shark endorsement. The information provided below gives a general outline of the different methods used.

Setlines/trotlines

Setlines and trotlines are similar gear types that may either be attached to a row of floats and suspended below the water surface, or weighted to the seabed by a series of weights with a mooring rope and buoy at one end of the line. Within the 3 nm boundary, a maximum of 10 lines with no more than 6 hooks or gangs of hooks attached per line may be used. The use of setlines as surface-set (or ‘pelagic’) longlines is managed by the Commonwealth Government and does not form part of the NSW OTLF.

Driftline

A driftline is a baited hook or gang of hooks attached by line from a single float or buoy which drifts freely on the ocean surface. Each line must not be attached to another driftline or any object which prevents it from floating freely.

Handline

Handlines are single lines with hooks or gangs of hooks lowered into the water by a rod or by hand.

Dropline

Droplines are vertically set lines with hooks attached by snoods. These are generally used in deepwater areas such as waters adjacent to offshore drop-offs and submarine canyons.

Trolling

Trolling involves using a line to tow lures or baited hooks behind a vessel to target pelagic fish. 'Leadlining' is a term given to trolling activities where weights are placed on the trolled lines to target fish lower in the water column.

Jigging

Jigging is a line with large weighted lure that is jigged near the seabed whilst drifting.

Poling

Poling is where bait or lures are attached to lines on the end of poles, which are lowered into a feeding school of fish and the hooked fish are then lifted into the boat.

D4.1.5 Boats used in the fishery

Due the diverse nature of the OTLF, the composition of the fleet varies significantly depending on the methods used and the species targeted. Fishers who operate in near shore waters are able to use relatively small boats, which require less capital investment. Fishers involved in fish trapping or deepwater lining operations generally use large ocean going vessels up to 20 metres in length, which require higher levels of capital investment. The average boat length is approximately 6-8 m.

D4.2 Species

D4.2.1 Species allowed

The OTLF is a multi-species fishery. Around 200 species are taken in the OTLF with the main species targeted being spanner crab, snapper, yellowfin bream, rubberlip morwong, bonito, yellowtail kingfish, blue-eye, bar cod as well as school and gummy sharks. This management strategy categorises retained species as "primary", "key secondary" or "secondary", depending on the quantity and relative value of that species taken by ocean trap and line fishing. A description of these categories is provided below. A total of 25 species or 'species groups' are listed as primary or key secondary species in this fishery (Table D4.2).

D4.2.1.1 Primary species

Primary species are the target species of the OTLF, or those species that are landed in large quantities or are economically significant to the fishery. Consequently the primary species receive a higher management and research priority within this management strategy. Initially, individual trigger points have been determined for the primary species to help determine if a species is likely (or not) to become overfished (see FMS Appendix 2 for further information). However, the strategy requires the development of a resource assessment for each of the primary species (see management response 2.1b) where necessary.

D4.2.1.2 Key secondary species

A number of species have been identified as "key secondary" species because, although not generally targeted, they are an expected catch of trap and line fishing and provide significant economic benefit to the fishery. These species are therefore subject to more rigorous performance monitoring requirements than the remaining secondary species, including the development of trigger points to be used in the monitoring of catches by the fishery (see FMS Appendix 2). Resource assessments will also be undertaken on these species, though at a more rudimentary level than for the primary species, where necessary.

Table D4.2 Primary and key secondary species in the OTLF

	Common name	**Scientific name**	**Family name**
Primary Species	Bar cod	*Epinephelus ergastularius*	SERRANIDAE
	Blue-eye trevalla	*Hyperoglyphe antarctica*	CENTROLOPHIDAE
	Bonito	*Sarda australis*	SCOMBRIDAE
	Gummy shark	*Mustelus antarcticus*	TRIAKIDAE
	Leatherjacket (mixed species)	various	MONACANTHIDAE
	Rubberlip morwong	*Nemadactylus douglasii*	CHEILODACTYLIDAE
	Silver trevally	*Pseudocaranx dentex*	CARANGIDAE
	Snapper	*Pagrus auratus*	SPARIDAE
	Spanner crab	*Ranina ranina*	RANINIDAE
	Yellowfin bream	*Acanthopagrus australis*	SPARIDAE
	Yellowtail kingfish	*Seriola lalandi*	CARANGIDAE
Key Secondary Species	Bass groper	*Polyprion americanus*	PERCICHTHYIDAE
	Dolphin fish	*Coryphaena hippurus*	CORYPHAENIDAE
	Gemfish	*Rexea solandri*	GEMPYLIDAE
	Hapuku	*Polyprion oxygeneios*	PERCICHTHYIDAE
	Jackass morwong	*Nemadactylus macropterus*	CHEILODACTYLIDAE
	Mulloway	*Argyrosomus japonicus*	SCIAENIDAE
	Pearl perch	*Glaucosoma scapulare*	GLAUCOSOMIDAE
	Pigfish	*Bodianus vulpinus*	LABRIDAE
	"Sharks" (mixed species)*	various	various
	Spanish mackerel	*Scomberomorus commerson*	SCOMBRIDAE
	Spotted mackerel	*Scomberomorus munroi*	SCOMBRIDAE
	Sweep	*Scorpis lineolatus*	SCORPIDIDAE
	Teraglin	*Atractoscion aequidens*	SCIAENIDAE
	Wobbegong sharks	*Orectolobus ornatus* & *O.maculatus*	ORECTOLOBIDAE

* “Sharks (mixed species)” includes catches reported as ‘unspecified sharks’, and also includes catches reported under other categories including whaler and dogfish groups, and school, hammerhead, mako and ghost sharks.

D4.2.1.3 Secondary species

Secondary species are categorised as those that are retained by the fishery but which do not fall under the primary or key secondary categories described above. These ‘secondary’ species are taken incidentally during trap and line fishing. This strategy contains measures to ensure the catch of secondary species by ocean trap and line fishers remains low and within the range of historic levels.

Many species taken in the OTLF are also taken in other NSW commercial fisheries, by other sector groups and by fisheries managed under the jurisdiction of the Commonwealth or other States. The FM Act establishes a system of advisory councils who provide advice to the Minister for Primary Industries on cross-fishery management issues. NSW DPI management and research staff will also meet periodically with adjacent jurisdictions to consider consistent management regimes for shared species and to discuss initiatives such as resource assessment, complementary size limits, monitoring programs and recovery programs for overfished species. Cross-jurisdictional collaboration has occurred often on an as-needed basis in the past, however, a more formalised approach to joint management will now be undertaken.

D4.2.2 Bycatch species

Bycatch consists of those animals that are discarded from the catch, and that part of the "catch" that is not landed but is killed as a result of interaction with fishing gear. Fish that are landed are sometimes discarded because there is no market for that type (or size) of fish, or because the regulations prevent the fish from being retained (e.g. if it is smaller than the minimum legal length or is a species protected from commercial fishing).

Bycatch species in the OTLF can generally be classified into fish that are juveniles of species that are of commercial or recreational importance, mature fish being smaller than the MLL, those that are of particular conservation significance and others which are neither a commercial or recreational species nor of specific conservation importance.

D4.2.2.1 Bycatch reduction devices

This management strategy includes the implementation of fish escape panels in fish traps to reduce the bycatch of small fish (see management response 1.2b).

D4.2.3 Size limits

Size limits apply to a number of species taken in the OTLF. Clause 9 of the FM Regulation lists the minimum legal lengths that apply to species permitted to be taken in the fishery. The strategy includes evaluation of the appropriateness of existing minimum size limits for ocean trap and line species, and an assessment of whether minimum size limits should be specified for any other ocean trap and line species (see management response 2.1f).

D4.2.4 Protected species

Commercial fishers are not permitted to take either protected fish or fish protected from commercial fishing. These species are listed in clause 6 and clause 7 of the FM Regulation.

A range of threatened species, other than fish, are protected by other legislation including the NSW *Threatened Species Conservation Act 1995*, the NSW *National Parks and Wildlife Act 1974*, and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Such species may be classified as endangered or vulnerable and cannot be taken by commercial fishers.

D4.2.5 Interactions with threatened species and species of public concern

Although interactions with threatened species have not been commonly recorded in this fishery, this management strategy proposes two direct measures to obtain data on any such interactions. The first of these measures is the implementation of a cross-fishery observer-based survey which will *inter alia* collect data on occurrences of threatened species in catches (see management response 1.2a in section 3 of this management strategy). Secondly, a modification to the catch reporting system will incorporate mandatory reporting of fishers' interactions with threatened species during fishing operations (see management response 3.1a).

A number of management responses also appear in section 3 of this management strategy aimed at minimising impacts on threatened species. These measures include educating fishers in the identification/avoidance of threatened species, using fishing closures, modifying gear use and implementing the provisions of any threatened species recovery plans and threat abatement plans.

D4.2.6 Status of species within the fishery

The determination of the status of the primary and key secondary species is central to the sustainable operation of the OTLF, and is a key component of the strategy. NSW DPI uses a standardised method of reporting on the exploitation status of fish stocks across all commercial fisheries. Stock status is described using the terms defined in Table D4.3. Where available, data on the recreational harvest, including charter boat catch, and catch from other sectors are also taken into consideration when determining exploitation status. This allows a species based management approach where all known impacts on a species are considered.

Table D4.3 Definitions of exploitation status of fish stocks

Exploitation status	Definition
Under fished	The appraisal of a fish stock that suggests that the stock has the potential to sustain catches significantly higher than those currently being taken
Moderately fished (sustainable)	The stock is assessed to be fished at levels which would probably allow only limited increases in catches
Fully fished (sustainable)	The appraisal of a stock which suggests that current catches are sustainable and close to optimum levels (the definition of which may vary between fisheries; e.g. catches are close to maximum sustainable yield, or fishing effort is close to a biological reference point). In a fully fished fishery, significant increases in fishing effort above current levels may lead to overfishing
Overfished (growth/recruitment)	The appraisal suggests that current fishing levels may not be sustainable, and/or yields may be higher in the long term if the fishing level is reduced in the short term. This may be due to recruitment overfishing, growth overfishing and/or as a result of habitat degradation. Growth overfishing occurs when individual fish are typically harvested under the size that takes best advantage of the species growth in relation to expected natural mortality. Recruitment overfishing occurs when fishing pressure has reduced the ability of a stock to replenish itself.
Undefined	Fishery dependent catch data exists but has not yet been appraised. The data may also be of limited value, particularly where the reported catch comprises multiple species or only very recent species-specific catch data.

Source: Adapted from Kennelly and McVea, 2003

Table D4.4 outlines the exploitation status of the primary and key secondary species taken in the OTLF. A number of species are classified as undefined, and the strategy includes responses to measurably improve the quality of reported information and knowledge of stock status for these species. FMS Appendix 2 provides details of the methods to be employed to detect undesirable changes in stocks of primary and key secondary species, prior to the development of more detailed resource assessments.

Table D4.4 Exploitation status of primary and key secondary species taken in the OTLF

	Species	Exploitation status
Primary Species	Bar cod	Undefined
	Blue-eye trevalla	Fully Fished
	Bonito	Undefined
	Bream	Fully Fished
	Gummy shark	Undefined
	Leatherjacket (mixed species)	Undefined
	Rubberlip morwong	Undefined
	Silver trevally	Overfished (growth)
	Snapper	Overfished (growth)
	Spanner crab	Fully Fished
	Yellowtail kingfish	Overfished (growth)
Key Secondary Species	Bass groper	Undefined
	Dolphinfish	Undefined
	Gemfish	Overfished (recruitment)
	Hapuku	Undefined
	Jackass morwong	Undefined
	Mulloway	Undefined
	Pearl perch	Undefined
	Pigfish	Undefined
	"Sharks" (mixed species)	Undefined
	Spanish mackerel	Undefined
	Spotted mackerel	Undefined
	Sweep	Undefined
	Teraglin	Undefined
	Wobbegong sharks	Undefined

D4.2.7 Overfished species

If a species taken in this fishery is determined as ‘overfished’, this management strategy requires the implementation of, or assistance in developing, a recovery program for that species (see objective 2.2 and related management responses in section 3 of this management strategy). However, a recovery program is not required for species that are determined as growth overfished if the Director-General, Agriculture and Fisheries, considers that the combination of the existing harvest strategy and life-history characteristics of the species provides sufficient protection for the stock from the effects of fishing.

The process of developing a recovery program for an overfished species initially involves NSW DPI preparing a summary of the known factors that have led to the determination of ‘overfished’ being made. In addition to the summary, a range of management options will be identified and outlined. Consultation will then formerly commence with the relevant MAC and advisory bodies. The recovery program will be developed under the management strategy for the fishery which is the key harvester of the species concerned, and must include a description of the actions proposed to return to acceptable levels those parameter(s) that have led to the determination of the species being 'overfished'. The recovery program will also set out a timeframe for that process (including annual reviews) and may specify further appropriate action should recovery targets not be met.

D4.2.7.1 Definitions of overfished status

There are two types of overfishing which, when detected, in most cases require management action. It is important to note that the two types of overfishing are not mutually exclusive. "Growth overfishing" occurs when individual fish are typically harvested under the size that takes best advantage of the species growth in relation to expected natural mortality. "Recruitment overfishing" is far more serious and occurs when fishing pressure has reduced the ability of a stock to replenish itself, i.e. the size of the spawning biomass is so reduced as to compromise recruitment.

D4.2.7.2 Designating a species as overfished

The information needed to clearly determine that a species has been growth overfished is more likely to be available than the information needed to detect recruitment overfishing (in the absence of an obvious stock collapse). Most formal definitions of recruitment overfishing are determined on the basis of an understanding of relative rates of fishing mortality, population growth and population biomass as well as the relationship between spawners and recruitment (e.g. Hilborn and Walters, 1992). Even the most thoroughly studied species in NSW may not have relevant information on all those topics.

NSW DPI will consider advice from fisheries scientists as part of the annual assessment of the status of fish stocks in NSW, or as a result of a review from a trip of the catch triggers (see FMS Appendix 2). That advice could result from the findings of monitoring and research conducted by scientists employed by NSW DPI, or from other agencies or institutions doing research relevant to assessment of species harvested in NSW. If the species is the subject of a formal resource assessment process, the indication of overfishing is likely to come from having a performance indicator outside acceptable bounds. Other species' status will be reviewed on the basis of the best available biological and catch information.

A stock that has had sufficient fishing mortality to cause a reduction in recruitment requires effective remediation. However, information that clearly demonstrates that a species' recruitment has been impacted by fishing is difficult and expensive to collect, and likely to be rare. Management responses will need to be precautionary and are likely to draw inference from total catch and catch composition, rather than from direct measurements of recruitment. For example, rapid declines in total catch (especially when the species is targeted in a spawning aggregation), decreases or rapid increases in average size or missing years in age compositions are all indicative of potential problems with recruitment.

When new information that is likely to change the present status of a fish species is received by NSW DPI, its scientists will review the status determination for that species against the criteria specified in Table D5 and report on the updated status in the resource assessment report. If a species is designated as overfished, a recovery program involving all harvest sectors will be developed.

D4.2.7.3 Appropriate management responses for different types of overfishing

Growth overfishing generally implies the productivity of a stock is being mismanaged by harvesting animals at too small a size. Fish stocks that are growth overfished are not necessarily in danger of imminent collapse and populations can be growth overfished and yet catches can still be stable. However, growth overfishing may increase the risk to the population of subsequent recruitment failure arising from increased fishing pressure or external factors. The typical and most appropriate response to growth overfishing is to increase the average size at first harvest. This is commonly done by imposing a minimum size limit or increasing an existing one. The efficacy of such a response depends largely on the methods of capture and whether the selectivity of those methods can be appropriately altered to match the new size limit, to prevent the wasteful discarding and possible mortality of large numbers of undersized individuals. Careful thought must be given to changing size limits where there are problems in adjusting the selectivity of the primary fishing methods for that species.

Recovery programs for species suspected of having depressed recruitment due to overfishing must include strong precautionary action. Actions could include (but may not be limited to) temporary fishery closures or caps on either catch or fishing effort. Recovery programs for recruitment overfished species may also include changes to the monitoring program for that species and/or require targeted research to improve the assessment of risk to the species in critical areas.

D4.2.7.4 Species in the fishery determined as being overfished

Gemfish (Rexea solandri) – *recruitment overfished*

The eastern stock of gemfish underwent a collapse in recruitment in the late 1980s, and the stock has failed to show any significant recovery since the mid 1990s (Rowling and Makin, 2001). Eastern gemfish has been nominated for listing as an endangered species under the EPBC Act, and a decision regarding the nomination is pending. All NSW commercial fishers are currently subject to a 50 kg trip limit for eastern gemfish, to discourage targeted fishing for the species.

The OTLF has been the primary harvester of gemfish in NSW and this management strategy requires the development of a recovery program for that species (see management response 2.2a). If eastern gemfish is listed as a threatened species under the EPBC Act, consideration will need to be given to more conservative measures, such as protection from fishing.

Silver trevally (Pseudocaranx dentex) – *growth overfished*

There has been a significant decline in commercial landings of silver trevally since the mid 1980s, and a recent study (Rowling and Raines, 2000) concluded that the stock was growth overfished. Significant quantities of silver trevally are landed by the OTLF, the Estuary General Fishery (prior to Botany Bay becoming a recreational fishing haven) and the Recreational Fishery, however more than 40% of commercial landings are taken by ocean fish trawlers. Significant quantities are also taken in the Commonwealth South East Fishery.

As the Ocean Trawl Fishery is the primary fishery in NSW in which silver trevally are taken, a recovery program for the species will be developed for the species under the Ocean Trawl FMS. The recovery program will include the introduction of a minimum legal length of 30 cm total length for silver trevally in NSW. The OTLF will contribute to the development of the recovery program, and will implement actions as needed under that program.

Snapper (Pagrus auratus) – *growth overfished*

More than 97% of commercial landings of snapper during 2000/01 were taken by fishers in the OTLF. Landings of snapper in all areas of NSW have been dominated by two and three year old fish (typically 70% of total landings). Fewer than two percent of landings were older than ten years despite clear evidence that longevity exceeds 30 years.

The OTLF is the primary harvester of snapper and this management strategy requires the development of a recovery program for that species (see management response 2.2a). A pilot research study on the discard mortality of snapper caught at various depths in fish traps is to be done in 2005/06, with an application for funding to extend this project to be sought at the conclusion of the pilot study. The results of this research are vital for the sustainable management of this species.

Yellowtail kingfish (Seriola lalandi) *– growth overfished*

Yield per recruit information shows that yellowtail kingfish in NSW are harvested at sizes that do not maximise biological yield (Stewart & Ferrell, 2001). The OTLF is the primary commercial harvester of yellowtail kingfish, however the recreational catch may be equivalent or greater.

The risk assessment in B2.4.2.2 was done on catch and CPUE information up to, and including, 2001/02. However, recent declines in catch and CPUE in 2002/03 and 2003/04 have increased the concern over the status of the stock. Monitoring of the length composition of commercial catches of kingfish is currently underway and further analysis of regional CPUE will be done in the resource assessment program. Despite its status of being growth overfished, a recovery program is not currently considered necessary for yellowtail kingfish. A recovery program will, however, be developed and implemented if analysis of the information being gathered warrants such a program.

There are also two management arrangements that have been specifically introduced for yellowtail kingfish in the last 15 years. In 1990, a minimum legal length of 60 cm was introduced which reduces harvest pressure on juvenile kingfish and increases the chance of escapement of fish through the fishery and into the spawning stock. In April 1996, the use of pelagic kingfish traps by commercial fishers was prohibited to reduce harvest pressure on the stock and reduce impacts on juvenile fish.

D4.3 Management Controls and Administration

There are two broad types of fishery management controls, known as input controls and output controls. Input controls limit the amount of effort commercial fishers put into their fishing activities, indirectly controlling the amount of fish caught. They need to continually be modified in response to fishing technology. Input controls can include restrictions on the number of licences, the size and engine capacity of boats, the number of fishing lines and/or hooks used, the construction and number of traps, and the areas and times which can be worked. Output controls, on the other hand, directly limit the amount of fish that can be landed and are well suited for single species, high value fisheries using single gear types.

The OTLF in NSW is managed predominantly by input controls. The following section describes in broad terms the diverse range of controls that apply to activities in the fishery. The general rules applying to commercial fishing and the specific rules for this fishery, such as gear specifications, are detailed in the FM Regulation. The preceding and following text represents the position at the commencement of the management strategy, however, some of these provisions will change as the strategy is progressively implemented.

D4.3.1 Limited entry

The OTLF is moving towards a category 1 share management fishery. Access to the fishery has been limited to eligible fishers since the restricted fishery regime commenced on 1 March 1997. The exception is the spanner crab fishery which was managed through a limited access permit scheme between 1995 and 1997.

D4.3.2 Commercial fishing licences

A commercial fishing licence is required by an individual before they can take fish for sale or be in possession of commercial fishing gear in or adjacent to waters. The licence only authorises activities that are covered by the endorsements, issued in respect of each part of fishery and specified on the licence. Conditions may be placed on licences in order to restrict fishers' commercial activities where required.

Commercial fishing licences are currently available to:

- persons who held a licence immediately prior to the commencement of the FM Act
- owners of a recognised fishing operation (RFO) which include a business that holds an offshore prawn trawl endorsement or contains a minimum level of validated catch history, or the nominated fisher of an RFO, or
- individuals who are the holder of shares in a share management fishery.

This last provision will become the more relevant requirement as the OTLF moves toward full implementation of share management.

D4.3.2.1 Fishing endorsements

It is important to identify the difference between endorsements and entitlements in the fishery and how they relate to commercial fishing licences.

Entitlements in the fishery are associated with fishing businesses, while endorsements appear on commercial fishing licences of individuals and authorise the use of specific gear or taking of certain species. Some fishing businesses can be owned and held in the names of more than one individual (including company or partnership names) and therefore, an entitlement associated with a business may entitle more than one person's licence to be endorsed to operate in the fishery. However, in the OTLF, only one person can be nominated to hold the primary endorsement in respect of a fishing business. Other licensed fishers may, subject to the criteria outlined in the FM Regulation, hold separate endorsements in the form of a 'skipper's endorsement'.

Six classes of endorsement will exist in the fishery at the commencement of the management strategy. Table D4.1 lists the endorsement types and the gear able to be used by virtue of holding each endorsement type.

The eligibility to hold endorsements on a commercial fishing licence in a share management fishery is based on the shareholder holding the minimum number of shares specified in the share management plan for the fishery. Separate minimum shareholdings may apply to each endorsement.

D4.3.2.2 Nomination policy

Part of the introduction of the restricted fishery regime was the creation of rules to allow the endorsements of a fishing business to be nominated to a person. This was necessary due to fishing businesses being held in company or partnership names, and because fishing licences can only be issued to natural persons.

This management strategy adopts a new approach to the issuing of endorsements that will reduce administration and associated costs and make it easier for business owners to obtain skippers at short notice (see management response 6.3a). It involves issuing a ‘fishing business card’ in respect of each fishing business that details the endorsements that may be activated by the licensed fisher in possession of the card. This program will replace the current endorsement nomination and skipper policies.

Pending the development of the fishing business card, the following interim arrangements apply in the OTLF with respect to nominations. Where the business meets the $20,000 ocean trap and line transfer criteria an unlimited number (one at a time) of skipper nominations can apply. Where the business does not meet the transfer criteria, i.e. < $20,000 and is and RFO the two nomination rule (one nomination and back to the owner) shall apply. Where the business is a Fishing Operation[5] (FO), nominations are not permitted’.

D4.3.2.3 Provision for unlicensed crew

The holder of a commercial fishing licence or fishing boat licence endorsed in the OTLF may also apply for an authorisation to employ unlicensed crew (commonly referred to as a “block licence”) or may employ a person who themselves are registered as crew. A fee for each applies.

A licensed fisher employing crew must maintain records about her/his crew. Information relating to crew must be recorded on the mandatory catch and effort return submitted by the licence holder.

D4.3.3 Fishing boat licensing

In addition to each fisher having to be licensed, every fishing boat used in connection with the OTLF must also be licensed. There has been a cap on the total number of boat licences since 1984 (includes boats used in all fisheries) and this restriction will remain for the duration of the management strategy.

To prevent any increase in size and therefore efficiency of vessels in the fishery, a strict boat replacement policy exists and will continue under the management strategy. Boats 5.8 metres in length or less may be replaced with boats up to 5.8 metres. Boats that are greater than 6 metres in length may only be replaced with boats that are no more than 10% or one metre greater in length, whichever is lesser. The 10% tolerance continues to relate to the original boat length to avoid a progressive increase in boat length over time.

In addition, fishers are permitted to temporarily replace their fishing boats with smaller boats for up to two years. During this time, a permanent boat replacement must be made with respect to the original boat.

Under the OCS agreement, fishing boats that were previously licensed to fish outside 3 nm under Commonwealth jurisdiction were automatically issued an authority on their State boat licence (called an 'OG1' or an offshore general authorisation) to continue to work in offshore waters. Only

[5] A fishing business for which NSW Fisheries has validated the catch history, and which does not qualify as a Recognised Fishing Operation.

boats that are licensed with an OG1 authorisation are permitted to operate in ocean waters beyond 3 nm.

D4.3.3.1 Controls on collection of bait-for-own-use

The fishery for bait-for-own-use is presently carried out under permit by fishers who target tuna in fisheries managed by the Commonwealth. This fishery is soon to become a restricted fishery for Commonwealth tuna operators. There is also some targeting of tuna within NSW jurisdiction that also utilises bait gathered by lift nets. These bait gathering activities have always been constrained to three species; yellowtail, blue mackerel and pilchards. NSW fishers using a lift net to gather bait have been required to report their bait catches since 1997, Commonwealth Section 37 permit holders are required to fill in a live bait daily logbook and return it to the Department within 7 days of fishing.

This management strategy proposes the participation of the Ocean Trap and Line MAC in the development of a policy for bait gathering using lift nets that is being prepared under the Ocean Hauling Fishery Management Strategy. Development of the policy will allow for the consideration of the use of lift nets by NSW line fishers to take bait for taking species other than tuna (e.g. kingfish).

D4.3.4 Renewal of licences

Commercial fishing licences and fishing boat licences must currently be renewed annually or upon the expiry of the period specified on the licence. Fishers are sent renewal application forms approximately one month before the expiry date on the licence. If a commercial fishing licence is not renewed within 60 days of the expiry date on the licence, the renewal application is taken to be an application for a new licence. Additional fees apply to late renewal applications.

D4.3.4.1 Abeyance period for fishing boat licences

Fishing boat licences can be held in abeyance for a period of up to two years from the date of expiry of the licence or when advised in writing by the owner. Fishing boat licence fees are not payable during the period of abeyance, but the full amount due is payable if the licence is reinstated within the two years specified.

D4.3.5 Transfer policies

D4.3.5.1 Transfer of licensed fishing boats

Licensed fishing boats used in the OTLF operate under "general purpose" or "boat history" licenses. The license of a general purpose boat may be transferred separately from any fishing business and has no associated catch history. General purpose boats are generally operated in fisheries where the fisher, rather than the boat, is the principal unit of effort. The majority of licensed fishing boats used in the OTLF operate with "boat history" licenses. The license of a boat history boat, and any associated endorsements, can only be transferred as part of the associated fishing business. The Licensing Branch can advise a fishing boat owner whether a boat has a boat history or general purpose license. Any transfer of a fishing boat license must first be approved by the Director-General, NSW DPI.

D4.3.5.2 Transfer of fishing business entitlements

Commercial fishing licences and endorsements to participate in a fishery are not freely transferable. Currently, commercial fishing licences and endorsements only become available to a new entrant if a fishing business with the required level of validated catch history or particular fishing entitlements.

Under the current Licensing Policy, fishing businesses must be sold as an entire package (i.e. the catch history, boat history vessels and/or endorsements associated with boats cannot be split). Proposals regarded as contrary to the intention of the Licensing Policy are not approved.

These transfer arrangements will be superseded by the implementation of share management provisions and minimum shareholdings for the fishery upon the commencement of the share management plan, however, the fundamental principle of avoiding increases in fishing effort through transfer arrangements will be applied.

D4.3.5.3 Licence splitting policy

The Commonwealth and the State Governments have a long standing nationally agreed policy in place on “licence splitting”. The policy seeks to prevent entitlements held by one person or entity, and issued by more than one jurisdiction, from being split and transferred separately. In NSW the transfer of a fishing business is not approved unless all entitlements issued to the business by other jurisdictions are also transferred to the same person or surrendered, unless the separate transfers have been approved by all fisheries management agencies involved.

Where fishing effort has been historically ‘shared’ across a number of entitlements held by a person, the National licence splitting policy seeks to prevent any increase in effort in each of the respective fisheries that might occur following the splitting of the entitlements.

A fishing closure, effective from August 2003, provides the basis for prohibiting the fishing activity of a business that transfers fishing entitlements in breach of the licence splitting policy.

D4.3.6 Appeal mechanisms

Fishers may lodge an appeal to the Administrative Decisions Tribunal (ADT) against a decision to refuse to issue or renew, suspend, cancel or place conditions on a commercial fishing licence (or an endorsement on that licence) or a fishing boat licence.

The main role of the ADT is to review administrative decisions of New South Wales government agencies. To lodge an appeal with the ADT, a request must first be made to NSW DPI for an internal review of the decision, then a written application should be lodged with the ADT no more than 28 days after the internal review was finalised.

The ADT can make various orders concerning an appeal application including:

- upholding the original decision
- reversing the decision completely or in part
- substituting a new decision for the original decision
- ordering the agency to reconsider the decision in light of the ruling.

For further information, refer to the *Administrative Decisions Tribunal Act 1997* or the following website: http://www.lawlink.NSW.gov.au/

D4.3.7 Code of practice

This management strategy promotes the development of a code of practice for all ocean trap and line fishers, to encourage responsible fishing practices and to minimise the impact of trap and line fishing on the environment (see management response 1.2e).

D4.3.8 Time and area closures

The *Fisheries Management Act 1994* provides for the use of fishing closures in the OTLF to, among other things:

- protect and conserve areas of key habitat
- manage the amount of fishing effort in an area/region
- manage conflicts between stakeholders over the use of the resource and to ensure it is equitably shared
- minimise bycatch and the impacts of the fishery on threatened and protected species.

Fishing closures can be established on a seasonal, time, area, operator or gear specific basis. Fishing closures are required to be published in the NSW Government Gazette, however, if the Minister for Primary Industries considers that a fishing closure is required urgently, the Minister may introduce the closure and advise the public through media outlets and by displaying prominent signs in areas adjacent to the waters affected. In the case of an urgent closure, the Minister is to publish the closure in the Government Gazette as soon as practicable. Details on up-to-date fishing closures that apply to the OTLF can be found on the NSW DPI website at: www.dpi.nsw.gov.au

D4.3.9 Permits

Section 37 of the *Fisheries Management Act 1994* allows for permits to be issued for research or other authorised purposes. These permits provide a legal framework for activities that fall outside normal operating rules set out in the Act or its Regulation. Each permit sets out a number of conditions, which vary depending on the purpose of the permit. These conditions ensure that permits are used only for the purpose intended by their issuing and are often used to limit the extent of the permitted activity.

Permits are issued under section 37 of the *Fisheries Management Act 1994* are only valid insofar as they do not conflict with approved determinations of native title made under the Commonwealth *Native Title Act 1993*. Permits are valid for the period specified on the permit, and may be suspended or cancelled at any time by the Minister for Primary Industries. Permits are not transferable.

D4.3.10 Catch limits or quotas

A commercial daily catch limit (or trip limit) applies to a range of species taken from NSW waters as part of the OTLF (see Table B9 in Chapter B). These daily catch limits are intended to complement the quota system administered by the Commonwealth Government that limits the harvest levels of these species by Commonwealth endorsed boats, and to achieve a level of consistency on the fishing controls that exist in State waters. Details of up-to-date trip limits applying to the Ocean Trap and Fishery can be found on the NSW DPI website at: www.fisheries.nsw.gov.au

D4.3.11 Seafood safety programs

Food safety programs that relate to the OTLF are administered by NSW Food Authority under the *Food Act 1989*. Food safety programs for all commercial fisheries are currently being prepared by NSW Food Authority and will be supported under the management strategy.

D4.3.12 Cost recovery policy

NSW DPI currently recoups some of the costs that are attributable to industry through a cost recovery policy. Cost recovery is a common principle among Australian commercial fisheries and an important component of ecologically sustainable development.

NSW DPI is in the process of implementing cost recovery in a progressive manner, so that charges are passed on to industry in a planned and orderly way. In November 2000, the Government announced a new cost recovery policy. The Government will develop and implement a cost recovery framework for the new category 1 share management fisheries. This framework will be subject to extensive industry consultation. During this period, the total amount of money collected for NSW DPI, for its existing management services, will not increase without the support of the relevant management advisory committee. After five years, the costs that have been identified as attributable to the industry will be progressively introduced over a further three-year period.

It is important to note that new services required to be implemented under the management strategy as a result of the environmental assessment process will need to be fully funded by the fishery participants. A range of regulatory and administrative fees are payable by fishing business owners in the OTLF. The management strategy does not, in itself, set the charges, or limit or otherwise govern the way fees are charged.

D4.4 Compliance

NSW DPI has approximately 100 fisheries officers responsible for coordinating and implementing compliance strategies in NSW. These strategies include:

- maximising voluntary compliance
- providing effective deterrence for offences
- providing effective support services.

Approximately 75 of these fisheries officers are located in areas along the NSW coast where the OTLF occurs. Their general duties include conducting patrols, inspecting commercial and recreational fishers and fishing gear, and recording rates of compliance.

A compliance strategic plan will be developed to provide the direction for education, advisory and enforcement services provided by NSW DPI for all designated commercial fishing activities, including the OTLF (see management strategy response 6.1a in section 3 of this management strategy). To ensure that compliance service is delivered in a consistent manner, quality inspection guidelines are being developed. These guidelines will set out a procedural approach to be adopted when undertaking inspections of fishers and fishing gear in the OTLF. The quality inspection guidelines will ensure that all issues requiring compliance by commercial fishers under this management strategy are subject to a compliance program.

D4.4.1 A penalty points system

A penalty points scheme linked to endorsement suspension and share forfeiture provisions will be introduced under the management strategy and developed as part of a share management plan for the OTLF (see management response 6.1d in section 3 of this management strategy).

The OTLF generally has a high compliance rate. However, despite the relatively large number of potential offences and the maximum penalties specified in the FM Act and Regulation, there are still a small number of ocean trap and line fishers who regularly operate beyond the rules. The penalty points system will provide a clear deterrent to fishers who are considering breaching the provisions of the management strategy or associated rules, as well as guiding the courts with a regulated management plan that reflects the serious nature of some fisheries offences.

Similar to the motor vehicle licence demerit points scheme (administered by the Roads and Traffic Authority), the system would provide for a list of penalty points assigned to serious or repeated offences. Under the scheme if a fisher accrues a certain amount of penalty points, endorsements could be suspended and/or shares forfeited. Details of how the scheme will operate such as the points attributable to each offence and the sanction threshold levels, will be developed in consultation with Management Advisory Committees and included in the share management plan.

D4.5 Research

NSW DPI has developed a strategic research plan covering priorities across all fisheries which is responsive and takes account of the research requirements identified under each fishery management strategy.

D4.5.1 Proposed research areas

Research needed for management of the OTLF can be categorised into five broad topics:

1. resource assessment of primary and key secondary species
2. quantification and reduction of bycatch
3. economic research
4. impacts of trap and line fishing on ecosystems (including habitat and trophic interactions)
5. impacts of fishing on threatened species

The first three topics above are considered to be the highest priority for research relevant to the sustainability and viability of the OTLF. Resource assessments of varying degrees have been done only for a few species in the fishery, and are therefore the highest priority for research. The impact of bycatch in this fishery on fish stocks is likely to depend on the mortality rates of discarded fish and needs to be quantified. Research on the economics of the fishery is important to provide better information on fishing businesses viability that can be taken into account in future fishery management. The impact of trap and line fishing on ocean ecosystems represents a very broad area for research, which will require significant resources and a long-term approach. The available data and anecdotal evidence suggests that the impacts on habitats and threatened species by the OTLF is minimal, with the priority at present being to obtain more accurate information about the levels of interaction, rather than undertake research projects on the impacts.

Outlined below are those strategies by which research into these priority areas should proceed.

D4.5.1.1 Resource assessment of important species

Targeted species within this fishery require effective processes of resource assessment so that significant changes in population abundance and structure can be detected and acted upon. All targeted species are economically important to some sectors of the fishery. Resource assessments for most species in the OTLF are at a rudimentary level. Monitoring of reported commercial landings each year has been done for many of the more important species, but its use in assessing the status of the stocks is limited. Size- and age-based monitoring is a significant improvement upon the monitoring of catch and effort alone. Resource assessment processes should be established for all high risk species as a priority, although the level of assessment is likely to differ due to the species identification problems with most sharks. Until identifications are consistent, it will not be possible to achieve Class 1 or 2 assessments (see Table D4.5 below). Where age based assessments have been previously completed on species in the fishery (snapper, silver trevally and yellowtail kingfish) the results have shown the species to be growth overfished. The steady declines in landings and average sizes that have been observed for some other species in the fishery suggests that they may also be growth overfished.

There remains a lack of knowledge of the general biology for most species harvested in the fishery. Fundamental information on growth rates, sizes at sexual maturity and spawning seasons is required to better inform fisheries management. This information should be combined with monitoring of the size and age structures of landings and the reported yearly catch and effort data to develop basic population models. These assessments will show whether species are currently being harvested at appropriate rates.

Classes of resource assessment for species harvested in NSW

Table D4.5 summarises the characteristics of each class of resource assessment that has been developed to replace the species exploitation status and assessment reliability process (Tables B1.4 and B1.5, respectively). A detailed description of the assessment classes is provided in FMS Appendix 4 (Scandol 2004). Table D4.6 (adapted from Scandol 2004) contains the initial assessment classes that are proposed for the primary and key secondary species of the fishery. Content within Table D4.6 will require continual revision.

Table D4.5 Summary of the attributes of the various classes of resource assessment

Attribute	**Class of Resource Assessment**				
	One	**Two**	**Three**	**Four**	**Five**
Biomass estimate	•				
Estimate of fishing mortality	•				
Quantitative risk analysis of future harvesting	•				
Standard fisheries biological reference points	•				
Credible indicator of abundance	•	•			
Representative time-series of commercial catch	•	•	•	•	
Age-structured data (where possible)	•	•			
Local information for growth, mortality, selectivity and maturity	•	•	•		
Length-structured data	•	•	•		
Non-local information for growth, mortality, selectivity and maturity			•	•	•
Externally reviewed or publishable	•	•	•	•	•

(Source: Scandol 2004)

Table D4.6 A summary of the proposed resource assessment classes for primary and key secondary species of the fishery. Age information will be collected for those species granted a Class 2 assessment where no local information on growth is available

Species	Species Type	Resource Assessment Class	Risk Rating (Chapter B2)	Indicators	Comments
Blue-eye	P	2	Moderate	Catch; CPUE; Age/Length	Ongoing monitoring program
Bonito	P	2	Moderately-High	Catch; CPUE; Age/Length	**New program - no existing age or length data**
Bream, Yellowfin	P	2	Low	Catch; CPUE; Age/Length	Ongoing monitoring program
Cod, Bar	P	2	**High**	Catch; CPUE; Age/Length	**New program - some existing length data**
Crab, Spanner	P	2	Moderately-Low	Catch; CPUE; Surveys; Length	Most of this stock is in Queensland; Subject to joint NSW/Qld survey program; Ongoing assessment program
Kingfish, Yellowtail	P	2	Moderately-High	Catch; CPUE; Age/Length	Ongoing monitoring program
Leatherjacket	P	2	Moderately-High	Catch; CPUE; Age/Length	Species complex; Most landings would be ocean leatherjacket
Morwong, Rubberlip	P	2	Moderately-High	Catch; CPUE; Age/Length	**New program - some existing length data**
Shark, Gummy	P	3	**High**	Catch; CPUE	Species identification issues - no existing age or length data
Snapper	P	2	Moderately-High	Catch; CPUE; Age; Length	Ongoing monitoring program
Trevally, Silver	P	2	Moderate	Catch; CPUE; Age/Length	Subject to recovery program; Ongoing assessment program
Dolphinfish	K2	3	Moderate	Catch; CPUE; Length	**New program - no existing age or length data**
Gemfish	K2	3	Moderately-Low	Catch; CPUE; Length	Mostly Commonwealth fishery; Ongoing monitoring program
Groper, Bass	K2	3	Moderately-High	Catch; CPUE; Length	**New program - some existing length data**
Hapuku	K2	3	Moderately-High	Catch; CPUE; Length	**New program - some existing length data**
Mackerel, Narrow-Barred Spanish	K2	3	Moderate	Catch; CPUE; Length	Most of this stock is in Queensland
Mackerel, Spotted	K2	3	Moderate	Catch; CPUE; Length	Most of this stock is in Queensland
Morwong, Jackass	K2	3	Moderate	Catch; CPUE; Length	Mostly Commonwealth fishery; some existing length data
Mulloway	K2	3	Moderate	Catch; CPUE; Length	FRDC study in progress - existing age and length data
Perch, Pearl	K2	3	Moderately-High	Catch; CPUE; Length	**New program - no existing age or length data**
Pigfish, Black-spot	K2	2	**High**	Catch; CPUE; Age/Length	**New program - no existing age or length data**
Shark, Wobbegong	K2	2	**High**	Catch; CPUE; Age/Length	Carpet sharks; Species identification issues
Sharks, Mixed	K2	3	**High**	Catch; CPUE	Species complex; Species identification issues
Sweep, Silver	K2	3	Moderate	Catch; CPUE; Length	**New program - no existing age or length data**
Teraglin	K2	3	Moderately-High	Catch; CPUE; Length	**New program - some existing length data**

D4.5.1.2 Quantification and reduction of bycatch

Levels of bycatch in the OTLF have not been assessed for most of the methods used, but have been assumed to be small when compared to other fisheries such as the Ocean Trawl Fishery, Estuary Prawn Trawl Fishery and Estuary General Fishery. Information from small-scale observer work and fishers logbooks has shown that levels of discarding in the demersal trap fishery (Stewart & Ferrell, 2001) and the kingfish fishery (Stewart *et al*., 2004) can be high. These identified bycatch issues generally incorporated the discarding of under-sized target species, and may be similar for other methods used in the fishery. Assumptions of low levels of bycatch have come from anecdotal evidence and these assumptions may, over time, be tested for all methods in the fishery through the scientific observer study (management response 1.2a).

Where information is available to show that levels of bycatch are unacceptably large, the activity should be phased out or research should be done to investigate:

i) the mortality of the discarded bycatch, and

ii) ways of reducing these discard levels.

Species captured from shallow waters in this fishery are generally alive with little or no obvious damage. However, it is important to estimate the mortality of these discards, and those drawn from deeper waters, to assess what impact the fishery may be having on stocks. A pilot study investigating the discard mortality of snapper caught in fish traps at various depths will be done in 2005/06, with increased funding sought for the study's expansion.

It is important that any modifications intended to reduce levels of bycatch, such as escape panels in demersal fish traps (management response 1.2b) and the use of circle hooks (management response 1.2f) be monitored for their ongoing effectiveness. Onboard observer studies can be used to provide reliable information in these cases.

Ghost-fishing of lost traps is assumed to be problematic and this strategy proposes mechanisms to quantify the numbers of traps that are lost (management response 1.1b). There is little information on whether lost traps continue to capture animals and, if so, whether they die or can escape. Small-scale manipulative field experiments can be done to quantify whether ghost-fishing is likely to be an issue in this fishery.

D4.5.1.3 Economic research

To address the economic objectives of the management strategy, research will be needed to assess the economic viability of businesses endorsed in the OTLF, and to quantify the flow-on effects from these activities to the economies of coastal communities.

Previous studies of the economic viability of ocean trap and line operators relied on the results of a survey of a sample of fishing businesses for the 1999/2000 financial year (Roy Morgan, 2001). As the financial situation of fishers is likely to have changed, a further survey is required to provide updated information. Additional information should also be collected on variations in prices among receivers and for different size classes of fish (particularly those where growth overfishing may become an issue).

Currently, there are only limited data available on the flow-on (or multiplier) effects from the OTLF, which includes not only the direct employment, income and expenditure generated by participants in the fishery, but also those benefits indirectly generated as a result of inputs and other ancillary services provided to the ocean trap and line fishing fleet. Study of flow-on effects should be undertaken at the regional level and would ideally be linked with regional economic assessments.

D4.5.1.4 Impacts of trap and line fishing on ocean ecosystems (including habitat and trophic interactions)

The structure and functioning of ocean ecosystems and the myriad of ecological processes that occur underpin the sustainability of the fisheries that depend on the fish, crustacean and mollusc resources of NSW oceanic waters. Little directed research has been done anywhere to assess the impacts that fishing has on the structure of oceanic ecosystems, although a number of recent reviews which assembled data from many diverse studies suggest that impacts of fishing may be severe (Jennings and Kaiser, 1998; Hall, 1999; Myers and Worm, 2003).

There is a need to develop biodiversity indicators for the ecological system in which the OTLF operates. Research to provide such indicators will likely be long-term, and will need to draw on a variety of expertise and knowledge. This management strategy promotes initiatives in research and monitoring that could significantly improve the working knowledge of the fishery in its environment. These initiatives, such as the mapping of major trapping grounds and associated geological features (management response 1.1a), collecting information on the potential for 'ghost-fishing' (management response 1.1b), improvements in the accuracy of species identification on catch returns (management response 7.3a), and the quantification of discards by the observer program (management response 1.2a), will provide a basis for future studies aimed at developing appropriate indicators for monitoring biodiversity.

A collaborative study currently underway between NSW DPI and the University of British Columbia should also provide an ecosystem-based model for fisheries operating in the coastal waters of NSW. This study will compile all the relevant data and examine the inter-relationships between species and/or trophic levels within our coastal ecosystems, thereby improving the knowledge base needed to help determine the impacts of fishing on natural systems.

The impacts of trap and line fishing on habitats are thought to be minimal, but have not been assessed by any scientific study. Physical damage to demersal habitats such as sponges, corals and rocky reefs may occur from demersal fish traps, entangled fishing lines and anchors. The observer-based study will be able to identify some interactions between habitats and the fishery by recording where and when the fishery uses different gear types, and noting any evidence of flora or fauna that are representative of different habitat types that become snagged on traps or lines and lifted to the surface. Where concerning interactions are identified, targeted research will be done to further quantify the extent of the interaction and, if necessary, develop methods to minimise the impact.

D4.5.1.5 Impacts of fishing on threatened species

Little is known about the biology and ecology of many of the species listed as threatened, and the potential impacts of commercial fishing on these species are also poorly understood. This strategy seeks to improve the accuracy of information available on interactions between the OTLF and threatened species through the observer study (management response 1.2a) and improvements in catch monitoring reports (management response 3.1a). The Recovery Plans for relevant threatened species should drive research on such issues, and determine specific projects to be targeted at the species of concern. Such studies would involve examining the biology and ecology of threatened species to assess the potential impact of a variety of threats, including trap and line fishing. A project assessing the broad-scale interactions between fishing and marine mammals, reptiles and avifauna in NSW marine waters commenced recently. This project will allow specific issues to be identified and further funding to address significant interactions may then need to be sought.

D4.5.2 The Conservation Technology Unit

In March 2001, NSW Fisheries established a Conservation Technology Unit to examine conservation-based gear technology in commercial and recreational fisheries. This focussed research initiative may help address gaps in knowledge including the mortality of released line caught fish and the selectivity of gears used in the OTLF. The research will also assist in identifying the most appropriate gear to be used in the fishery and ensure that future changes to gear regulations can be based on accurate scientific information. The development of new and innovative fishing techniques will help minimise unwanted catches, discarding and impacts on the environment.

D4.5.3 Catch monitoring

The information collected on commercial catches assists in the ongoing monitoring and assessment of the status of fish stocks. The catch and effort information collected from commercial fishers has other critical roles in fisheries management including helping to understand patterns of fishing activities and the mix of species from targeted and general fishing operations.

Fishers in the OTLF will continue to be required to submit records on a regular basis detailing their catch and fishing effort. Information includes the total landed catch by species, days fished and area fished for each method used. All commercial landings in the fishery are reported by the one-degree latitude ocean zones, consistent with all other ocean fisheries in NSW. This information will continue to be entered onto a database by NSW DPI, to allow for analysis of fishing activity, catch and effort levels. The entry of catch return information onto the database will be subject to stringent control procedures including deadlines for data entry following the receipt of a catch return by NSW DPI. A policy will be developed to manage the timely receipt and entry of commercial catch return data into the commercial catch records database. A number of management responses are contained in this strategy to improve the quality and reliability of the information provided by ocean trap and line fishers catch returns.

To maximise the accuracy of the data collected on catch returns a range of quality-control procedures are currently in place or scheduled for implementation in the near future. A brief synopsis of these quality control procedures is provided here:

- every return is scanned for errors when received by the “Commercial Catch Records” section in NSW DPI, and suspected omissions or errors are queried with fishers (by phone and/or written correspondence) and corrected if necessary
- logical checks of data accuracy (range, consistency and validity checks) are performed automatically by computer during data-entry. Likely errors are queried with fishers (by phone and/or written correspondence) and corrected if necessary
- data from the commercial catch statistic database “FINS” is regularly downloaded to a database “COMCATCH”, which can be accessed or queried by scientific staff and managers responsible for individual fisheries. Subsequently, any problems with data identified by these officers are queried and may be corrected by the commercial catch records section after consulting fishers where necessary

- a previous pilot survey was undertaken to assess the accuracy of data entry with respect to the catch records. The results showed that data-entry errors by staff were of minimal significance. Errors were rare and generally concerned minor species. It is planned to repeat this survey to provide ongoing monitoring of the quality and accuracy of data entry
- following implementation of routine reporting of the quantities of fish handled by registered fish receivers in NSW, it will be possible to compare the quantity of catch (by species) reported by fishers on catch returns with the quantity handled by fish receivers in NSW. This will provide a cross-validation of weights of individual species caught and handled in NSW
- the information collected on catch returns and options for improving the catch return forms (and increasing the reliability of data) will be reviewed periodically by the management advisory councils and annually by the "Catch and Effort Working Group" which comprises stakeholder representatives, including each commercial fishery.

All existing and proposed procedures attempt to maximise data quality. It is, however, inevitable that the accuracy of data supplied by fishers cannot be directly assessed and can sometimes be variable, particularly with respect to fishing effort data. Consequently, the commercial catch statistics supplied by fishers and maintained in the commercial catch records database are most accurately described as representing "reported landed catch".

D4.6 Consultation

There are a range of consultative bodies established in NSW to assist and advise the Minister and NSW DPI on fisheries issues. There are committees that are established to provide advice on specific issues as well as bodies that advise on matters which cut across different fisheries or sectors.

D4.6.1 The Management Advisory Committee

Share management and major restricted fisheries in NSW each have a Management Advisory Committee (MAC) that provides advice to the Minister for Primary Industries on:

- the preparation of any management plan or regulations for the fishery
- monitoring whether the objectives of the management plan, strategy or those regulations are being attained
- reviews in connection with any new management plan, strategy or regulation
- any other matter relating to the fishery.

The industry members of the MAC comprise representatives that are elected by endorsement holders in the fishery. There is an industry representative from each section in the fishery. The members hold office for a term of three years, however, the terms of office are staggered and the terms of half of the industry members expire every 18 months.

The non-industry members on the MAC representing recreational fishers, conservation groups and NSW Primary Industries, are appointed by the Minister for Primary Industries and also hold terms of office for up to three years. To ensure that all issues discussed by the committee are fairly represented, the MAC is chaired by a person who is not engaged in the administration of the FM Act and is not engaged in commercial fishing.

Although the MAC receives advice from NSW DPI observers on research, compliance and administrative issues relating to the fishery, only members of the MAC have voting rights on the decisions of the MAC.

The actual composition and role of the MAC is set by the FM Act and its regulations and may be altered from time to time.

D4.6.2 Ministerial Advisory Councils

Two Ministerial advisory councils are currently established under the *Fisheries Management Act 1994*. The Councils provide advice on matters referred to them by the Minister for Primary Industries, or on any other matters the Councils consider relevant. They report directly to the Minister for Primary Industries.

The Ministerial advisory councils in place at January 2006 are the:

- Seafood Industry Advisory Council (SIAC)
- Advisory Council on Recreational Fishing (ACoRF)

The OTLF and each of the other share management fisheries have representatives on the SIAC. These representatives are nominated by each of the respective management advisory committees and appointed by the Minister for Primary Industries.

A “Discussion paper on the advisory structures in the NSW seafood industry” was distributed in December 2003 and resulted in changes to the then existing advisory structure, which comprised of ACoRF, Advisory Council on Commercial Fishing (ACCF) and the Advisory Council on Aquaculture (ACoA): the latter two were amalgamated to create SIAC. The name and composition of ministerial advisory councils are determined by regulations under the FM Act, and may be altered from time to time.

D5 Performance Monitoring and Review

D5.1 Performance Monitoring

Many of the management responses listed in section 3 of this FMS assist in achieving multiple goals. Therefore, rather than examining the performance of each individual response or objective, it is more efficient and appropriate to measure the performance of the management strategy against the seven goals (i.e. the major objectives). A periodic report will, however, be prepared (as outlined later in this section) detailing the progress made in implementing each of the management responses.

D5.1.1 Performance indicators

The performance indicators provide the most appropriate indication of whether the management goals are being attained. A number of monitoring programs are to be used to gather information to measure performance indicators. These performance indicators are detailed in Table D5.2. It should be noted that a number of relatively direct performance indicators have been selected rather than using a large number of surrogate indicators, in order that the limited resources available for implementation of the management strategy can be most effectively utilised. These will be further refined in light of the practical implementation of the management strategy.

D5.1.1.1 Data requirements and availability

The data requirements and availability for each performance indicator in Table D5.2 relate to the collection of information used to measure the performance indicators and the data that are available. The data requirements may be specific to the fishery, or encompass cross-fishery interactions such as the catch of a species by several commercial fisheries or harvest sectors.

D5.1.1.2 Robustness

The robustness ratings applied to each performance indicator in Table D5.2 has been selected using the definitions outlined in Table D5.1 below.

Table D5.1 Robustness classifications

Level	Description
High	The indicator is a direct measure of the goal, or if indirect, is known to closely reflect changes in the issue of interest
Medium	The indicator is suspected to be reasonably accurate measure against the goal, or the known error is in the conservative direction
Low	The degree to which the indicator measures against the objective is largely unknown, or known to be low. Often this will involve surrogate indicators

(source: SCFA 2000)

D5.1.2 Trigger points

The trigger points specify the point when a performance indicator has reached a level that suggests a potential problem with the fishery and a review is required. The review will determine the suspected reasons for the tripping of the trigger point and whether any action is required (see section 5c for further information on reviews in response to trigger points).

Table D5.2 establishes the performance indicators and trigger points that will be used to measure whether each of the management goals described in section 3 of this management strategy are being attained.

D5.2 Predetermined Review of Performance Indicators and Trigger Points

It is likely that changes to the activities authorised under the management strategy will evolve over time. It is also likely that better performance indicators will become apparent over the course of the next few years and it would then be an inefficient use of resources to continue monitoring the performance indicators that appear in the management strategy. If new information becomes available as a result of research programs, more appropriate performance indicators and trigger points can be developed and the Minister for Primary Industries may amend the management strategy accordingly.

A comprehensive review of the appropriateness of all performance indicators and trigger points will be carried out not more than two and a half years from the commencement of the management strategy, in consultation with the Ocean Trap and Line MAC.

As new or improved guidelines for fishery reporting become available, such as those being considered in the '*National ESD Reporting Framework for Australian Fisheries – the how to guide for wild capture fisheries report*', they will be taken into account to promote continuous improvement in the management of the fishery.

D5.3 Reporting on the Performance of the Management Strategy

There are two types of performance monitoring reports to be prepared under this management strategy. One is a performance report, which reports generally on the performance of the fishery with respect to the management strategy. The other type of report is a review report, which is to be prepared if a performance indicator for the fishery is tripped. Both types of reports are discussed in further detail below.

D5.3.1 Performance report

A performance assessment examining each performance indicator will be undertaken annually and a report on the performance indicators will be submitted to the Minister for Primary Industries within two years of the commencement of the FMS, and biennially thereafter. The report is the formal mechanism for reporting on performance indicators and trigger points, and will be made publicly available. It will also include a review of progress made in implementing each of the management responses. The performance report may be submitted to the Minister for Primary Industries in conjunction with performance reports for other relevant fishery management strategies.

The vast majority of management responses in the management strategy are linked to specified implementation timeframes. Some of these management actions are subject to specific trigger points that ensure reviews and appropriate remedial actions if the target timeframes are not met.

If the performance report identifies that any specified target timeframe has not been met, a review will be undertaken and any necessary remedial measures recommended to the Minister for

Primary Industries[6]. The fishery will continue to be regarded as being managed within the terms of the management strategy whilst any remedial measures associated with unmet timeframes or triggering of performance indicators are being considered through the review process and/or by the Minister for Primary Industries.

D5.3.2 Review report in response to trigger points

If the trigger point for a performance indicator is tripped, a review is to be undertaken of the likely causes for the trip. Any such review is to include consultation with the Ocean Trap and Line MAC. In some circumstances, the trip may be related to a performance indicator that measures broader cross fishery issues and will require consultation with other management advisory committees or the Ministerial advisory councils. Cross fishery issues are most likely to involve catch levels of a species that is harvested in more than one fishery.

NSW DPI will collect and analyse information relevant to the performance of the fishery, such as compliance rates, economic data, catch data and other statistics as the information becomes available and prior to the preparation of reports relating to performance monitoring in the management strategy. This does not, however, prevent a review from being conducted at any other time should it become apparent that a performance indicator has tripped a trigger point.

Once the relevant information is obtained an initial analysis against the trigger points will be undertaken by NSW DPI. Where the data or information indicate that a trigger point has been tripped, details will be provided to the relevant fishery MAC and the relevant Ministerial advisory councils. Consultation will then occur with the Ocean Trap and Line MAC and other relevant advisory bodies either through a meeting or out of session. During this consultation, advice will be sought on the suspected reasons for any trips. During this consultation the MAC will also be able to provide advice on the preparation of any review reports that are required.

A review report outlining the remedial actions recommended in response to trigger point trips, is to be provided to the Minister for Primary Industries within 6 months of the trigger point being tripped.

Reviews arising from landings data exceeding trigger points should consider, but not be limited to, the following factors:

- changes in the relative catch levels among harvest sectors (including those beyond NSW jurisdiction)
- new biological or stock information (from any source) available since the most recent review of the species
- changes in the activities or effectiveness of fishing businesses targeting the species
- changes in principal markets or prices for the species
- environmental factors.

Review reporting should include whether the suspected reasons for the trigger point being tripped are the result of a fishery effect or an influence external to the fishery, or both.

[6] In some circumstances a required action may be completed outside the scheduled timeframe, but prior to the commencement of the review (e.g. an action was due for completion by September 2005, but it is actually completed in October 2005). When this occurs, it is not necessary to proceed with a review.

If a review concludes that the reasons for the trigger point being tripped are due to the operation of the fishery, or if the fishery objectives are compromised if the fishery continued to operate unchanged, management action must be taken with the objective of returning the performance indicator to an acceptable range within a specified time period. The nature of any remedial action proposed may vary depending on the circumstances that have been identified as responsible for the trigger point being tripped.

If a review considers that the management objectives or performance monitoring provisions are inappropriate and need to be modified, the management strategy itself may be amended by the Minister for Primary Industries. If the reasons are considered to be due to the impacts on the resource from factors external to the fishery, these factors should be identified in the review and referred to any relevant managing agency for action.

A review may recommend modifications to any fishery management strategy that allows harvesting of that species. This approach to the review process will avoid triggering multiple reviews for a species that is caught in multiple fisheries.

All review reports will be publicly available.

D5.3.2.1 External drivers

External drivers are factors that are known to potentially impact on the performance of the fishery but which are outside of the control of NSW DPI or the commercial fishing industry (e.g. market prices, pollution etc.). Any external influences that may contribute to a trigger being tripped will be identified during the review and, if necessary, referred to any relevant managing agency for action.

Accordingly, there may be circumstances where no change to management arrangements or the management strategy is deemed necessary following the review. For example, a review could be triggered because the landed catch of a species declines. However, there would be little cause for concern over the performance of the management strategy if the decline in landed catch of a species was clearly caused by a drop in market prices. Any price fluctuations can result in fishers adjusting their activities.

Table D5.2 Performance indicators, monitoring programs and trigger points to measure the success of each of the goals of the fishery

GOAL 1. Manage the ocean trap and line fishery in a manner that promotes the conservation of biological diversity in the marine environment					
No.	**Performance indicator**	**Data requirements and availability**	**Trigger point**	**Robustness**	**Justification/comments**
1	Species composition (for all retained and bycatch species) in the fishery	Quantitative landings from fisher logbooks and discard data from onboard observer program	Significant shift in species composition as determined by the "Large Area Species Richness" index (Gray, 1997)	Medium	It is difficult to directly measure the impact of this fishery on biodiversity in the ocean environment. Research aimed at developing more appropriate indicators is proposed in the FMS. Until an appropriate baseline or reference point is established, interpretation of changes in the species composition of catches will not be able to be clearly linked to changes in fishing practices
2	The proportion of the total trap and line catch which is discarded, and the species composition of the discards	Estimates of discarded catch (by species) from onboard observers, and information on the type of BRD	The 'species richness' and quantity of discards does not on average decrease from the implementation of BRD and/or the commencement of the FMS	High	Continuous improvements in BRD design and efficiency are a feature of the FMS. Operation of the various approved BRD will be examined using data from onboard observers. As above, until an appropriate baseline is established, interpretation of changes in the discarded component of catches will not be able to be clearly linked to improvements. Note: BRD is used as a broad term including any modification of gear that reduces bycatch and/or reduces the mortality of bycatch
3	Response of the fishery to marine pest and disease incursions	Reports on the monitoring of marine pests and diseases are needed and will be provided to the Ocean Trap and Line MAC through the marine pest management program	Guidelines specified in any Marine Pest and Disease Management Program are not adhered to by the OTLF	Medium	Marine Pest and Disease Management Programs are responsible for monitoring marine pests and diseases (e.g. noxious fish), and developing contingency plans in the event of new incursions. This performance measure provides that management of the fishery will be responsive to existing or new marine pest or disease incursions that may threaten the biodiversity in the marine environment
4	Areas closed to commercial ocean trap and line fishing in NSW managed waters and the percentage of closed areas with adequate descriptions of broad habitat types	Spatial information is required for all closures (including marine parks, aquatic reserves and section 8 fishing closures). This information is available through the Marine Parks Authority and through NSW DPI in the event of any future fishing closures implemented for fishery management purposes	Areas closed to commercial ocean trap and line fishing become open after the commencement of the FMS or the percentage of closed areas with adequate descriptions of habitat types is unknown or does not increase within 5 years	Medium	Significant closed areas prevent any direct impacts of the fishery on biodiversity in those areas, thus minimising the total impact on biodiversity at the regional or state scale. A triggered review would consider the merits of opening and/or closing different areas to the OTLF

Table D5.2 cont.

GOAL 2. Maintain stocks of primary and key secondary species harvested by the OTLF at sustainable levels					
No.	**Performance indicator**	**Data requirements and availability**	**Trigger point**	**Robustness**	**Justification/comments**
1	Exploitation status of primary and key secondary species	Landings data, onboard observer data, biological catch sampling data and any fishery independent data; analyses of landings data against the catch triggers in Appendix D3; resulting resource assessments prepared by NSW DPI scientists	The number of primary or key secondary species determined as 'overfished' (other than those already identified in the FMS) is more than one in any year	High	An increasing number of primary or key secondary species being identified as 'overfished' will indicate that the management strategy is not moving the fishery towards a sustainable basis
2	Total annual landings of all secondary species (other than key secondary species) taken in the fishery as a percentage of the total annual OTL landings	Requires commercial landings data for all species taken in the fishery. Data will be obtained through mandatory catch reporting provided by endorsed ocean trap and line fishers	Contribution of secondary species to total trap and line landings exceeds 15% in any two consecutive years	Low	This indicator does not measure sustainability levels per se, but might indicate shifts in targeting or sudden declines in catch of primary/key secondary species or increases in catch of secondary species. The ratio in the 2001/02 fiscal year was 10.86%

Table D5.2 cont.

GOAL 3. Promote the conservation of threatened species, populations and ecological communities and protected species of fish likely to be impacted by the operation of the OTLF					
No.	**Performance indicator**	**Data requirements and availability**	**Trigger point**	**Robustness**	**Justification/comments**
1	Interactions which may threaten the survival of threatened species, population or ecological community	Data will be obtained through catch reporting provided by endorsed ocean trap and line fishers and also by onboard observers and reports from compliance officers	Any interaction which may threaten the survival of a threatened species, population or ecological community	High	Currently, little information is available on interactions between the OTLF and threatened species. Every interaction recorded will be referred to the Threatened Species Unit to determine whether the interaction is likely to threaten the survival of a threatened species, population or ecological community
2	Interactions which may threaten the survival of a protected species	Data will be obtained through catch reporting provided by endorsed ocean trap and line fishers and also by onboard observers	An annual review of interactions determines that the level of interaction may threaten the survival of a protected species	High	Currently, little information is available on interactions between the OTLF and protected species. The Threatened Species Unit will undertake an annual review of the level of interaction with protected species to determine whether the levels are likely to threaten the survival of a protected species
3	Number of grey nurse sharks caught by the OTLF	Data will be obtained through monthly catch reporting provided by endorsed trap and line fishers, the observer program and from any targeted research programs being undertaken on grey nurse sharks	Trigger point to be determined once baseline data collected through observer program and catch reporting system	High	There is a high level of scientific and community concern about the status of grey nurse sharks and there is demonstrated interaction between this species and hook and line fishing, particularly before their critical habitat areas were declared. As such, this indicator has been separated from the more general threatened species indicator (see performance indicator 1 above) and will highlight trends in the future level of interaction and cause a review with possible mitigative action if the level is found to be unacceptable

Table D5.2 cont.

GOAL 4. Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts					
No.	**Performance indicator**	**Data requirements and availability**	**Trigger point**	**Robustness**	**Justification/comments**
1	Proportion of the catch of primary, key secondary and secondary species taken by the commercial sector relative to all non-commercial sectors (combining commercial, recreational and Indigenous)	Requires commercial landings data and information (or estimates) of catches by other stakeholder sectors. Data will be obtained through mandatory catch reporting provided by commercial fishers and through any recreational or Indigenous fishing surveys, and compliance observations	Relative catch between commercial and non-commercial sectors shifts by 25% between year 1 and year 5 values following the commencement of the FMS and then every five year period thereafter	Medium	Further work would be needed to define specific targets for appropriate sharing of the resource and what might be considered a negative social impact. In the interim, however, a trigger point can be specified that will detect a relative large shift in catch over time between stakeholder sectors
2	Proportion of each primary and key secondary species between the OTLF and other NSW commercial fisheries	Requires commercial landings data from NSW commercial fisheries. Data will be obtained through mandatory catch reporting provided by NSW commercial fishers	Relative catch each species taken by the OTLF and other NSW commercial fisheries shifts by 25% between year 1 and year 5 values following the commencement of the FMS and then every five year period thereafter	Medium	This indicator provides an indication of the allocation of the key species taken in the OTLF compared with other commercial fisheries
3	Proportion of each primary and key secondary species between endorsement types within the OTLF	Requires commercial landings data from NSW ocean trap and line fishers, that will be collected through mandatory catch reporting arrangements	Relative catch between endorsement types shifts by 25% between year 1 and year 5 values following the commencement of the FMS and then every five year period thereafter	Medium	This indicator provides an indication of the allocation of the key species taken by each endorsement type within in the OTLF

Table D5.2 cont.

No.	Performance indicator	Data requirements and availability	Trigger point	Robustness	Justification/comments
GOAL 5. Promote a viable commercial fishery, consistent with ecological sustainability					
1	Median gross return of fishing businesses with ocean trap and line endorsements	Data on average market price of fish (CPI adjusted), and total commercial landings by each ocean trap and line business are required. Average price data is available from the Sydney Fish Market and landings data are available through the catch returns submitted by fishers	Median gross return has not increased by at least 20% five years after the commencement of the share management plan	Medium	This indicator provides a measure of the central tendency of gross returns from fishing (i.e. the median), rather than the average return, because of the tendency for the average to be skewed by more extreme observations (i.e. the distribution of fishing returns is not normal). Gross, rather than net return, is used because data on the costs of fishing are not readily available. Management response 5.4a seeks to refine this indicator so as to be based on net returns. The trigger point should not be interpreted as the gross return of individuals increasing by that amount
2	Average market value of ocean trap and line shares when traded	The market value of shares will be collected and recorded by the Share Registrar upon each share transfer	Trigger to be determined within two years of the commencement of the share management plan	Medium	Market value of shares provides a general indication of investor's confidence in the economic viability of participating in the OTLF, as it takes account of a range of contributing factors
GOAL 6. Facilitate effective and efficient compliance, research and management of the OTLF					
1	The percentages of total inspections which result in the detection of minor or major offences	Data requirements include a record of the number and types of offences detected, records of which are kept by NSW DPI	Percentages of detections of minor offences is >20%; detection of major offences is > 10%	Low	This indicator provides a simple low cost measure of compliance by ocean trap and line fishers with management rules. Differentiation between major and minor offences will be made during development of the penalty points scheme as part of the compliance management plan
2	Number of Ocean Trap and Line MAC meetings held each year	The number of Ocean Trap and Line MAC meetings held is available through records kept by NSW DPI	Number of OTL MAC meetings is less than 2 in any calendar year (unless otherwise agreed to by the MAC)	Low	Holding two Ocean Trap and Line MAC meetings per year is currently a requirement of the Regulation, which ensures that regular consultation is taking place
3	Reviews and outcomes of strategic plans for research and compliance in the OTLF	Data about frequency and outcomes of reviews required - available through records kept by NSW DPI	The research or compliance strategic plans expire without being reviewed by NSW DPI, or the strategic plans are not modified consistent with the approved outcomes of a review	Medium	Strategic plans focus research and compliance activities and help to ensure maximum efficiency and cost effectiveness of the programs undertaken. It is important that they are reviewed and updated within the timeframes specified therein

Table D5.2 cont.

GOAL 7. Improve knowledge about the OTLF and the resources on which it relies					
No.	**Performance indicator**	**Data requirements and availability**	**Trigger point**	**Robustness**	**Justification/comments**
1	An appropriate scientific observer program is operated in accordance with the specifications developed to meet the requirements of the relevant management responses	Detailed specifications for an appropriate observer program (these will need to be based on FMS requirements)	Observer program does not meet specifications	High	An appropriate onboard observer survey is fundamental to the success of the FMS. The first step will be the development of specifications that outlined the standard of information required, taking account of the range of program aims. The second phase will involve the carrying out of the surveys in accordance with the established specifications. This performance measure seeks to ensure that the observer program is supplying data to the standard sought by the specifications. Note: a review is triggered under the management strategy if the observer program is not implemented within the specified timeframe
2	The number of research projects underway which have a flow of benefits to the OTLF and fill information gaps identified by the environmental impact assessment for the fishery	Relevant data will be held by NSW DPI and/or external funding bodies	The number of relevant research projects relevant to identified information gaps falls to less than two during any one year	Medium	This is a general indication of the minimum commitment consistent with improving the knowledge base relating to the fishery. Note: the number of research projects does not include routine monitoring and observer programs
3	Accuracy of catch return data	Requires commercial landings, marketing data and information on species identification. Information available from catch returns submitted by fishers, Registered Fish Receiver data and through the observer program	The percentage of species records with poor reporting does not decline after 1 year of operation of new reporting procedures	High	Improving the accuracy of data, in terms of quantity of product retained and species identification, is important for improving the knowledge base. This performance indicator picks up on the re-design of the 'returns' form and the accuracy of reporting of both quantity retained and species identification

D5.4 Contingency Plans for Unpredictable Events

In addition to the circumstances outlined above, the Minister for Primary Industries may order a review and/or make a modification to the fishing regulatory controls, administrative arrangements or the management strategy in circumstances declared by the Minister for Primary Industries as requiring contingency action, or upon the recommendation of the Ocean Trap and Line MAC. In the case of the former, the Minister for Primary Industries must consult the Ocean Trap and Line MAC on the proposed modification or review.

These circumstances may include (but are not limited to) food safety events, environmental events, results of research programs or unpredictable changes in fishing activity over time. The Minister for Primary Industries may also amend this fishery management strategy if matters identified during the finalisation of any other fishery management strategy indicate that a modification is necessary.

Notwithstanding the above, the Minister for Primary Industries may also make amendments to the management strategy that the Minister considers to be minor in nature at any time.

D5.5 Monitoring Performance of Resource Assessment

Stock assessment involves the use of various statistical and mathematical calculations to make quantitative predictions about the reactions of fish populations to alternative management choices (Hilborn and Walters, 1992). These calculations can vary from simple graphical presentations of commercial landings to sophisticated computer models that predict the biomass of the stock under various harvest regimes. The data and the scientific expertise required to apply these methods varies enormously. Stock assessment processes for the OTLF need to be defined to suit the resources available. To achieve this, short-term and long-term approaches will be applied.

The short-term approach will be to use landings of primary and key secondary species to monitor the performance of this fishery. This approach involves the use of ‘trigger’ levels of commercial landings (see Table D5.2). A resource assessment process for primary and key secondary species has been developed (Scandol 2004). This framework summarises the issues associated with resource assessment in NSW and proposes a long term strategy to monitor stock status and assess stocks. Because of the relatively large number of primary species, and the range of knowledge about these species or species-groups, the resource assessment strategy will need to be appropriately based on the level of existing knowledge, the data likely to be available, and the value of the fishery. A long-term approach will be used to assess the status of the primary species. Two principles have been applied to the long-term proposal for resource assessments:

- assessment methods will be consistent with the data (i.e. the assessment program design will not rely on data sources that are not funded)
- assessment methods will be at least equivalent to approaches for fisheries of similar value in other Australian jurisdictions.

The exact methods applied to assess the state of the stock may require the development of novel approaches. Performance indicators and trigger points will be an integral component of the resource assessment proposal and, where possible, the robustness of the indicators and trigger points will be evaluated. An independent review of the assessment methods will be completed within three years of the proposal being developed, with the following terms of reference, to:

- report upon the technical soundness of the assessment methods proposed
- report upon the cost-effectiveness of the assessment methods proposed
- indicate if the assessment process will be likely provide timely information for the management of the fishery
- report upon the conditions where the assessment process is likely to be unsatisfactory
- recommend revisions to the proposed approach including additional data collection strategies that should be considered.

The schedule for providing resource assessments cannot and should not be the same for all primary species. Priorities for each species should be determined in consultation with the assessment scientists and the appropriate MAC. Consequently, those species that are identified as having the highest risk will be assessed first.

Appendices to the FMS

FMS Appendix 1 - Implementation table for the OTLF

The following implementation table outlines the time periods within which each management response is scheduled to be implemented. The table also provides information relating to the head of power for implementation and who has the lead responsibility for carrying out the action(s). A general description of the terms used in the table with respect to timeframes are:

Term	Description
Immediate	Upon the time of approval of the strategy
Short Term	Within one year of the date of approval of the strategy
Medium Term	Within 3 years of the date of approval of the strategy
Long term	In excess of three years of the date of approval of the strategy
As required	Whenever the circumstances warrant action
Ongoing	Continuing into the future

Where the implementation date (e.g. a particular month) has been included for a management response instead of the terms above, the date represents a specific target time within which the management response is planned to be implemented.

FMS Appendix 1 cont.

Goal 1. Manage the Ocean Trap and Line Fishery in a manner that promotes the conservation of biological diversity in the marine environment					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
1.1 Mitigate the impact of trap and line fishing in NSW ocean waters on ecosystem integrity (species, populations, and ecological communities)	a) Map major trap and line fishing grounds (including available information on associated geological features), assess the level of use of the Ocean Trap and Line Fishery on each ground and define the areas in NSW ocean waters open for trap and line fishing (taking account of marine protected areas)	1, 7	Long term	NSW DPI OTL MAC OTL Fishers	-
	b) Collect information on the number of fish traps in the fishery that are lost during fishing operations and implement appropriate management actions if necessary	1, 2, 3, 7	Short term and then as required	NSW DPI OTL Fishers	-
	c) Use fishing closures to control fishing activities within the Ocean Trap and Line Fishery	1, 2, 3, 4, 6	As required	NSW DPI	Regulatory
1.2 Mitigate the impact of ocean trap and line fishing activities on bycatch (i.e. non-retained catch including prohibited species and unwanted catch)	a) Design and implement an industry funded scientific observer program to document the degree of interaction of commercial designated fishing activities, including the OTL Fishery, with non-retained and threatened species	All	Short term	NSW DPI OTL MAC	-
	b) Implement fish escape panels in fish traps to minimise bycatch and the retention of juvenile and small fish	1, 2, 3, 4	50 x 75 mm mesh - short term	NSW DPI	Regulatory
	c) Use best-practice handling techniques, including the prohibition on the use of fish spikes, clubs or any other such implement that could unduly harm non-retained organisms	1, 2, 3, 4	Ongoing (except immediate for spikes and clubs)	NSW DPI OTL Fishers	Various
	d) Prohibit the finning of sharks and discarding carcasses	1, 2, 3, 4	Ongoing	NSW DPI	Regulatory
	e) Develop a code of practice for the Ocean Trap and Line Fishery	1, 2, 3, 4, 5, 6	Medium term	NSW DPI OTL MAC	Various
	f) Implement the exclusive use of circle hooks for all unattended line fishing methods to reduce gut hooking of prohibited size and other non-retained fish	1, 2, 3, 4, 5	Short term	NSW DPI	Regulatory
1.3 Mitigate the impact of the Ocean Trap and Line Fishery on ocean habitats and their associated biota	a) Modify the use of trap and line fishing methods in areas where their use is identified as having a detrimental impact on fish habitat.	1, 2	As required	NSW DPI	Various
1.4 Prevent the introduction and translocation of marine pests and diseases by fishing activities	a) Implement, in consultation with the MAC, measures required in accordance with any marine pest or disease management plans	1, 2, 6	As required	NSW DPI OTL Fishers	To be determined

FMS Appendix 1 cont.

Goal 2. Maintain stocks of primary and key secondary species harvested by the Ocean Trap and Line Fishery at sustainable levels					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
2.1 Prevent overfishing of the stocks of primary and key secondary species by ocean trap and line fishers	a) Monitor the quantity, length, and/or age and sex composition of the primary and key secondary species taken by commercial designated fishing activities, including the Ocean Trap and Line Fishery, as part of the overall resource assessment system	2, 7	Short term and then ongoing	NSW DPI	-
	b) Using the approved resource assessment framework, conduct resource assessments of the primary and key secondary species taken by commercial designated fishing activities, including the OTLF, where necessary, and review the assessments at least every three years thereafter with an external review of the assessment framework at least every four years	1, 2, 4, 7	Short term to develop and then ongoing to conduct assessments	NSW DPI	-
	c) Monitor the annual landings of primary species, key secondary species for comparison against reference levels set out in Appendix D3 as part of the overall resource assessment system	1, 2, 4, 7	Short term and then ongoing	NSW DPI	-
	d) Monitor commercial landings of all secondary species (other than the key secondary species) taken in the fishery annually for comparison against an historical range for each of those species or groups of species, as part of the overall resource assessment system	2, 4, 5, 7	Short term and then ongoing	NSW DPI	-
	e) Investigate the cost effectiveness of using fishery independent surveys to provide abundance indices and other information for resource assessment of the primary species taken in the OTLF	2, 6, 7	Medium term	NSW DPI OTL MAC	-
	f) Review and where appropriate implement MLL for the primary and key secondary species to give a high probability that at least 50% of the fish of each particular species landed have reached reproductive maturity (unless alternative strategies apply to individual species)	2, 4	Medium term	NSW DPI	Regulatory
	g) Implement minimum size limits for wobbegong sharks (initially at 130 cm total length), and adjust the size limits based on research results	2	Short term and then as required	NSW DPI	Regulatory
	h) Assess the economic impacts of increasing the size limit for snapper to 32 cm	2, 5	Short term	NSW DPI	-
	i) Cap the NSW catch of school and gummy sharks and participate in the development of a multi-jurisdictional quota scheme with the Commonwealth and southern States	1, 2, 4, 6	Short term and then ongoing	NSW DPI	Policy and/or Regulatory
	j) Modify the gear controls applicable to the spanner crab fishery and investigate the feasibility of a quota system to manage the harvest of spanner crabs in the longer term	2, 6	Immediate for gear, medium for quota mgt	NSW DPI OTL MAC	Various
	k) Utilise onboard observers to collect additional biological information, including size at maturity and fecundity/brood size data, for the important elasmobranch species taken by the fishery	1, 2, 7	Medium term and then as required	NSW DPI	-
	l) Prohibit the taking of all female spanner crabs carrying ova	2	Ongoing	NSW DPI	Regulatory
	m) Prohibit the taking of male spanner crabs from 20 November to 20 December and female spanner crabs from 20 October until 20 January.	2	Ongoing	NSW DPI	Regulatory

FMS Appendix 1 cont.

Goal 2. Maintain stocks of primary and key secondary species harvested by the Ocean Trap and Line Fishery at sustainable levels

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTES TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY
2.2 Promote the recovery of overfished species	a) Where the Ocean Trap and Line Fishery is a major harvester of a species determined as overfished in NSW (recruitment or growth overfished) develop and implement a recovery program for that species	1, 2, 4, 5	i – Short term ii – Medium term iii - As required	NSW DPI	Various
	b) Where the fishery is a minor harvester of an overfished species, contribute to the development of a recovery program for the species, and adopt any measures required by a program	1, 2, 4, 5	As required	NSW DPI OTL MAC	Various
2.3 To conserve fish stocks by managing levels of active fishing capacity in the fishery	a) Implement limits on gear use in the fishery	1, 2, 3, 4	Short term	NSW DPI	Regulatory
	b) Prohibit the use of on-board automatic baiting machines in the fishery	2, 4, 5	Immediate	NSW DPI	Regulatory

Goal 3. Promote the conservation of threatened species, populations and ecological communities and protected species of fish likely to be impacted by the operation of the Ocean Trap and Line Fishery

OBJECTIVES	MANAGEMENT RESPONSES	CONTRIBUTES TO GOALS	TIMEFRAME	RESPONSIBILITY	AUTHORITY
3.1 Identify and minimise or eliminate any impacts of fishing activities on threatened species, populations and ecological communities (including mammals, birds, reptiles, fish, invertebrates and vegetation), and protected species of fish and, where required, promote their recovery	a) Modify, in consultation with Ocean Trap and Line MAC, the mandatory reporting arrangements to enable the collection of information on interactions with or sightings of threatened or protected marine species and interactions with other threatened or protected species	3, 7	Immediate	NSW DPI OTL MAC	Policy and/or Regulatory
	b) Implement, in consultation with the Ocean Trap and Line MAC, the provisions of any relevant threatened species recovery plans, threat abatement plans, or other similar management arrangements designed to protect critical habitat areas	3, 6	As required	NSW DPI OTL MAC	Various
	c) Implement changes to reduce or prevent the impact of the Ocean Trap and Line Fishery on grey nurse sharks	1, 3	i & ii - Immediate iii & iv - Short term	NSW DPI	Regulatory
	d) Using the code of practice, promote the use of fishing techniques that avoid the capture of or interaction with protected fish and fish protected from commercial fishing	3	Medium term and then ongoing	NSW DPI OTL fishers	Regulatory

FMS Appendix 1 cont.

Goal 4. Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
4.1 Provide for appropriate access to the fisheries resource by other stakeholders (e.g. recreational, Indigenous), acknowledging the need of seafood consumers to access fresh quality fish	a) Estimate the total catch of primary and key secondary species in the Ocean Trap and Line Fishery, taking account of the recorded commercial catch and estimates of recreational, Indigenous and illegal catch	2, 4, 5, 7	Ongoing	NSW DPI	-
4.2 Provide for fair and equitable sharing of the fisheries resource with other commercial fisheries (NSW, interstate and Commonwealth)	a) Monitor management arrangements and the annual landings of key ocean trap and line species in fisheries that are outside NSW jurisdiction but which impact on stocks shared with the NSW Ocean Trap and Line Fishery, as part of the resource assessment system.	2, 4, 5, 7	Ongoing	NSW DPI	-
	b) Monitor the annual landings of secondary species (other than the 'key secondary' species) in the Ocean Trap and Line Fishery	1, 4, 6, 7	Ongoing	NSW DPI	-
	c) Use cross-fishery and cross-jurisdictional consultation to discuss and manage issues relating to, but not limited to, the multiple use of specific fishing grounds, collaborative research, fair and equitable access to stocks, complementary management arrangements and other interactions between fishing sectors	1, 2, 4, 5, 6, 7	Ongoing	NSW DPI	-
	d) Participate in the development and implementation of a policy (including reporting procedures) to manage the use of the lift net for collection of 'live' bait by NSW ocean trap and line fishers.	1, 2, 4, 5, 6, 7	Short term	NSW DPI OTL MAC	Policy
	e) Implement a policy to manage the impact of dual endorsed Commonwealth tuna boats in NSW waters, in particular to regulate boat length and/or catches taken by larger than standard size boats, such as through removing the existing policy that allows tuna boats to upgrade in length whilst retaining State entitlements	1, 2, 4, 5	Short term	NSW DPI	Policy

FMS Appendix 1 cont.

Goal 4 cont. Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
4.3 Provide for the fair and equitable sharing of the fisheries resource within the Ocean Trap and Line Fishery	a) Respond to information about significant changes in the relative catches of the primary and key secondary species taken by endorsement types within the Ocean Trap and Line Fishery	4, 5	Ongoing	NSW DPI OTL MAC	Various
4.4 Identify and mitigate any negative impacts of the Ocean Trap and Line Fishery on Aboriginal cultural or other heritage	a) Manage the Ocean Trap and Line Fishery in a manner consistent with the Indigenous Fisheries Strategy and Implementation Plan	4	As required	NSW DPI	Various
	b) Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from ocean trap and line fishing activities	4	As required	NSW DPI OTL Fishers	Various
4.5 To promote harmony between the commercial fishery and other resource users through fair and equitable sharing of the resource	a) In consultation with the OTL MAC, identify areas of high interaction between the Ocean Trap and Line Fishery and other resource users and respond appropriately to resolve any conflicts	4, 6	As required	NSW DPI OTL MAC OTL Fishers	-

FMS Appendix 1 cont.

Goal 5. Promote a viable commercial fishery, consistent with ecological sustainability					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
5.1 Provide secure fishing entitlements for ocean trap and line fishers	a) Implement the share management provisions of the *Fisheries Management Act 1994*	2, 4, 5	Ongoing	NSW DPI	Regulatory
5.2 Manage the harvesting of the primary and key secondary species by size to achieve optimal biological yield and economic return in the longer term	a) Determine and implement strategies for harvesting fish at a size that provides optimum biological yield and economic return for the primary and key secondary species in the longer term	2, 4, 5	Long term	NSW DPI OTL MAC	-
5.3 Establish a level of fishing effort to achieve a fishery that is commercially viable (and ecologically sustainable) over the longer term	a) Manage fishing effort in the Ocean Trap and Line Fishery by: (i) capping the number of each endorsement type at currently active levels (ii) establishing a maximum level of fishing effort for each sector of the Ocean Trap and Line Fishery to be achieved within 10 years of the commencement of the share management plan	1, 2, 3, 4, 5	(i) To be determined (ii) Medium term	NSW DPI	Various
5.4 Promote the economic viability of the Ocean Trap and Line Fishery and assess the economic benefits of the fishery to the community	a) Refine the performance indicator for monitoring trends in the commercial viability of typical fishing businesses within each designated commercial fishing activity, so as to be based on net returns	5, 6, 7	Medium term	NSW DPI OTL MAC	-
	b) Investigate the data available to assess the economic multiplier (flow-on) effects of commercial fishing, including the Ocean Trap and Line Fishery, to the broader community, and develop strategies to improve the quality/usefulness of such data	5, 7	Medium term	NSW DPI OTL MAC	-
	c) Identify and promote post-harvest practices which will ensure the best return in dollars per kilogram for product of the fishery	5, 6	Ongoing	OTL MAC	-
	d) Develop a cost recovery framework, in consultation with the MAC and the Ministerial advisory body relating to commercial fishing	4, 5, 6	Short term	NSW DPI OTL MAC	Policy
5.5 Manage food safety risks in the harvesting of fish in the fishery	a) Co-operate with NSW Food Authority in the development and implementation of food safety programs relevant to the fishery	5, 6	Ongoing	OTL Fishers	FP Act

FMS Appendix 1 cont.

Goal 6. Facilitate effective and efficient compliance, research and management of the Ocean Trap and Line Fishery					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
6.1 Promote and maximise compliance with the provisions contained in the Ocean Trap and Line Management Strategy	a) Develop, implement and monitor a compliance plan for commercial designated fishing activities, including the Ocean Trap and Line Fishery	1, 2, 3, 4, 5, 6	Short term and then ongoing	NSW DPI	Policy
	b) Investigate the feasibility of the vessel monitoring system (VMS) with a view to implementing the system if it is found to be a cost-effective alternative to existing compliance and/or catch reporting methods	1, 2, 5, 6, 7	Medium term	NSW DPI OTL MAC	-
	c) Implement a penalty points scheme (incorporating endorsement suspension and share forfeiture for serious offences and habitual offenders)	1, 2, 3, 4, 5, 6	Medium term	NSW DPI	Regulatory
	d) Develop strategies to support appropriate practices and behaviour in commercial fisheries, including development of training and accreditation courses in core competencies and the introduction of fit and proper person requirements	All	Long term	NSW DPI OTL MAC	Regulatory
6.2 Identify research priorities required to provide for the sustainable operation of the Ocean Trap and Line Fishery	a) Develop and implement a Research Strategic Plan for designated fishing activities, including the Ocean Trap and Line Fishery, taking account of the priorities for research outlined in the harvest strategy	1, 2, 3, 5, 6, 7	Short term and then ongoing	NSW DPI	Policy
6.3 Ensure effective and efficient management of the Ocean Trap and Line Fishery	a) Develop and implement a fishing business card system	5, 6	Short term	NSW DPI OTL MAC	Various
6.4 Provide effective and efficient communication and consultation mechanisms in relation to management of the Ocean Trap and Line Fishery	a) Utilise a key consultative body, the Ocean Trap and Line Management Advisory Committee (MAC), when undertaking industry consultation on all aspects of the Ocean Trap and Line Fishery	6	Ongoing	NSW DPI	Policy and/or Regulatory
6.5 Implement this Strategy in a manner consistent with related Commonwealth and State endorsed programs aimed at protecting aquatic environments and achieving the objectives of ecological sustainable development	a) Manage the Ocean Trap and Line Fishery consistently with other jurisdictional or natural resource management requirements, such as the marine parks program, aquatic biodiversity strategy, threatened species program, Indigenous Fisheries Strategy and other relevant strategies	1, 3, 4, 5, 6	Ongoing	NSW DPI	Various
	b) Provide for the issue of permits under Section 37 of the FM Act authorising the use of modified fishing practices to assist research programs or for purposes consistent with the vision and goals of this management strategy.	All	Ongoing	NSW DPI	Regulatory

FMS Appendix 1 cont.

Goal 7. Improve knowledge about the Ocean Trap and Line Fishery and the resources on which it relies					
OBJECTIVES	**MANAGEMENT RESPONSES**	**CONTRIBUTES TO GOALS**	**TIMEFRAME**	**RESPONSIBILITY**	**AUTHORITY**
7.1 Improve the community's understanding and perception of the Ocean Trap and Line Fishery	a) Promote awareness of the Ocean Trap and Line Fishery as part of the overall communication strategy across all commercial designated fishing activities by implementing issue-focused education programs	4, 6, 7	Medium term, then ongoing	NSW DPI OTL MAC	-
7.2 Promote scientific research to collect relevant information about the biology of the primary and key secondary species, the impacts of fishing on other species and the environment, and the status of the fishery as a whole, including economic and social factors	a) Promote and support targeted research projects	All	Short term and then ongoing	NSW DPI OTL MAC	-
7.3 Improve the quality of the catch and effort information collected from endorsement holders	a) Periodically review the mandatory catch and effort return forms submitted by ocean trap and line fishers	All	Ongoing	NSW DPI OTL MAC	Policy and/or Regulatory
	b) Assess the accuracy of the current catch recording system, and species identification in catch records, and provide advice to industry to make needed changes	1, 2, 3, 6, 7	Medium term	NSW DPI OTL MAC	-
	c) Modify the reporting system to remove lobster trap as a method on the ocean trap and line catch returns	2, 4, 6, 7	Immediate	NSW DPI	Policy and/or Regulatory

FMS Appendix 2 - Using changes in commercial landings as an indicator of stock status

A system to detect undesirable changes in landings will be used while resource assessments are being developed for primary and key secondary species. This primary monitoring tool is also likely to be in place for an extended period for the many species of lower value (and/or catch) that do not have better estimates of stock status. As biological reference points become available from resource assessments, monitoring based solely on landings will be phased out.

Monitoring systems based on landings such as those outlined in this management strategy are rarely formalised, and published examples of such systems could not be found. However, the large number and relatively low commercial value of species caught in most NSW fisheries means that some species must remain a relatively low priority for resource assessment. For these species, monitoring landings is the only practical choice.

A more sophisticated treatment of catch data often used in resource assessments is catch per unit effort (or CPUE) analysis. However, caution must be taken in analysing CPUE information for the reasons described in the box below.

The aim of trigger points based on changes in catch is to force a review of a species' circumstance (i.e. status) when landings go beyond a reasonable expected range. Trigger points must be set at a level where they are sensitive enough to be likely to register a real problem but not so sensitive that they constantly trigger when there is no need for a review.

Trigger points will be set in a precautionary manner relative to known levels of variation in annual catch levels. That is, trigger levels will be set to be within the known range of past landings variation, leading to the expectation of "false alarms". This is desirable insurance that ensures reviews will be done when management action is needed.

Note on the use of catch per unit effort as an indicator of relative abundance

It is tempting to consider that there is a simple relationship between fish stock abundance and catch which has been scaled by units of fishing effort (known as catch per unit of effort or CPUE). Most stock assessment models assume that CPUE is directly proportional to stock abundance. This can only be the case if fishing effort is randomly distributed, and we know that this is seldom the case. Some fisheries target aggregations of fish, which can mean that CPUE stays high, even as total abundance drops because the remaining fish continue to aggregate.

The correct use of fishing effort data requires a good knowledge of the biology of each species that it is applied to, so that its spatial distribution can be adequately considered. Information about fishers' behaviour and gear is also important so that effort units can be standardised and changes over time can be accounted for.

An index of relative abundance based on CPUE is likely to be biased when applied to a range of species, even when caught by the same gear (Richards and Schnute, 1986). This means the application of CPUE information from commercial catch records would need to be adjusted for each species.

Finally, CPUE series need to take account of changes in reporting (see Pease and Grinberg, 1995) or other changes that may have changed catchability. For these reasons, CPUE has not been used in the development of initial performance indicators and trigger points in this management strategy.

There are a number of factors that must be considered when selecting a trigger level based on performance of fishery or species landings:

- level of variation in recorded historic landings
- management changes over time that may affect landings levels
- changes in the catch recording system that limit interpretation of landings data
- relevant environmental events
- changes in activities by important harvesters of that species.

All these factors have and will continue to influence how changes in catch can be interpreted.

The landings-based trigger points are designed to measure different types of changes in catch of the primary and key secondary species.

Trigger points based upon commercial landings have been calibrated to cause a review of a species' status when landings vary by an uncommon amount. The change that triggers a review is not an unprecedented change but rather a change that was well within the normal range of variation, but expected infrequently (perhaps once every five to ten years). The triggers are based on the variation in year-to-year changes in the historical landings data. The trigger points are set at a level of change that occurs less than 20% of the time. In other words, changes that are at least as large as the largest 20% of historical changes will trigger a review. This level of change is chosen to ensure that there will be a review if there is a dramatic change in the circumstances of the fishery over a short period. Setting the trigger points this way means accepting the inevitable "false alarms" when the performance indicator is at the edge of its natural range. The review will aim to determine if trigger trips are "false alarms" or whether they indicate a need to change the species' status. The reference level for this short-term trigger system will be the landings during the previous year.

There are many potential improvements that could be made to these simple trigger points using commercial landings (Scandol, 2004). The most important limitation of the current trigger points is that they do not take into account information about upward or downward 'trends' in landings. Unfortunately any scheme that attempts to capture trends in the landings data requires additional parameters to be specified. For example, moving averages of the landings data can capture trends but requires the window of averaging years to be defined.

Several schemes are being investigated to interpret trends in landings or, for that matter, any indicator. A particularly promising method is the CUSUM, or cumulative sum control chart. Such methods are not, however, as easy to interpret as the simple interval-based trigger points. There is an important trade-off between the introduction of methods for interpreting indicators (and defining trigger points) that improve robustness but also have the potential to reduce transparency. It is likely that these statistically sophisticated methods for interpreting stock-status indicators would be most beneficially applied to indicators that are more robust than commercial landings.

As the resource assessment process is developed there will be careful consideration of appropriate indicators and trigger points for each species, and incorporating information about trends will be a priority when developing stock-status indicators. In cases where credible indices of abundances can be derived from catch per unit effort data, then these will be used as performance indicators. In most cases, more robust indicators of stock sustainability, such as the fraction of commercial catch that is immature, will be developed. Definition, evaluation, consultation and implementation of these indicators and trigger points will be the primary objective of the resource assessment strategy outlined above. Trigger points associated with stock-status indicators will always be specified in a precautionary manner.

How trigger points based on landings will be applied

The single year trigger is explained in the example shown below in Figure App1. This example shows how the trigger points will work with a hypothetical starting point (five years ago), trigger levels and existing catch data.

Hypothetical examples are applied to existing catch data with an arbitrary starting point that shows the trigger levels relative to the most recent five years catch. For the example below (Figure App1) a large one year change in landings would have triggered reviews 4 years after the strategy commenced. It is important to remember that the trigger levels are not error bars, so the overlapping between years 3 and 4 is not significant. That the reported catch for year 4 (~3000 tonnes) is outside of the year 3 lower trigger point (~ 3500 tonnes) is the significant feature that triggers the review

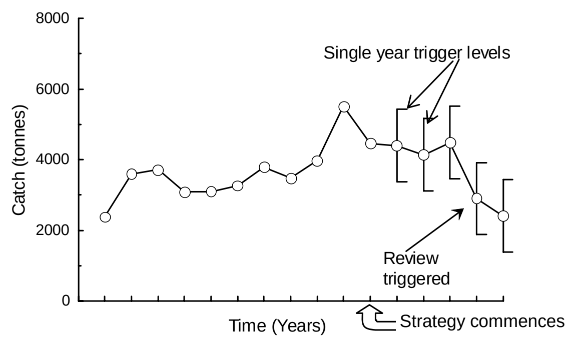

Figure App1 Hypothetical example of use of trigger levels for an Ocean Trap and Line species.

Table App1 Levels of trigger points for primary and key secondary species in the Ocean Trap and Line Fishery.

Note: These levels will apply for the first year of the management strategy only. At each annual review the trigger levels for the next year will be calculated, using the most recent year of catch data as the new reference level. The average annual change (not shown) used to determine the trigger levels was calculated over the 16 years commencing in 1984/85 except for gummy sharks, wobbegong sharks, pigfish, sweep, pearl perch, dolphin fish, spotted mackerel where records commenced in 1990/91, as well as hapuku and bass groper, where records commenced in 1997/98. All values are in tonnes. Gemfish will be subject to a ‘recovery program’ and review will occur irrespective of whether the catch triggers are tripped or not. Reference level data extracted in March 2005.

	Reference Level (03/04 catch)	First Year Upper Trigger	First Year Lower Trigger
Primary Species			
Australian bonito	124.4	169.6	79.2
Bar cod	16.3	22.8	9.8
Blue-eye	40.7	54.2	27.1
Bream, black & yellowfin	307.5	380.7	234.4
Gummy shark	22.7	32.6	12.7
Leatherjacket (mixed spp)	258.6	292.9	224.4
Rubberlip morwong	49.7	92.7	6.7
Silver trevally	421.6	595.8	247.5
Snapper	175	252.6	97.3
Spanner crab	187.1	265.3	108.9
Yellowtail kingfish	103.1	170.2	36
Key Secondary Species			
Dolphinfish*	3.6	4.8	2.4
Gemfish	12.8	17.1	8.5
Hapuku/Bass groper*	13.5	26.2	0.7
Jackass morwong*	13.2	17.5	8.8
Mulloway	58.4	77	39.7
Pearl perch	10.3	13.6	7
Pigfish	3.3	4.5	2.1
"Sharks" (mixed spp)**	152.8	251.7	54
Spanish mackerel*	4.5	6	3
Spotted mackerel	15.4	27.9	2.9
Sweep*	34.6	21	42
Teraglin	9.8	19.2	0.4
Wobbegong sharks	64.4	86.8	42

* = formula not used for these species when calculating first lower year trigger, due to result of less than 5 tonnes. In these cases, the reference level (03/04 catch) was halved to obtain the first lower year trigger.

**"Sharks" mixed species includes whalers, hammerhead, tiger, dogfish, school, ghost, saw and unspecified sharks

FMS Appendix 3 - Input controls for the spanner crab fishery

The following is a range of modified input controls to be implemented in the spanner crab sector of the OTLF within the short term (unless an alternative timeframe is stated below):

1) Zoning

i) Fishing business owners will be permitted to hold both a southern and northern spanner crab endorsement on the same fishing business.

Background: Presently, fishing businesses are not permitted to hold a southern and northern zone spanner crab endorsement. To assist in improving the economic viability of the fishery, this restriction will be removed so that businesses can operate in both components of the fishery, providing the fishing business holds both endorsements.

2) Fishing Gear

i) The Regulation will be amended to define the basic unit of fishing gear used in the spanner crab fishery as a ‘dilly’ instead of a ‘spanner crab net’.

Background: The term dilly is commonly used through the NSW and Queensland fishery. This change will provide better consistency with the Queensland regulations.

ii) The use of regulated size mesh and double-layered mesh netting will be reviewed within 18 months of the commencement of the management strategy, with the view to reducing the capture of small spanner crabs.

Background: Double-layered meshing may be more effective at catching smaller spanner crabs because it reduces the effective mesh size of the dillies. A review will examine the available information on the effect of varying mesh sizes on the catches of small spanner crabs, and will result in the implementation of additional management measures if warranted.

iii) Dilly frame size will be amended in the short term to be a maximum area of 1.6 m^2.

Background: This change gives endorsement holders greater flexibility with respect to design of the gear without increasing the overall area of netting.

iv) The following <u>boat</u> limits will apply:

a) not more than 20 dillies for a single commercial fisher, and

b) not more than 30 dillies for a commercial fisher with crew.

Background: ‘Boat limits’ as opposed to ‘in use’ limits are easier to enforce in the spanner crab fishery and, as such, this response should improve the effectiveness of the compliance program.

3) Identification of dillies

i) The floats attached to each string of dillies must:

a) be at least 15 cm in diameter or the shortest dimension if the float is not round

b) clearly display the owner's licensed fishing boat (LFB) number

c) have a flag attached that rises least 2 metres above the water, and

d) clearly display the number of dillies attached to that string, unless that number is clearly displayed on the flag attached to the float.

Background: Improved identification has been suggested from a compliance perspective. These changes are consistent with current Queensland regulations and support present NSW regulations of identification of set fishing gear. The identification of set fishing gear must comply with all other relevant parts of the FM Regulation.

4) Stock Management

i) To integrate results of NSW/QLD survey comparison project with future management.

Background: A project is currently underway to compare the resource assessment work undertaken in NSW and Queensland and to investigate opportunities for further collaboration with respect to research and management arrangements. The results of this study may influence future research and management programs relating to the spanner crab sector of the OTLF.

ii) Best handling practices such as the careful removal of crabs from dillies and return to water to be included in the code of practice.

Background: Previous research has demonstrated the negative effects that poor handling practices can have on spanner crabs caught in dillies and subsequently discarded (e.g. because they are undersize). This response seeks to encourage industry, through the code of practice, to take greater care when removing spanner crabs from dilly nets to reduce the number of flippers or legs damaged during the removal process.

FMS Appendix 4 - Classes of resource assessment for species harvested in NSW

Class One

Class One or dynamic assessment models have been built and successfully applied to the management of the NSW eastern rock lobster, abalone and gemfish fisheries. This class of assessment calibrates complex population models to indices of abundance and other information about population structure. These models require a credible and high contrast index of abundance or the integration of other data. Projecting the stock dynamics forward in time can be used as the basis of a quantitative risk analysis of alternative harvesting options. The "trigger points" of these models should be interpreted in terms of the limit/target biological reference points, such as B_t/B_0 or $F_t/F_{0.1}$, that are used to manage international fisheries. Such models are time consuming and expensive to prepare, execute and analyse. The best forecast results of these models are obtained when an index of recruitment is available and applied. Application of stock-recruitment relationships will degrade the forecasts from these models.

It is recommended that lobster and abalone fisheries continue to use Class One assessments. Other primary/target species will be provided with Class One assessments upon the basis of assessment priority and research opportunity. In the short term (less than three years) most species will not have a research program focussed upon the completion of Class One assessments. Effective and efficient management systems will be built upon other classes of resource assessment. The proposal to use the TAC Committee to determine the effort in the commercial prawn fisheries will require improvements to the resource assessment of these stocks. The socio-economic and biological consequences of allocating effort between fisheries requires additional consideration and analysis. Prawns support the most valuable commercial fishery in NSW and require prioritisation within resource assessment research programs. The ARC Linkage (PhD-based) project to investigate these fisheries was initiated in March 2004[7]. Even if the TAC Committee does not play a significant role in the management of these stocks, this research should generate important outcomes for these fisheries and raise the assessment of these important stocks to Class One.

Class Two

Class Two assessment would be applied when there is a good understanding of the individual growth and total mortality in NSW and a credible, though not necessarily excellent, index of abundance for that species (such as a credible CPUE time-series). The population structure would be monitored with indicators derived from age and length-based data (only lengths would be used for crustaceans).

Class Two assessments would thus be completed using empirical indicators only. These indicators and the associated target and trigger points would be determined and, after appropriate consultation, included in an amended FMS. Targets and trigger points for these indicators will be

[7] Mathew Ives was selected as the successful candidate and is expected to complete his PhD on a "Quantitative Analysis of Prawn Harvesting Strategies in NSW" by the end of 2006.

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determined using: biological knowledge of a species (such as length at maturity); and/or simulation testing methods. Certain primary/target species would be promoted to Class One assessments as priorities indicate. Species identified as primary or target species within an FMS would be given Class Two assessments along with as many key secondary species as possible (but with lower priority).

Class Three

Class Three assessment would be applied to the more valuable species when the indicator of abundance was less credible or there was no potential for any age structured monitoring to occur. Length structured monitoring and assessment would be applied to these species only. There should be basic local information on the biology and mortality of species undergoing Class Three assessments. Class Three assessments would thus be completed using empirical indicators only. These indicators and the associated target and trigger points would be determined and, after appropriate consultation, included in an amended FMS. Targets and trigger points for these indicators will be determined using: biological knowledge of a species (such as length at maturity); and/or simulation testing methods. All species identified as byproduct or key secondary species (but not given a Class Two assessment) should be assessed in this way. Some non-key secondary or byproduct species could be included as growth and mortality information became available.

Class Four

Class Four assessments would be applied only to species of very low value and where very little information exists apart from landings data. Resource assessment would be based upon landings or catch per fisher data only. The method currently used to define the trigger points for commercial landings within the completed FMS will continue to be used until a superior methodology can be justified. This would be the simplest form of resource assessment and only used for any secondary or byproduct species that are not assessed with Class Two or Class Three methods. There must be at least credible information on commercial landings for this method to be applied.

Class Five

Class Five assessment recognises that no species-specific resource assessment can be undertaken (usually because there is no locally collected information from commercial or recreational fisheries). Assessment of these species could be based upon data from the observer program or fishery independent surveys as it became available but such work is not likely to be high priority. It is probable that assessment of these species will be via “ecosystem” indicators and/or indicators of discarding. This class is reserved for species where there is no information at present but where the species is known to experience some type of fishing mortality.

CHAPTER E ASSESSMENT OF THE IMPLICATIONS OF THE DRAFT FMS

The purpose of this chapter is to determine the extent to which the draft FMS has averted or mitigated the moderate to high risk issues that were identified in Chapter B, and consequently ensure that the fishery will operate in an ecologically sustainable manner for at least the next five years. Like the risk assessment in Chapter B, the lack of data means that the following assessments of risk mitigation are also qualitative. As such, this chapter is a theoretical appraisal of the measures proposed in the draft FMS, as there are no measurable baselines against which any changes due to the draft FMS could be measured. Only by monitoring the implementation of these measures will it be possible to fully determine whether they are sufficient to reduce risks due to the operation of the fishery.

The role of the FMS is to outline the long term approach to management of the fishery. Accordingly, the strategy does not include full details for the implementation of specific management changes. Ultimately, the FMS will be implemented through various supporting documents and operational plans, such as the share management plan, research plan and compliance strategic plans, which will establish the specific mechanisms for implementing and monitoring the changes foreshadowed by the FMS. Many of the detailed actions will require consultation with affected stakeholders so as to obtain the support that is often necessary to achieve effective implementation and compliance with the new rules.

E1 Ecological Issues

E1.1 Outline of the Process to Assess the Draft FMS

E1.1.1 Introduction

It is difficult to predict the effectiveness of management responses, particularly in the absence of quantitative data on the extent and magnitude of the impacts that are being addressed. Further, there are no readily identifiable methods, rules, guidelines or criteria against or with which effectiveness can be determined. Fletcher *et al*., (2003) have produced an assessment manual designed as a general guide when preparing or assessing fishery management reports to comply with the principles of ESD. They are not prescriptive, but provide considerable guidance to those responsible for determining acceptable performance with regards to performance measures, indicators and management responses for fishery reports written consistently with the earlier "How to Guide" (Fletcher *et al*., 2002).

This EIS and its components, particularly the draft FMS and this assessment of the draft FMS, were written against a specific legislative framework, and whilst broadly consistent with Fletcher *et al.*, (2002), there are significant differences that complicate the use of the assessment manual (Fletcher *et al*., 2003). In particular, the "How to Guide" (Fletcher *et al*., 2002) sets performance measures and indicators for each management response, whereas the draft FMS uses multiple management responses to achieve goals and objectives, and sets multiple performance indicators to achieve the goal. To overcome these difficulties, a qualitative assessment process (explained in 1.1.2) was developed to assess the effectiveness of the draft FMS in addressing the issues and reducing the risks of the existing fishery.

The objectives of this qualitative evaluation of the proposed management responses were to:

a) classify the relevant management responses in terms of their potential for risk reduction for the ecological components at highest risk; and

b) determine whether the main issues identified in the risk assessment (Chapter B2) have been adequately addressed.

It is not the aim of this section to appraise every management response in the draft FMS, as it would become un-necessarily lengthy, responses can affect multiple objectives, and would shift the focus away from the components at risk from the existing activity. Rather, this section will appraise the management responses that are directly related to the components or sub-components perceived to be at risk in Chapter B2.

Those components, their associated issues and common information gaps are summarised in Table E1.1, and some or all of the information gaps can be simultaneously addressed with one or more of the issues. It is important to note that many components and issues overlap, as you would expect given the complexity of the marine environment, and that the table is a simplified representation that does not attempt to create linkages between any components.

Table E1.1 Summary of ecological components at greatest risk from the existing activity and issues and information gaps that the draft FMS needs to address

Components at moderate or greater risk	**Issues**	**Information gaps (not specific to any particular component)**
Ecological processes and biodiversity	Lack of information & understanding - need for adaptive management	Distribution, intensity and frequency of fishing effort
	Linkages to other components	
	Information about habitat types and their associated assemblages	Distribution of fished habitats
Primary and key secondary species - 5 of 25 species at high risk - 9 at moderately-high risk - 8 at moderate risk	Direct measures for 14 species at greatest risk	Spatial and temporal rates, composition and mortality of <u>all</u> bycatch
	Monitoring, as a minimum, for the 8 species at moderate risk	
	Data quality, identifications and recording procedures	Gear loss / ghost-fishing
	Biological and ecological data and resource assessments for all P & K2	
	Recovery programs for overfished species	
	Discarding rates and mortalities	
Threatened species	Need to strengthen existing protective measures for grey nurse sharks	
	Levels of interactions and their consequences	
	Ability to account for future listings	

E1.1.2 Methodology to assess the draft FMS

In the absence of a recognised prescriptive procedure or assessment method for determining the effectiveness of the various management responses within the draft FMS, numeric values from 1 to 4 will be assigned to each management response directly related to a component at risk. The scores of

1 to 4 will transparently describe the potential risk reduction offered by each response, and are defined in Table E1.2. The scores for a component will be summed and calculated as a percentage of the potential total to account for different numbers of responses for different components, i.e. a component with 10 responses could score a minimum of 10 (25%) and a maximum of 40 (100%). The overall risk reduction for a component is then determined as either None (25%), Minor (26-50%), Moderate (51-75%) or Major (76-100%). The components outlined in Table E1.1 will be discussed in sections E1.2 to E1.5, each with a table summarising the overall risk reduction due to the draft FMS. In addition to those assessments of collective management responses, the Fishery Impact Profile factors (from B2.4.4, Tables B2.25 and B2.27) that have been affected by the draft FMS will be re-defined for each of the primary and key secondary species. Theoretically at least, this should provide a more accurate, rapid assessment of the influence that the draft FMS could have on reducing the risk to individual species.

It is important to remember that in assigning scores for management responses, the focus is on its ability to achieve a reduction in risk to a specific component, so whilst a response may not reduce risk for one component to which it is directly related, it could do so for another component. This complexity is due to the multi-faceted nature of the management responses, their position under particular Goals, and the fact that the draft FMS is a management strategy as opposed to an operational plan.

Management strategies attempt to establish a longer term framework within which certain broad goals need to be met (and are thus measured by performance indicators), whereas operational plans are able to much more action-focused and thus much easier to both measure and assess. That does not, however, alleviate the strategy of the responsibility for setting appropriate and targeted responses for each Goal, which will be determined in the following sections.

Table E1.2 Types of management responses and their potential risk reduction

Score	Potential risk reduction	Justification
1	None	These responses may be one or a combination of the following: an existing ineffective control; show an intent to act but do not specify the management control; identify regulations that need to be changed; based on an unspecified type or source of information; and/or do not appear sufficiently precautionary relative to the risk
2	Minor	These responses may be one or a combination of the following: show an intent to act and specify the management control or head of power, but lack detail for rigorous assessment; collect information to more accurately define the level of risk; based on information that has not been independently validated; and/or do not appear sufficiently precautionary relative to the risk
3	Moderate	These responses may be one or a combination of the following: show a commitment to act via a control mechanism that can be assessed; provides clear actions that can be tracked during implementation; based on information that has been collected or independently validated as part of a descriptive (i.e. monitoring) program; and/or are sufficiently precautionary relative to the risk
4	Major	These responses may be one or a combination of the following: provide feedback information on whether implementation of management measures are reducing the initial risks; based on information that has been collected or independently validated as part of an experiment (i.e. adaptive management); and/or test alternative management measures

The key determinants in the score for each management response will be the quality of information that is used in the construction of a management response, and whether a management control or regulatory head of power has been identified or is unspecified. It should be noted that a management response that focuses on the collection of information does not, on its own, reduce risk. It does, however, provide essential data that can be used to refine the level of risk which best fits a component and may, where necessary, provide the foundation for more appropriate and effective management measures.

There are four broad information types used in the development of a management response – unspecified information, regulation reviews or non-independently validated information, descriptive information, and experimental information (mensurative and/or manipulative). These different information types can vary considerably in their reliability (accuracy) and hence when used to develop management responses should be expected to lead to variable outcomes on actual risk reduction following the implementation of the management responses.

As a general guide, not specifying the type or source of information means that it cannot be assessed and can only be reported as offering no risk reduction. Self-reported and thus potentially biased information that has not been independently validated is of low quality because the interests of the information provider are often different to the interests of the agency requesting the information.

In contrast, information that has been collected or independently validated by trained observers or scientific staff as part of a descriptive (passive monitoring program) or experimental study (active monitoring program) have moderate and major potential for risk reduction, respectively. Such information is generally of high quality because robust, scientifically-based sampling protocols minimise, but don't remove, the possibility of collecting biased data.

Monitoring can be either passive or active (Sainsbury *et al.*, 2000). Passive monitoring is the routine collection of information about a fishery, such as weights of landings, lengths and sex of species caught. The information is used to update resource assessments but does not specifically change management procedures (Sainsbury *et al.*, 2000). Active monitoring, also referred to as adaptive management (Walters, 1986; Sainsbury *et al.*, 2000), sets up management controls to test specific hypotheses about the effectiveness of alternate management strategies or action. Such active monitoring must also adhere to rigorous experimental design (Walters, 1986; Peterman and McAllister, 1993; Underwood, 1990). Whatever form of monitoring is used it is important that there is a review of the information at predetermined frequencies so that the effectiveness of management responses can be evaluated and any necessary adjustments or changes to the activity or the FMS can be done.

A control mechanism is simply a tool of management that is the means by which a management response will be achieved (Table E1.3). Management controls are either output focused or input focused (Walters and Pearse, 1996). Output controls place limitations on how much can be taken out of a resource, such as quotas. Input controls place limitations on the effort to catch fish, such as restrictions on number of days fished, gear specifications and closures. Usually a fishery management strategy will use a combination of management controls because of the complexities of the ecological, economic and social structure of a fishery.

Table E1.3 Different types of management controls used in fisheries management.

Management Control	**What the management control does**	**Information needed for effective implementation and monitoring**
Output controls		
Total Allowable Catch Quota	Limits quantity of landings (usually species specific for the duration of the fishing season/year)	Detailed catch statistics Proportion of quota taken during quota period Information quantifying any high-grading issues
Protected Species	Prevents landings of selected species. Protects endangered species.	Quantify interactions between protected species and the fishery Information about discard mortality
Trip catch limits	Limits quantity of landings usually on a daily or trip basis	Detailed catch statistics on a daily or trip basis Information quantifying any high-grading issues
Input controls		
Fishing closure	Fishing grounds are closed temporarily to: - allow the recovery of degraded habitats - protect spawning sites and stocks - enable the rebuilding of overfished fish stocks Closures can also apply to species, e.g. spanner crabs carrying eggs (‘in berry’)	Location, size, shape, timing of closure Position relative to fishing grounds Compliance information (e.g. vessel monitoring system)
Code of practice Voluntary or mandatory	Specifies the way fishers should conduct their fishing activities with a view to reducing discards and discard mortality	Need cooperation of fishers Assessment of compliance by fishers to code
Mesh selectivity in traps	Bycatch reduction for traps	Species composition of catch Size structure of catch by species Discard mortality rate
Change efficiency of gear e.g. use of circle hooks	Reduce discard mortality in unattended line fishery	Species composition of catch Size structure of catch by species Discard mortality rate
Restrict catch to part of population	Reduces fishing mortality on vulnerable parts of a population. This type of control can be achieved in many ways (e.g. minimum legal size limits, prohibit taking of berried female crustaceans, seasonal spawning closures)	Size structure of population Proportion of population protected by management control Quantification of discard issues (e.g. number of discards, mortality rate of discards) Compliance information
Limit fishing efficiency	Limits the efficiency of fishing thereby reducing catch. This type of control can be achieved in many ways (e.g. prohibit use of onboard automatic baiting machines, limit power of fishing vessels)	Description of fishery (fleet characteristics, methods used, gear types used, efficiency of gear)
Limit fishing effort	Sets limits of effort that can be used in the fishery (usually in the form of a cap or maximum amount of effort that can be used)	A measure of latent effort A measure of active effort Continual monitoring of actual effort in the fishery.

E1.2 Ecological Processes and Biodiversity

Predicting fishery-related impacts at the ecosystem level for major ecological processes and biodiversity of the marine environment of NSW waters are made difficult by the large information gaps. As summarised in Table E1.1, a better understanding is needed of:

a) the way ecological processes function and change through time and along the coast

b) linkages between processes and the spatial and temporal distribution patterns of habitats, biodiversity and species assemblages, and

c) the association between different habitat types and fish assemblages in the fishing grounds and adjacent areas.

In addition to addressing those component-specific issues, filling the information gaps listed in Table E1.1 will also contribute to reducing the risk, as those information gaps are an integral part of, or have a significant bearing on ecological processes and biodiversity. As was acknowledged in the risk assessment, whilst this lack of information is a major obstacle to reducing the risk from fishery-related impacts, it is obvious that the task of collecting this important information is beyond the scope of a single agency. Clearly, these large-scale ecological issues need to be addressed by collaborative research across many disciplines and agencies.

The extent to which the issues and information gaps are addressed by the draft FMS is summarised in Table E1.4. All responses from Goal 1 (Manage the OTLF in a manner that promotes the conservation of biological diversity in the marine environment) are considered directly related, as are some from Goals 6 and 7. Whilst there are many other indirect responses that could contribute in some manner to the conservation of biodiversity, they are more appropriately addressed in the assessment of other components, e.g. threatened species.

Table E1.4 Summary of the reduction in risk due to the proposed management responses to address ecological processes and biodiversity

Management response (& key feature)	Type of information	Management control	MR score
1.1a - Map fishing grounds	Descriptive	Unknown	1
1.1b - Trap loss	Descriptive	Unknown	1
1.1c - Closures	Unspecified	Fishing closure	2
1.2a - Observer program	Descriptive	Unknown	1
1.2b - Escape panels	Unspecified	Mesh selectivity	2
1.2c - Fish handling	Unspecified	Code of Practice	2
1.2d - Shark finning	Unspecified	Code of Practice	1
1.2e - Code of Practice	Unspecified	Code of Practice	1
1.2f - Circle hooks	Unspecified	Gear change	2
1.3a - Modify methods	Unspecified	Unknown	2
1.4a - Disease plans	Unspecified	Unknown	1
6.1b - Feasibility of VMS	Unspecified	Fishing closure	1
6.5a - Non-fishery programs	Unspecified	Unknown	2
7.2a - Promote research	Descriptive or experimental	Unknown	1
Total MR score 20 out of 56 = 36% = **MINOR RISK REDUCTION**			

Overall, the draft FMS is assessed as potentially affording only a minor reduction in the risk to ecological processes and biodiversity. Many of the responses lack detail, limiting the ability to assess their potential outcomes. Of the three issues listed in Table E1.1, only one (information about habitat types) is considered in the draft FMS, and that is only as a potential product of trying to map major fishing grounds. The lack of detail about the mapping process and information gathering means that despite potentially being addressed by an indirect response, overall there is no risk reduction for the three issues specifically related to ecological processes and biodiversity.

As previously discussed, this is not overly surprising given the complex task of gaining a better understanding of ecological processes and biodiversity of the marine environment in which the fishery operates, particularly if trying to elucidate fishery-related impacts from other important factors. Although the fishery could make contributions, financial or in-kind to such studies, they are likely to be beyond the scope of the FMS and fishery alone.

Further, none of the information gaps listed in Table E1.1 are adequately addressed by the management responses listed in Table E1.4, although many responses have the potential to provide important information to better understand the potential impacts on ecological processes and biodiversity, and the related components of marine habitats and non-commercial species. Without clear mechanisms by which to achieve those responses it is not possible to say that they offer anything greater than a minor reduction in risk. Of equal or greater importance will be the how any information that is collected is used, as there is no clear process or mechanism by which that would occur. The biennial performance reports will include a review of progress made in implementing each management response, but it also needs to include a statement or outline of actions pending as a result of the review, not just that a timeframe has or hasn’t been met.

Combined, the management responses have been assessed as having the potential for minor reduction in risk, but there are some particular responses that warrant further discussion as in their current form they offer very little, but with more detail or more certainty could result in an overall moderate risk reduction.

- 1.1a could achieve a major reduction in risk if the management control to be implemented was VMS. The use of VMS is likely to be the only accurate and reliable method with which to map fishing grounds and assess the level of activity at each ground, which would simultaneously address two significant information gaps of this fishery. Accepting that gathering information about species assemblages at fished and non-fished grounds is probably beyond the scope of the FMS, as a minimum a better understanding is required of the proportion of those fished and non-fished habitats (as a surrogate) to enable a more accurate assessment of the potential extent and magnitude of the impacts of the fishery. It would also provide a more transparent process and independent source of information with which to educate and promote awareness in the non-commercial fishing public about the fishery, which is consistent with Goals 4 and 7.
- 1.1b must be coupled with a short-term research program, as we do not currently know the effective fishing life of the traps used in the fishery, or what is caught in them, if anything, after they are lost, and thus their potential impact on biodiversity. There is a lot of anecdotal argument that the traps rapidly break down, and that fish can swim in and out unimpeded, but as yet there has been no research to confirm or deny any such reports. Simply counting the number of traps lost in a year, via self-reporting, will achieve nothing without an indication of the potential consequences, which is a necessary first step after

which some level of trap loss and associated impact could be determined as acceptable by the FMS. This management response will not provide the necessary data to fill the information gaps about gear loss and ghost-fishing.

- The industry-funded observer program (1.2a) was given a score of 1 because, owing to likely funding limitations, its ability to be comprehensive enough to address the many issues and information gaps identified in Chapter B, is uncertain. The monitoring program (which includes the observer program and resource assessments) will also be reviewed every two years to determine whether or not it is needed in future years and if so, to set priorities and the level of work commensurate with risks and funding. The economic assessment in Chapter B highlighted the poor economic viability of many businesses in the OTLF, not to mention minimum shareholding requirements under the share management plan, so it is difficult to envisage fishers being able to adequately fund such an important facet of the draft FMS. Additional sources of funding would need to be sought to ensure that the observer program can provide the necessary level of information to eventually reduce the risks to this fishery. In particular, the lack of information about the spatial and temporal rates, composition and mortality of discards (commercial and non-commercial) within the fishery was one of the main issues that was identified in the risk assessment, and affects all ecosystem components, including the main species of the fishery. Although it has been acknowledged that many proposals in the draft FMS will be developed and strengthen during implementation, without a basic outline of the content and associated funding of the program, it is difficult to assess how the draft FMS will collect information about discard rates, composition and mortality, which is of particular importance for the primary and key secondary species of the fishery. Collecting information on these aspects of discarding for non-commercial species would also provide a better understanding of the potential impact on ecological processes and biodiversity. These information gaps remain unfilled, and although it is broadly discussed in the research section (D4.5), there is no clear commitment or timeframe within which to conduct the research.
- 1.2b is largely directed at commercial species of the fishery, but by default should assist non-commercial species. The issues associated with this response are discussed in E1.3.
- 1.2c-e relate to the Code of Practice, which in order to be effective and offer any kind of risk reduction must be supported by consequences for violating the code.
- 1.2f also requires a small amount of research in the operating environment of the OTLF to validate overseas studies that report less gut hooking and associated mortality. Overseas studies have reported significant reductions in hooking mortality of non-target species and increases in catches by using these hooks in some fisheries, particularly those using setlines and trotlines (Cooke and Suski, 2004). They do not appear to have been tested in Australia, and overseas studies have shown a variety of results in relation to hooking efficiency, hooking mortality and fish injury. Slight differences in circle hook design can greatly influence circle hook performance, which is also influenced by interspecific variation in mouth morphology, feeding mode and fish behaviour. Assuming circle hooks are as effective in Australia for setline and trotline fishing as reported from overseas, then it is likely that they will reduce the impact of hooking-related injuries and mortalities in shallow waters, but owing to the probable effects of barotrauma are unlikely to mitigate any risks to species captured from deepwater. Circle hooks are also already in common use through out the existing fishery, so making them compulsory for one component (unattended line

methods such as setlines and trotlines) of the fishery will not appreciably reduce the risks. There is strong evidence that circle hooks can also reduce post-release mortality for attended line fishing methods for some species. The high risk posed to threatened and protected species by attended line fishing methods can be reduced by requiring the use of circle hooks where it is shown that they reduce mortality and injury for species of concern.

- 1.3a, like many of the responses, is sound in its intentions but does not have a definitive mechanism. In the absence of targeted research to more adequately define the impact on marine habitats, which was assessed in B2 as a low risk, other non-targeted research has little chance of identifying such impacts. Further, as discussed later in the threatened species section, despite this response and its background which notes that "...methods known or believed to be having detrimental impacts on fish habitat or threatened species...should be modified..", the draft FMS does not minimise those impacts.
- 6.1b proposes to "Investigate the feasibility..." of VMS. This management response does not provide any risk reduction because it remains uncertain if and when the vessel monitoring system would be implemented. The mandatory introduction of VMS would offer a major risk reduction, as it has the potential to affect and provide information for many other responses and goals. It would effectively: provide data for the mapping (1.1a); obtain information on the distribution, intensity and frequency of fishing effort (significant information gaps); provide better spatial information for use in the design of the observer program; and provide an indicator of compliance with closures and protected areas. Acknowledging that the initial purchase and ongoing maintenance of such units are likely to be relatively expensive, and that other users and non-users of the fish resources benefit from the use of VMS by OTLF fishers, some form of subsidy would appear appropriate, as would a phase-in period. Assuming VMS resulted in savings due to less time spent on compliance operations for the fishery, any savings could also be used to offset the cost. As such, the VMS should be regarded as a vital tool for precautionary fisheries management.

Further, there is no management response that represents the simplest way to achieve the Goal of "...the conservation of biological diversity...", and that would be by limiting the number or volume of species permitted to be caught in the fishery. As was discussed in Chapter B, the existing fishery is relatively non-selective, retaining more than 200 species, although many of them are caught in very small amounts. The draft FMS does little to change this perception of a non-selective fishery.

In its simplest form, the response would be a list that comprised Primary, Key Secondary and, for example, the 28 Secondary species that, by descending order, collectively account for 10% of the landed catch (see Table B2.20). Similarly, to avoid restricting the number of species that could be retained, a response could be to set annual catch ratios for Primary and Key Secondary species against all other species at 95:5 (it should be noted that a Performance Indicator has been set at 15% and is discussed further in E5). Similar measures have been implemented in other commercial fisheries in NSW (Ocean Hauling and Lobster), and in addition to aiding ecological processes and biodiversity, are likely to reduce potential conflicts with other resource users.

E1.3 Primary, Key Secondary and Secondary Species

The risk assessment of these main species of the fishery determined that there were numerous issues and information gaps (Table E1.1) that needed to be addressed by the draft FMS to reduce the risk to these species, but they basically come back to a lack of data, or that which is available is of limited use for effective management. Filling those information gaps and basing management responses on that information should reduce the risk to the primary, key secondary and secondary species. The considerable number and complexity of the information gaps, however, means that the draft FMS will largely be restricted to data collection, the effectiveness of which is difficult to adequately assess because any feedback and associated outcomes are unknown until after implementation.

The performance indicators and trigger points are assessed in E5, so the following assessment will focus on the individual management responses, and whilst acknowledging the importance of the data collection responses, must assess them in terms of whether or not they can clearly demonstrate that risk will be reduced.

The extent to which the issues and information gaps are addressed by management responses in the draft FMS is summarised in Table E1.5. All responses from Goal 2 (Maintain stocks of primary and key secondary species harvested by the OTLF at sustainable levels) are considered directly related, as are some from Goals 1, 4 and 5. Whilst there are many other indirect responses that could contribute in some manner to the conservation of biodiversity, they are more appropriately addressed in the assessment of other components, e.g. threatened species.

Table E1.5 Summary of the reduction in risk due to the proposed management responses to address primary, key secondary and secondary species

Management response	Type of information	Management control	MR score
1.2a - Observer program	Descriptive	Unknown	1
1.2b - Escape panels	Unspecified	Mesh selectivity	2
2.1a - P & K2 monitoring	Descriptive	Unknown	3
2.1b - P & K2 resource assessments	Unspecified	Unknown	3
2.1c - P & K2 trigger levels	Descriptive	Unknown	3
2.1d - Monitoring landing levels of S	Descriptive	Unknown	2
2.1e - Cost fishery-independent surveys	Descriptive	Unknown	1
2.1f - Review MLL for P & K2	Regulation review	Catch restriction	1
2.1g - Wobbegong MLL 130 cm	Unspecified	Catch restriction	1
2.1h - Impact of 32 cm MLL for snapper	Economic/Descriptive	Catch restriction	1
2.1i - Cap gummy/school shark catch	Unspecified	Quota	2
2.1j - Spanner crab gear	Unspecified	Gear modification	2
2.1k - Biological data for sharks	Descriptive	Unknown	1
2.1l - Prohibit take of crabs carrying ova	Unspecified	Catch restriction	1
2.1m - Spawning spanner crab closure	Unspecified	Catch restriction	1
2.2a - Recovery program, gemfish	Descriptive	Trip limits	2
2.2a - Recovery program, snapper	Descriptive	Unknown	1
2.2b - Assist other recovery programs	Unspecified	Unknown	1
2.3a - Gear limits	Unspecified	Effort caps	2

Table E1.5 cont.

Management response	Type of information	Management control	MR score
2.3b - Ban auto-baiting	Unspecified	Fishing efficiency	3
4.2e - Boat length	Unspecified	Fishing efficiency	2
5.2a - Biological yield & economic return	Unspecified	Catch restrictions	1
5.3a - Effort levels	Unspecified	Effort caps	3
Total MR score 40 out of 92 = 43% = **MINOR RISK REDUCTION**			

Where: P = Primary species; K2 = Key Secondary species; S = Secondary species; MLL = Minimum Legal Length; MR scores are explained in Table E1.2

Overall, the draft FMS is assessed as potentially affording only a minor reduction in the risk to the primary, key secondary and secondary species of the fishery as a whole (Table E1.5). In other words, according to this assessment, the management responses should go some way towards achieving their goal of sustainable harvest levels for some species, but considerably more work is needed in most areas. Of particular concern is that the draft FMS has not reduced the high risk of overfishing for the sharks of the fishery (despite the reduced fishing pressure due to proposed gear restrictions) and the continued overfishing of snapper and kingfish. The reduction in risk on these and other primary and key secondary species is presented in Table E1.6, which reassesses factors 3 (stock assessments) and 5 (gear selectivity/effort) from the Fishery Impact Profile (FIP). The other factors cannot be appraised in this manner as they either require data to assess the effectiveness of the draft FMS (e.g. changes in CPUE) and/or have not been affected by the measures of the draft FMS (e.g. proportion of catch). This rapid and theoretical appraisal of the draft FMS should be used cautiously, and preferably repeated using the entire matrix as part of any review of the implemented FMS.

Table E1.6 shows that as a result of the draft FMS, the number of primary or key secondary species at high risk could drop from five to three; moderately-high risk from nine to eight; moderate risk from eight to four; moderately-low risk remains at two; and low risk increases from one to eight.

The draft FMS will not reduce the FIP or moderately-high risk levels for kingfish and snapper and moderate risk for blue-eye trevalla (a Type 1 effect in Table E1.6). For kingfish, the gear restrictions and modifications (FIP factor no. 5) have little or no effect on the main harvest methods for the species, which are handlining and trolling. Similarly for snapper, the proposed escape panels with 50 x 75 mm mesh for fish traps only reduce the proportion of snapper below the current 30 cm MLL from approximately 52% to 45%. Voluntary use of larger mesh sizes on a regional basis is not considered sufficiently precautionary to the risk of ongoing overfishing of snapper. Until there is considerable, across the fishery demand for larger mesh, then it is unlikely to be a readily available, relatively inexpensive option for fishers. Despite the reduction in hook numbers, blue-eye trevalla remain risk prone in terms of gear owing to the fact that the fishery primarily catches fish below their size at maturity and there has been a considerable drop in the proportion of mature fish landed from seamounts in recent years. This could be a reflection of environmental conditions, but until there has been a formal assessment of the status of blue-eye in this fishery and the Commonwealth's South East Fishery, then it is considered more prudent to maintain the moderate risk level for the species.

Leatherjackets, bonito, all sharks, hapuku and bass groper have had a reduction in their FIP, but no change in their overall level of risk (a Type 2 effect in Table E1.6). The sharks remain at high risk and the other species at moderately-high risk. With the exception of bonito, these species had seven or more risk prone factors in the existing fishery, and as such would require more than just factors 3 and 5 to be reduced in order to detect a reduction in risk level. As with kingfish, the gear restrictions and modifications (FIP factor no. 5) have little or no effect on the main harvest methods for bonito, which are trolling and handlining, hence that factor remains risk prone.

Twelve of the 25 species have had a reduction in their FIP and their overall level of risk (a Type 3 effect in Table E1.6). With the exception of silver trevally, none of these species have had stock assessments and as discussed further below, the commitment in the draft FMS to do those assessments underpins any potential risk reduction for those species. The assessment framework has been developed and so the assessments need to commence in the short term in order to realise any risk reduction. The remaining three species were already at low or moderately-low risk from the existing fishery and the measures in the draft FMS should ensure that they remain as such.

Table E1.6 Potential changes to the Fishery Impact Profiles and associated risk reduction for primary and key secondary species

	Existing fishery			**Potential changes due to the draft FMS**					
	No. of risk prone factors	Fishery Impact Profile	Risk	FIP factor No. 3	FIP factor No. 5	No. of risk prone factors	Fishery Impact Profile	Risk	Type of effect
Primary species									
Yellowtail kingfish	5	MH	MH	**A**	**P**	5	MH	MH	1
Snapper	5	MH	MH	**A**	**P**	5	MH	MH	1
Leatherjackets	7	H	MH	A*	A	5	MH	MH	2
Silver trevally	4	M	M	**A**	A	3	ML	L	3
Australian bonito	6	H	MH	A	**P**	5	MH	MH	2
Blue-eye trevalla	4	M	M	**A**	**P**	4	M	M	1
Rubberlip morwong	6	H	MH	A	A	4	M	M	3
Yellowfin bream	2	L	L	**A**	**A**	2	L	L	4
Bar cod	7	H	H	A	A	5	MH	MH	3
Gummy shark	6	H	H	**P**	A	5	MH	H	2
Spanner crab	3	ML	ML	**A**	**A**	3	ML	ML	4
Key secondary species									
Sharks	7	H	H	**P**	A	6	H	H	2
Wobbegong sharks	8	H	H	**P**	A	7	H	H	2
Silver sweep	4	M	M	A	**A**	3	ML	L	3
Mulloway	4	M	M	A	**A**	3	ML	L	3
Gemfish	3	ML	ML	**A**	**A**	3	ML	ML	4
Teraglin	5	MH	MH	A	**A**	4	M	M	3
Jackass morwong	4	M	M	A	**A**	3	ML	L	3
Dolphinfish	4	M	M	A	**A**	3	ML	L	3
Spotted mackerel	4	M	M	A	**A**	3	ML	L	3
Pearl perch	6	H	MH	A	**A**	4	M	M	3
Hapuku	7	H	MH	A	**A**	6	H	MH	2
Bass groper	7	H	MH	A	**A**	6	H	MH	2
Black-spot pigfish	6	H	H	A	**A**	5	MH	MH	3
Narrow-barred Spanish mackerel	4	M	M	A	**A**	3	ML	L	3

Bolded P (risk prone) or A (risk averse) denotes that there has not been a change to that Fishery Impact Profile (FIP) factor as a result of the draft FMS. Asterisk denotes resource assessment will be of ocean jackets.

Types of effect: 1 = no change to FIP or risk level; 2 = reduced FIP but no change in the risk level; 3 = reduced FIP and risk level; 4 = no change to existing low or moderately-low risk level

All of the issues and information gaps listed in Table E1.1 are addressed in the draft FMS, indicating a commitment or intent to mitigate the risks, but unfortunately not to the extent that would afford moderate or greater risk reduction. Considerably more work is required to address two of the six issues that were identified in the risk assessment, namely effective recovery programs for overfished species, and discarding rates and mortalities. This is evident in the management responses that score values of 1 or 2 because they are not considered to be sufficiently precautionary relative to the risk.

Importantly, the draft FMS has developed the framework and set resource assessment levels for all primary and key secondary species of the fishery, and the assessments will be externally reviewed every four years. Of the five species at highest risk due to the operation of the existing fishery, pigfish and bar cod will appropriately receive Class 2 levels of assessment, whereas the sharks will receive Class 3 assessments that will be monitored through the observer program. Whilst it is acknowledged that Class 2 resource assessments will not be possible for the sharks of this fishery until species identifications and reporting procedures are resolved, which is proposed in the draft FMS, as the observer program is not fishery-specific there is concern that it may not be able to collect sufficient data to enable better levels of assessments. The species at moderately-high and moderate risk will also receive appropriate levels of resource assessment. This indicates that with the exception of the shark species of this fishery, the levels of resource assessment as proposed in the draft FMS for the primary and key secondary species are commensurate with the risk. The monitoring programs and the resource assessments that they support will make a substantial contribution to reducing the risk to most of the primary and key secondary species of the fishery, although the three groups of sharks will remain at high risk and snapper and kingfish at moderately high risk.

Further, there are numerous responses that individually and collectively seek to reduce effort within the fishery, in the first instance by capping effort at currently active levels, thereby instantly removing latent endorsements. This is a significant step towards improving the sustainability of this fishery, both for the species and fishers alike. Of concern, however, is the ten year timeframe after commencement of the share management plan for establishing the maximum level of fishing effort. The maximum level is the currently active level, which will be capped, but to reduce the risks the currently active level of effort will need to be further reduced (remembering that from Chapter B2, it was the currently active level that was assessed as posing a significant risk to the sustainability of the fishery). Ten years is too long a timeframe to decide on that number, which will largely be dictated by the allocation of shares and associated restructure. It will be important that during the restructuring process, changing effort levels in terms of business numbers and days fishing by individual methods and species are appraised as part of the annual review (reported biennially) of the fishery, and not just restricting effort controls to the gear limitations proposed in the draft FMS. A performance indicator should also be included so that there is some measure of the process and its outcomes.

As detailed in Table D4.6, most of the resource assessments represent new programs or improvements to existing ones, and in conjunction with and supported by other equally precautionary measures, could have resulted in moderate or major risk reduction. Unfortunately, many of the other management responses offer very little, but with more detail or certainty could result in an overall moderate risk reduction. The resource assessment response has already been discussed, and some of the other responses that could be readily improved include the following:

- 1.2a has the potential to provide a lot of important information that would contribute to reducing the risks, but as discussed in E1.2, there is some concern about the adequacy of any such industry-funded program and whether or not the program will be able to collect sufficient data specific to the OTLF. In addition to gathering data on discard rates and composition, another issue that the observer program is proposed to address is the need for independent validation of commercial catch and effort data. The draft FMS does not adequately address this major problem by relying on the observer program to provide the necessary level of independent validation. The draft FMS proposes that the observer program will "estimate the accuracy of catch returns in terms of the quantity caught and species identification". This assertion can only be true if commercial catches are reported on a trip or daily basis, however, commercial catches in the OTLF are currently self-reported as monthly aggregates, and this situation does not change under the draft FMS. The observer program will most likely be based on a random stratified design in which daily trips form the basis of the replicated sample. This means that any comparisons such as those suggested in the draft FMS will probably be confounded by the different scales of reporting and sampling. It is recommended that commercial fishery statistics should be reported on a trip or daily basis, and/or should be validated against marketing/disposal records, as the current system of fish receivers and associated record keeping was designed to allow for such cross-checking.

- 1.2b proposes the use of escape panels comprised of 50 x 75 mm mesh in the back panel of fish traps, and to review their effectiveness after five years. The study that prompted the response (Stewart and Ferrell, 2001) was done when the MLL for snapper was 28 cm TL and traps were primarily covered in 50 mm hexagonal wire. In that scenario, the proposal could reduce the proportion of undersized snapper in fish traps from 30% to 10%, potentially representing a substantial reduction in discarding. The problem, as recognised in the draft FMS, is that the MLL for snapper has been increased to 30 cm and could be increased to 32 cm. This potentially means that at the current size limit of 30 cm, the proportion of undersized snapper in traps with 50 mm hexagonal mesh could have increased to approximately 52%, and even using the escape panels could still be as high as 45%. The escape panels would reduce the proportions of undersized bream, rubberlip morwong and tarwhine and many other species without size limits, such as leatherjackets, but size limits for those species are also currently under review and any increases would also see discarding increase. As previously discussed, larger mesh escape panels are proposed to be implemented on a voluntary and regional basis, but there are serious concerns about the logistical constraints related to that proposal, and there is no associated research to determine its effectiveness. Whilst a pilot study is proposed to investigate the mortality rates of discarded snapper, which could provide the impetus for a more comprehensive study and some resolution of the rates and mortality of discarding in this fishery, it is not part of the recovery program for the species, may not be comprehensive enough to be widely accepted and in any case may not eventuate. This assessment is responsible for auditing the draft FMS and aiming to make the fishery operate in an ecologically sustainable manner. For snapper, a species already recognised as growth overfished, the draft FMS is unlikely to achieve that aim. Furthermore, whilst it is acknowledged that fishers need to be offered some certainty against continual gear changes, the five year review of the escape panels is not commensurate with the risk as the 50 x 75 mm panels are already known to be inappropriate and is acknowledged as such in the background for the response. To reduce discarding, in particular of snapper, the draft FMS would need to propose larger mesh escape panels, and/or consider the use of multiple mesh configurations, and/or consider whether spatial management of different trap types is necessary to cater for the multi-species nature of the fishery.

- 2.1f proposes to "review and where appropriate implement minimum legal lengths for the primary and key secondary species...". A research program to support this MR has commenced (FSC 2003/126 in Table B1.15), however, there is insufficient detail in 2f to determine the potential effectiveness of that measure, and given the reluctance to accept scientific evidence of the need to increase MLL for other species of the fishery, such as snapper, it is difficult to see how 2f changes that situation. The '..where appropriate..' part of this response offers flexibility where there should in fact be rigidity. This is further complicated by the selectivity of the gear used in the fishery, which as previously discussed, is proposed to be changed, but that the changes also seem inappropriate given current MLL, to say nothing of any future changes. There is also considerable uncertainty as to which harvest strategy will be implemented, as this response relates to reproductive biology, whereas 5.2a will use a harvest strategy based on optimum biological yield and economic return. The determination of the size at harvest for a species will be expected to change depending on which strategy is used, and it is unclear as to when the various strategies will be used, or the criteria for making that decision.

- 2.1g does not reduce the existing high risk to wobbegongs as the proposed MLL of 130 cm is only likely to protect two of the three species (there are currently two known species but a current genetics survey indicates the existence of a third, much smaller species - N. Otway, DPI, pers. comm.). If there was catch data to indicate that the two smaller species accounted for almost all of the catch, then such a measure may be appropriate, however, we do not have such data and are unlikely to in the medium term. The 130 cm MLL may only be an interim measure pending the results of ongoing research, but it certainly isn't a precautionary one. Given that approximately 50% of female ornate wobbegongs are currently thought to mature at approximately 175 cm, a MLL closer to that mark, for example 150 cm, would seem more appropriate until fishers are better able to distinguish between the species or research indicates that the catch is dominated by one or both of the other species. Acknowledging the dangers in handling or measuring sharks of that size, it may be necessary to put markers or some form of indicator on the long sides (2m) of the traps at 50 cm intervals to which the shark could be rolled within the trap for measurement. Line-caught sharks would need to measured in a manner that minimises the potential for unnecessary handling and maximises fisher safety.

- 2.1h may appease some fisher concerns in the short-term, but does nothing to reduce the risk of overfishing to snapper, and thus the long-term viability of that component of the fishery. Long-term yield for the species would be increased and the risk of further overfishing reduced if the size limit change and more appropriate mesh escape panels (see discussion of response 1.2b) were implemented.

- 2.1i and j will reduce risks in their current forms, and will have greater potential if those caps or modifications are set below current levels (which appear unsustainable particularly in the Commonwealth fisheries). The influence of adjacent jurisdictions in those decisions prevents allotting a higher score for risk reduction to the response, and the school shark fishery itself could become a moot point if the current nomination for inclusion in the EPBC threatened species provisions is upheld.

- 2.1l and m represent existing measures, and so do not reduce the risk of overfishing to spanner crabs. Response 2.1m could be improved and clarified by unifying the closures, such that the fishery was closed from mid-October to mid-January. This would both reduce discarding and minimise the likelihood of catching females with ova, the topic of 2.1l.
- 2.2a will continue to assist the recovery of gemfish stocks, and the resource assessments will provide an indication of the success or otherwise of such measures. It is important to note that the SETF catch is approximately 13 times the size of the OTLF catch, severely limiting the potential power of this FMS to significantly reduce the risk to the species. The cross-jurisdictional consultation discussed in response 4.2c will be an important avenue by which to more appropriately address the issue of gemfish recovery. 2.2a will do nothing to reduce the risk of overfishing for snapper (as previously discussed under 2.1h) or kingfish, although some risk reduction is likely for kingfish due to other management responses. Where recovery programs are proposed they should be more specific, including a definition based on biological or landings data of the point at which the species is considered to have ‘recovered’. By not setting targets for recovery and timeframes it will mean that there is no way of measuring the success or otherwise of any recovery programs. As two of the most important species of the fishery, it would appear more precautionary measures are required to ensure their sustainability.
- 2.3a is complicated by a lack of documented baseline information against which to compare the proposed gear changes, rather this assessment is reliant upon anecdotal information. There is also no information about the existing capacity of the various methods, so it will be important for any future management to take technical efficiencies of vessels and crews into consideration when trying to standardise power across the fishery. In the absence of such information, against the reported use of gear in the existing fishery the proposals represent a substantial restriction. In addition to such gear limits, during the formulation of the share management plan consideration should be given to the use of more direct and complimentary effort controls, such as caps on the maximum number of fishing days for each gear type and linking those days to minimum shareholdings.

E1.4 Threatened Species

E1.4.1 Overall effectiveness of proposed mitigation measures

In summary, the measures proposed in the draft FMS to mitigate risk to threatened species are likely to be adequate for the majority (56/58) of species, primarily because the majority of species were at moderately-low risk from the existing activity. The draft FMS is likely to further reduce any potential impacts on those 56 species or groups, including great white sharks that were assessed at moderate risk.

For grey nurse shark and black cod the draft FMS does not appreciably reduce the risk in that although numerous measures are proposed to address grey nurse sharks in particular, and by default black cod (of which little is known other than it is often found in the same habitats as grey nurse sharks), they are not sufficiently precautionary to the risk. The draft FMS proposes measures to adequately address two of the three issues identified in the risk assessment as important for threatened species in general (Table E1.1), i.e. mechanisms to incorporate future listings of threatened species and may determine the level of interactions with threatened species, but does not propose sufficient gear and area modifications to specifically address grey nurse shark and black cod. The OTLF draft FMS does, however, state that the fishery will implement the provisions of any relevant threatened species recovery plans. From a fishery perspective, this is likely to represent a more equitable approach to managing the issue considering the potential impact of the recreational sector, but changes to the FM Act in December 2005 means that it is no longer mandatory to develop and implement recovery plans, thus limiting the potential effectiveness of the proposal. In the event that a recovery plan is produced for grey nurse shark, it is likely to include regulations in critical habitat sites and other key aggregation sites that remove high and medium risk methods or possibly prohibit all OTLF methods at some sites. However, since the operation of the fishery as proposed under the draft FMS has not reduced the risk to grey nurse sharks or possibly black cod in the short term, then there is still a high and moderately-high risk, respectively, that the fishery will have a significant impact on those species. Pursuant to that risk, an eight part test will be presented in section E1.4.2.

The rest of this section will focus on the management responses that are proposed to reduce risks to threatened species, and most of these are appropriately located in Goal 3. In addition to the management responses dealing directly with threatened species under Goal 3, other management responses under Goals 1 and 6 are also likely to contribute to the wellbeing of threatened species. The extent to which those management responses address the issues is summarised in Table E1.7 and are discussed below, including justifications for the previous statements about why the responses are considered to reduce the risk to grey nurse sharks and black cod to a minor degree, although the overall risk to these species remains high and moderately-high, respectively.

Table E1.7 Summary of the reduction in risk due to the proposed management responses to address threatened species

Management response	**Type of information**	**Management control**	**MR score**
3.1a - Modify reporting arrangements	Descriptive	Unknown	2
3.1b - Implement recovery plans etc.	Regulatory	Catch restriction	2
3.1c - Gear changes to protect grey nurse	Unspecified	Gear modification	1
3.1d - Code of Practice	Unspecified	Code of Practice	2
1.1a - Map fishing grounds	Descriptive	Unknown	1
1.2a - Observer program	Descriptive	Unknown	1
6.1b - Feasibility of VMS	Unspecified	Fishing closure	1
Total MR score 10 out of 28 = 36% = **MINOR RISK REDUCTION**			

Owing to the limited number of directly related management responses, each of them will be assessed in terms of their likely ability to achieve their objective.

- 3.1a, whilst consistent with similar protocols in the Commonwealth guidelines for ecologically sustainable fisheries, is reliant on self-reporting of such interactions and as such is unlikely to be consistently applied across the fishery and so may do little to achieve the objective. The background to this response also discusses identification material for grey nurse sharks as an example, but it is apparent from the risk assessment that this sort of material also needs to include serranids, as many of them are protected species and one, bar cod, is a target of the fishery. The catch returns should be modified to avoid reporting of 'unidentified cod/serranids', which would naturally follow on from a better understanding of distribution and appearance of the various species.
- 3.1b acknowledges the importance of recovery plans and similar conservation measures under the various legislature and gives them precedence over the provisions of the FMS, rightly assuming that such arrangements would be completed and be effective. The fishery is already consistent with the draft recovery plan for grey nurse sharks, and this measure and others in the FMS ensure that it remains so. Despite being protected for more than 20 years and the subject of a draft recovery plan, grey nurse shark numbers do not appear to be increasing. Whilst probably due to a variety of factors, being able to conduct the Key Threatening Process of Hook and Line Fishing (by recreational and commercial fishers) in grey nurse shark Critical Habitats is likely to have constrained its recovery. The inclusion of more proactive conservation measures in the draft FMS, instead of being reactive to future recovery plans would clarify the arrangements to protect grey nurse sharks. In the longer term, this response should reduce the risk to the majority of threatened species, although it is not possible to determine to what extent, as that depends on the effectiveness of the measures included in the completed recovery plans.
- 3.1c acknowledges the risk that the fishery poses to the grey nurse shark but does not provide measures with which to significantly reduce the risk. The draft FMS proposes to implement the exclusive use of circle hooks for unattended line methods, investigate their use on attended lines and prohibit the use of wire trace on bottom setlines. Circle hooks are already used by a large proportion of OTLF operators and unattended line methods are not currently permitted in critical habitats, so the proposal does not represent a major change to the fishery and subsequently does not significantly change the risk. As previously discussed, as an absolute minimum, the use of circle hooks and prohibiting wire trace would need to be implemented across all demersal and midwater bait-based line methods, not investigated as proposed, to reduce the risks. The risk of the OTLF to grey nurse sharks would be significantly reduced if the draft FMS closed critical habitats to the remaining high risk method of the fishery that can still be done in those areas (i.e. handlining) and removing all high and medium risk methods from other key aggregation areas that are not currently listed as critical habitat.
- 3.1d is good in principle, particularly if the use of whole fish baits are prohibited, but is unlikely to substantially contribute to achieving the objective, as this fishery is inherently based on gear that could incidentally capture some protected fish and is likely to interact in some way with almost all of them. If data collected in future shows that the OTLF catches these species, it will be necessary to implement a direct management response that

addresses the species and or area of concern, not via the code of practice, which should address fisher behaviour and education.

- 1.1a could positively assist the overall management of threatened species within the fishery. Knowing where, when and how intensely areas are fished was identified as a major information gap in the risk assessment, which prevented a more accurate assessment of the risk to each species. There is, however, no clear mechanism or process by which the information will be collected and analysed and compared against non-fished areas. Any information that is collected should be used in the design or ongoing refinement of the proposed observer program.
- 1.2a, the observer program, provides an opportunity to gather quantitative data upon which to more accurately assess the potential impacts of this fishery. The observer program will underpin many of the management responses within the FMS, and as previously discussed ideally would be fishery-specific, but as a minimum needs to be adequately resourced and to ensure that it is done at the appropriate spatial and temporal scales within the OTLF.
- 6.1b proposes to investigate the cost-effectiveness of VMS, which would be an effective tool for ensuring compliance with regard to grey nurse shark critical habitats, Marine Park zoning, aquatic reserves and any other spatial closures designed to mitigate risks to threatened species. Implementation of VMS would act as a complementary measure by providing extra data for the mapping scheme proposed in Goal 1, in addition to numerous other responses. Data on fishing activity collected by VMS would also assist in addressing one of the information gaps identified in the risk assessment by providing more accurate data upon which to base any future risk assessments, should they be required (for example for a review following the triggering of a trigger point related to threatened species). The introduction of VMS would be consistent with other commercial fisheries in adjacent jurisdictions. VMS need not immediately follow release of the FMS, but could be phased in over a couple of years to allow fishers to adjust to any potential economic burden.

The draft FMS acknowledges the significant information gaps relating to threatened species that were highlighted in the risk assessment, and many of the proposed measures are focused on obtaining better information on interactions between these species and the fishery. This is a necessary first step in determining the extent and frequency of any potential impacts, and can be used to design further surveys, if necessary, to determine the magnitude of those impacts. The observer program will be the primary, objective tool to obtain this information, in addition to changes to catch reporting forms, and some of the potential problems of the program and self-reporting have been discussed in previous sections.

Additionally, the observer program should be designed in collaboration with the Threatened Species Unit and fishery managers from other fisheries to avoid duplication and ensure that the areas and or species of highest priority are targeted. The proposed observer program should also be repeated in the medium term, say after five years, to make provision for increases in the distribution and abundance of threatened species as a result of recovery of the species, and as a result of changes to the operation of the fishery. It will be important to ensure that information gathered through the observer program is fed back into the management of the fishery in a timely manner, so that effective measures (e.g. closures) are used to deal with risks should they arise in future.

E1.4.2 The Eight-Part test

The various pieces of legislation under which this assessment is being done require the determination of whether there is likely to be a "significant effect" of the draft FMS for the OTLF on any threatened species, populations or ecological communities or their habitats. The methodology used in this assessment has already indicated that by failing to reduce the existing high and moderately-high risks to grey nurse shark and black cod, respectively, the draft FMS may have a significant effect on those species. To ensure compliance with the legislation and keep the assessment as broad as possible, this assessment will address the matters listed in s5A of the EP&A Act, generally referred to as the Eight Part Test of Significance. If the test reveals that a significant impact is likely, then a Species Impact Statement (SIS) will be required, or the FMS may be modified such that a significant effect is unlikely.

It is important to remember that the eight factors presented below were originally designed to address small-scale developments in terrestrial systems, where the impacts of such developments are usually fairly predictable and the habitat and biological requirements of potentially affected animals are reasonably well understood. This is not the case in the marine environment in which the OTLF operates - little is known of either the impacts due to the fishery or of the biological requirements of the majority of threatened species therein. This complicates the determination of whether or not there will be a significant effect, but for the purposes of this assessment, each part will be more broadly defined so that the parameters against which the determination was made can be judged.

The majority of the biological information for each species upon which these answers are based is provided in Appendix B2. Only species and aspects of their biology directly related to the eight questions are presented below, and a summary of the eight-part test is provided in Table E1.8.

1. *"In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction"*

The key aspects of this part are lifecycle, disrupted and viable local population. For the purposes of this assessment, lifecycle includes the primary components of feeding, breeding and dispersal, and the various habitats in which these components take place. Disruption is taken to broadly mean the degree to which the fishery interrupts or disturbs any of the lifecycle components, and includes a consideration of the overlap with the fishery: the equivalent of interaction and overlap, respectively, considered in the risk assessment in Chapter B and Appendix B2. Local population is much harder to define for marine systems, as they exist within an effectively continuous habitat and the movement of animals or exchange of genetic material cannot be readily confined. This concept is further complicated as the study area of this activity is the State and Commonwealth waters in which it operates, not a discreet, isolated location.

Irrespective of these complications, the risk assessment of the current fishery indicated that grey nurse sharks, black cod and great white sharks were at risk. The various management responses within the draft FMS are considered likely to reduce the risk to great white sharks, but not grey nurse sharks or possibly black cod. Little is known about the biological and habitat requirements of black cod, other than it is found in some grey nurse shark critical habitats, as well as offshore areas around caves and shipwrecks. In the absence of such information, it is uncertain as to the impact of the fishery on the lifecycle of the species and whether or not local populations are found in NSW waters, although given that the species occurs along the Queensland coast, the latter appears unlikely.

Much is known about the grey nurse shark, which is listed as an endangered species under the FM Act and a critically endangered population under the EPBC Act, including the position of what are thought to be the majority of the species' key aggregating sites. Ten of these key sites have been recognised as critical habitats for the species, because they are important feeding, breeding and pupping areas. Critical habitats are currently broadly defined as a 200 m radius around the site, with an associated 800 m buffer zone. Droplining, driftlining and setlining are prohibited in critical habitats and adjacent buffer zones, limiting the scope for disruption by the fishery. Hook and line fishing, which is also listed as the Key Threatening Process for the species, and trapping are currently allowed in both the critical habitats and buffer zones. These methods, but particularly line fishing, have the potential to affect the feeding and breeding components of the grey nurse shark's lifecycle. Current research suggests that grey nurse shark numbers are not increasing, and that in fact the population is continuing to decline. There are currently no published data to quantitatively determine the number of sharks killed among or within the various commercial and recreational fishing sectors each year, although several were reported as killed due to some form of hook and line fishing between October 2001 and September 2002 (N. Otway and B. Talbot, NSW DPI, pers. comm.). As previously discussed in Chapter B, the number of deaths attributable to the OTLF is unknown, however, given the significant spatial, temporal and methodological overlap between the OTLF and grey nurse sharks, it is probable that the fishery is contributing in some part to the fishing-related mortality of grey nurse sharks. Given the known vulnerability of grey nurse shark populations to fishing mortality, the OTLF (as proposed in the draft FMS) is considered likely to be a strong contributory factor in placing the species at the risk of extinction.

The lifecycles of other threatened species that occur in the waters in which the fishery operates are not going to be disrupted such that local populations are at risk of extinction.

2. *"In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised"*

The key aspects of this Part are similar to Part 1, but are applied to endangered populations as recorded under the specific schedules of the FM Act, TSC Act and the EPBC Act.

Only two endangered populations are thought to be affected by the fishery. They are the little penguin population at Manly (TSC Act), and the critically endangered east coast population of grey nurse sharks (EPBC Act). The critically endangered east coast population of grey nurse shark was considered in Part 1, and in respect of this Part, that population is likely to be significantly compromised.

The OTLF does not target the preferred prey of little penguins, primarily pilchards and anchovies, and although pilchards and anchovies are occasionally recorded on catch returns, the methods of this fishery do not catch significant volumes and may represent misreporting. The fishery also takes place well beyond the critical habitat of the population, which is where nesting, breeding and fledgling of the young occur, severely limiting potential disruption of the population. The fishery does not modify or destroy any abiotic (i.e. non-living, such as beaches or nests) habitat of the population, and none have been reported as captured by, or notably disturbed by this fishery. The activity of the fishery as proposed under the draft FMS is not going to significantly disrupt the endangered population of little penguins at Manly such that their viability is likely to be significantly compromised.

3. *"In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed"*

The key aspects of this part are regional distribution, habitat and significant area. For the purposes of this Part, regional distribution refers to the five marine bioregions of the NSW coast established by IMCRA (1998) and shown in Figure D4.1. Under the FM Act and the TSC Act, habitat is to include both the abiotic (i.e. non-living, physical structure - rocks, sand etc.) and biotic (i.e. living organisms) components, and will be used in this assessment even though this Part of the test appears to focus on area/spatial distribution of the abiotic component. As previously discussed, this is largely due to the terrestrial origins of the test and a good understanding of the some or all of the following: distribution and spatial extent (i.e. area) of habitats of threatened species; the amount found within a given development area; the amount that could be modified or removed and thus the proportion that could be adversely affected by said development; the amount and utility of habitat required to support the threatened entity; the ecological integrity of the habitat that could be affected; and/or the degree of tolerance that the threatened entity has to habitat removal or modification.

As discussed in Part 1, this sort of information is not available for the majority of threatened species that occur in the marine environment off NSW, although some qualitative and quantitative information is available for grey nurse sharks. Until an accurate, quantitative assessment of the distribution of aquatic habitats along the NSW coast, of the threatened species, populations or communities that occupy them and of their dependence upon particular habitats is available, it is not possible to quantitatively determine if a significant area is to be modified. Some qualitative estimates can be made for grey nurse sharks, however, and some broad conclusions drawn for most other species in an attempt to answer this part of the test.

The risk assessment for the OTLF suggested that for most species, the potential overlap with many species was considerable, however, there appears to be very little interaction between the fishery and most threatened species. Importantly, most of this potential interaction is at the individual level, rather than at the habitat level, and although not based on any quantitative data, the methods of the fishery are unlikely to modify or remove a significant area of abiotic habitats. The biotic component for some species, such as black cod and great white sharks, could be affected by the removal of prey items, but in the absence of quantitative information, it is unlikely that the volume of prey removed by the fishery represents a significant volume such that it could further threaten those species.

For grey nurse sharks, however, there is considerable potential for the fishery to affect a significant area of its known habitat. Grey nurse sharks occur along the entire NSW coastline, and have been recorded from at least 50 recreational dive sites (see Otway and Parker, 2000). There are also likely to be other non-dive sites frequented by grey nurse sharks, given that mark-recapture studies are not recording 100% recaptures (Otway and Burke 2004). On a bioregional scale, 19 of those more readily accessed dive sites occur in the Tweed-Moreton Shelf, 18 in the Manning Shelf, 13 in the Hawkesbury Shelf, 21 in the Batemans Shelf and two in the Twofold Shelf Bioregion. Ten of those sites are considered so important to the species for feeding and breeding that they have been declared Critical Habitats (addressed in Part 5). Irrespective of the uncertainty surrounding the frequency of use, importance of the known sites and existence of unrecorded sites and sharks, the fishery is likely to operate in all of the known sites and habitats frequented by grey nurse sharks. There are some limitations, including the prohibiting of setlining, droplining and driftlining in the ten critical habitats and throughout Marine Parks, but overall this represents a small proportion of the preferred abiotic habitats of grey nurse sharks. In addition, the fishery targets many species that are likely to be prey items of the shark, thus removing 'habitat' from a significant area of known habitat. The draft FMS does propose some changes to the line methods of the fishery, and proposes that in future the FMS will respond to any provisions under the recovery plan for grey nurse shark. In the short term, however, with the absence of any grey nurse shark-specific closures, this assessment concludes that the operation of the OTLF as proposed in the draft FMS will modify a significant area of known habitat of grey nurse shark.

4. *"Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community"*

As discussed in Part 1, marine systems provide an effectively continuous habitat and the movement of animals or exchange of genetic material cannot be readily confined. The activity of the fishery as proposed in the draft FMS would not isolate areas of habitat.

5. *"Whether critical habitat will be affected"*

Critical habitats are defined under the various Acts and are recorded on a Register of Critical Habitats, which is kept by the Directors-General of both NSW DPI and the National Parks and Wildlife Service (section of the Department of Environment and Conservation). For the purposes of this assessment, affected is taken to mean modified, removed or destroyed, and refers to both the abiotic and biotic components. Critical habitat has been declared for the endangered population of little penguins at Manly Cove (TSC Act), and for the endangered grey nurse shark (FM Act).

The critical habitats for the penguins are mostly terrestrial (extending to 50 m from shore) and found within the North Harbour Aquatic Reserve in Sydney Harbour. The OTLF does not operate within the estuary and therefore would not affect critical habitat of the endangered population of little penguins.

The ten identified critical habitats of grey nurse shark are all affected to some degree by the fishery, both in terms of disturbance by the setting and retrieval of gear, as well as the removal of prey items. Whilst the methods of the fishery are unlikely to cause significant structural modifications of the geophysical habitat at the ten sites, they will remove some fish and invertebrates (i.e. biotic habitat) from those sites. The draft FMS does not propose to close those areas to the fishery, and so it must be concluded that the fishery will affect critical habitat of grey nurse shark.

6. *"Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region"*

To adequately address this Part, knowledge of a multitude of things is needed, including, but not limited to: which species occur in which reserves, an estimate of the proportion of the population protected by such reserves, the habitats contained within each conservation reserve and the proportion of such habitats that they represent, the spatial and temporal use of those habitats by the species, their importance relative to similar habitats outside of the reserves, the degree of protection afforded by the reserve, and the historical distribution of those relative to the location of reserves. Most of the species listed under the TSC Act have a general description of their occurrence in particular reserves, but little is known of the other equally important information. Most of the species listed under the FM Act do not have even the most fundamental level of information, let alone an understanding of what proportion of the remaining population is protected within such reserves. Further, it is assumed that in attempting to address this Part, there is an underlying acceptance that the presence of the threatened entity or its habitats in a conservation reserve could buffer or mitigate the potential effects of the development being assessed. This may be so in terrestrial environments, but is less applicable in marine environments given the limited extent of marine conservation reserves, the protective measures that currently exist within them, their occurrence within coastal waters, and the difficulty of determining adequate representation.

There are currently six marine parks and 13 aquatic reserves declared under the FM Act, as well a marine extension of Bouddi National Park declared under the NPW Act. In addition to the six existing marine parks, NSW DPI and the MPA are currently considering the establishment of a marine park in the remaining regions, that is Hawkesbury and Twofold Bioregions, which would mean that there is at least one marine park in each of the five marine bioregions and the marine province of Lord Howe Island. The current marine parks include Cape Byron and Solitary Islands (Tweed-Moreton Bioregion), Lord Howe Island (Lord Howe Province), Port Stephens/Great Lakes (Manning Bioregion), and Jervis Bay and Batemans Bay (Batemans Bioregion). The current aquatic reserves include Cook Island, Fly Point (Halifax Park), Barrenjoey Head, Narrabeen Head, Long Reef, Cabbage Tree Bay, North (Sydney) Harbour, Bronte-Coogee, Cape Banks, Boat Harbour, Towra Point, Shiprock (Port Hacking) and Bushrangers Bay.

Species of fish that are represented in conservation reserves include black cod, blue groper and grey nurse shark. Black cod and grey nurse shark are known from Cook Island Aquatic Reserve, Solitary Islands Marine Park, Jervis Bay Marine Park, Cape Byron Marine Park, Port Stephens/Great Lakes Marine Park, Batemans Bay Marine Park, and Lord Howe Island Marine Park. Grey nurse sharks are also known from Long Reef Aquatic Reserve and the other areas of critical habitat not covered in marine parks (or in Port Stephens/Great Lakes and Batemans whose zoning plans are not yet finalised), namely Fish Rock (South West Rocks), Green Island (South West Rocks), The Pinnacle (Forster), Big and Little Seal Rocks (South of Forster), Little Broughton Island (North of Port Stephens), Magic Point (Maroubra), Bass Point (Shellharbour), Tollgate Islands (Batemans Bay) and Montague Island (Narooma). The restrictions in force around these areas include prohibiting fishing with bait from anchored or moored vessels within 200 metres, and prohibiting commercial drop, drift and setline fishing within 1000 metres of the site.

Blue groper and a variety of the other rocky reef fish are likely to occur in many of the marine protected areas that contain rocky shores, and juveniles of the species are likely to occur in marine protected areas containing seagrass beds. Black cod are found in most marine conservation reserves and may gain particular protection due to their reef dwelling habits and territorial nature.

Many of these threatened species travel long distances in search of food or as part of their natural migration. Included in this group of highly mobile species are the birds, mammals, turtles, southern bluefin tuna and sharks. While some species may occur in conservation reserves at times, it is likely that, for the majority of the time and species, these species would be very poorly represented in conservation reserves or similar marine protected areas. In fact, for such highly mobile and wide-ranging species, it has been argued that marine reserves are necessary but not sufficient to protect the species from the processes that threaten them (Allison *et al.*, 1998). The majority of species are unlikely to be adequately represented in conservation reserves, but overall the fishery is unlikely to have a significant impact on them. An exception to this is the grey nurse shark, which is considered at risk despite its occurrence in, and the existence of some of its habitat within marine conservation areas.

7. *"Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process"*

Key Threatening Processes are listed under the FM Act, TSC Act and EPBC Act. These and a variety of other potentially threatening processes were discussed in section B2.5.2, and only those of most relevance will be discussed.

The KTP of most importance in this fishery are:

- Hook and line fishing in areas important for the survival of threatened fish species (henceforth referred to as hook and line fishing)
- The entanglement in or ingestion of harmful marine debris by vertebrate marine life, and
- Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations (henceforth referred to as bycatch by longlines).

The fishery could be contributing to the latter two processes, but any contribution is likely to be minimal and further mitigative measures are proposed in the draft FMS. Those measures are considered adequate to minimise the contribution of the fishery to these KTP.

Hook and line fishing is an integral part of the fishery, and despite its listing as a KTP, is currently permitted within the critical habitats and adjacent buffer zones of grey nurse sharks by both commercial and recreational fishers. It is prohibited within the sanctuary zones of marine parks, some of which are likely to contain threatened species and their habitats, but given the small proportion and limited habitats that sanctuary areas represent, and the migratory nature of grey nurse sharks, sanctuary zones are unlikely to mitigate the impact of this KTP and thus the line component of this fishery on the species.

8. *"Whether any threatened species, population or ecological community is at the limit of its known distribution."*

For the purposes of this assessment, this Part is trying to address the issue of range contraction. The premise is that if a species is at the limit of its range and is repeatedly captured or disturbed or otherwise significantly affected, it may no longer be able to inhabit that area, further reducing what is already likely to be a very restricted range since we are considering threatened species. To adequately address this Part requires not just an understanding of a species' distribution, but also of the degree to which the activity is going to affect the species such that it becomes regionally extinct or suffers a marked range contraction.

As this fishery/activity takes place at the level of the State, then almost all of the threatened species considered in the risk assessment are at the limit of their distribution. Despite this acknowledgment, their appears to be a very low level of interaction between this fishery and the majority of threatened species, and that level is not indicative of such an impact as to result in the range restriction or local extinction of any of those species. The observer survey and other mitigative measures proposed in the draft FMS should also provide an opportunity to better understand these interactions and information with which to base management responses that avoid potential range restrictions due to the fishery.

Conclusion

This assessment has considered the eight factors under s5A of the EP&A Act in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats. The assessment was based on a review of available biological information derived from the various agencies responsible for those species, from published literature and from personal communications. The assessment has found that the activity of the OTLF as proposed under the draft FMS will have a significant effect on grey nurse shark, and as such a Species Impact Statement is required. The SIS will be presented in section E1.5.

Table E1.8 Summary of the results of eight-part test for the impacts of the draft FMS for the OTLF on threatened species listed under the FM Act, TSC Act and/or EPBC Act, and protected species listed under the FM Act.

Information supporting the answers to each part can be found in Appendix B2; N/A indicates that the particular factor is not applicable to the species; NO indicates that the factor is relevant but is not affected; RNS indicates that the factor is relevant but the effects are not negatively significant; RS indicates that the factor is relevant and the effects are negatively significant; ? indicates a high degree of uncertainty and/or insufficient information.

	Factors considered in the Eight-Part Test							
Common name	**1** lifecycle	**2** endangered populations	**3** habitat modification	**4** habitat isolation	**5** critical habitat	**6** protected areas	**7** KTP	**8** range limit
Fish								
Australian bass	NO	N/A	NO	NO	N/A	NO	RNS	NO
Ballina angelfish	NO	N/A	NO	NO	N/A	?	RNS	RNS?
Black cod	?	N/A	?	NO	N/A	RNS	RNS	NO
Black marlin	NO	N/A	NO	NO	N/A	NO	RNS	NO
Blue groper	NO	N/A	NO	NO	N/A	RNS	RNS	NO
Blue marlin	NO	N/A	NO	NO	N/A	NO	RNS	NO
Eastern blue devil	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Elegant wrasse	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Estuary cod	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Estuary perch	NO	N/A	NO	NO	N/A	NO	RNS	RNS
Giant Queensland groper	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Great white shark	NO	N/A	NO	NO	N/A	NO	RNS	NO
Green sawfish	NO	N/A	NO	NO	N/A	NO	RNS	RNS
Grey nurse shark	RS	RS	RS	NO	RS	RNS	RS	NO
Herbsts nurse shark	NO	N/A	NO	NO	N/A	NO	RNS	RNS?
Southern bluefin tuna	NO	N/A	NO	NO	N/A	NO	RNS?	RNS
Striped marlin	NO	N/A	NO	NO	N/A	NO	RNS	NO
Whale shark	NO	N/A	NO	NO	N/A	NO	RNS	NO
Birds								
Antipodean albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Black-browed albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Black-winged petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS?
Buller’s albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Campbell albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Flesh-footed shearwater	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Gibson’s albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Gould’s petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Grey ternlet	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Indian yellow-nosed albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Kermadec petrel (western)	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Little penguin population (Manly)	NO	RNS	NO	NO	N/A	RNS?	RNS	RNS

Table E1.8 cont.

Common name	Factors considered in the Eight-Part Test							
	1 lifecycle	**2** endangered populations	**3** habitat modification	**4** habitat isolation	**5** critical habitat	**6** protected areas	**7** KTP	**8** range limit
Birds cont.								
Little shearwater	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Little tern	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Northern giant-petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Northern royal albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Osprey	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Providence petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Red-tailed tropicbird	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS?
Salvin's albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS?
Shy albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Sooty albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Sooty tern	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Southern giant-petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Southern royal albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Wandering albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
White tern	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
White-bellied storm petrel	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
White-capped albatross	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS?
Mammals								
Australian fur-seal	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Blue whale	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Dugong	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Humpback whale	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
New Zealand fur-seal	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Southern right whale	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Sperm whale	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Reptiles								
Green turtle	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Hawksbill turtle	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS
Leatherback turtle	NO	N/A	NO	NO	N/A	RNS?	RNS	NO
Loggerhead turtle	NO	N/A	NO	NO	N/A	RNS?	RNS	RNS

E1.5 Species Impact Statement

E1.5.1 Introduction

E1.5.1.1 Background

This EIS has been written in accordance with guidelines provided by the Department of Planning (DP, 2003). Accordingly, it has included a risk assessment of the existing fishery (Chapter B2), a fishery management strategy designed to mitigate those risks and to operate in an ecologically sustainable manner (Chapter D), and an assessment of the adequacy of those measures in the draft FMS to reduce or minimise the risks (Chapter E). Section E1.4 determined that the activity as proposed in the draft FMS did not substantially reduce the existing high risks to the endangered east coast population and endangered species of grey nurse shark and was thus likely to have a significant impact on that population and species.

Consequently, under section 115N(2) of the *Environmental Planning and Assessment Act 1979*, this EIS must include a Species Impact Statement (SIS) to assess the impacts of the proposed fishery arrangements on the population. This section (E1.5) constitutes that SIS for the designated fishing activity of the NSW Ocean Trap and Line Fishery.

A SIS is an additional decision making tool for the Minister/s approving the proposal, i.e. the draft FMS. To this end, when making the determination for the fishery under section 115O of the *Environmental Planning and Assessment Act 1979* and considering the draft FMS, the EIS and the Preferred Strategy Report, the broad options available to the Minister/s are to conclude that some significant impacts remain and to:

- refuse to permit the activity, or
- permit the existing activity to continue unchanged, or
- permit the activity to continue subject the proposals in the draft FMS and Preferred Strategy Report, or
- permit the activity to continue subject to the proposals in draft FMS, the Preferred Strategy Report and additional controls to prevent or minimise the impacts on the grey nurse shark population.

E1.5.1.2 Legal requirements

Having determined that a SIS is required under section 221L, the sponsor must request from the Director-General (D-G) for NSW DPI and must, in preparing the species impact statement, comply with any requirements (hereafter referred to as the D-G's requirements) notified to the person by the D-G concerning the form and content of the statement. Section 221J describes the form and sections 221K(1, 2, 4 and 5) describe the content of a SIS as it relates to endangered species or populations. Section 221L of the Act requires the D-G to advise of any limited or modified requirements and additional matters that must be addressed in the preparation of a SIS.

The specific D-G's requirements and additional matters in this instance are outlined below.

Definitions

The definitions given below are relevant to these requirements:

development has the same meaning as in the *Environmental Planning and Assessment Act 1979*.

activity has the same meaning as in the *Environmental Planning and Assessment Act 1979*.

proposal is the development, activity or action proposed.

All other definitions are the same as those contained in the *Fisheries Management Act 1994*.

General requirements

Your attention is drawn to the publication "Guidelines for the Assessment of Aquatic Ecology in EIA" (Draft 1998) produced by the Department for Urban Affairs and Planning. Where relevant, the approaches, procedures and methodologies presented in this publication must be adopted when developing the SIS.

Previous surveys and assessments may be used to assist in addressing these requirements.

All references used in the SIS must be cited and listed in a bibliography.

Where plans or maps are presented, each plan or map must include:

- an appropriate legend
- orientation marks and a scale.

Matters which have been limited or modified

None.

Matters to be addressed

The SIS must meet all the matters specified in the recently (and unintentionally) repealed Sections 221J, 221K(1), 221K(2), 221K(4) and 221K(5) (Table E1.9) of the *Fisheries Management Act 1994*. In addition to the statutory requirements (see *Fisheries Management Act 1994*) the matters described below are required to be addressed.

<u>*Initial assessment*</u>

Consideration must be given to the population status of the grey nurse shark, habitat types used by the population and recent records of the distribution and abundance of the species.

Databases from sources such as NSW DPI, Australian Museum, Universities and consultants may be used to assist in compiling this information.

<u>*Relevant recovery and threat abatement plans*</u>

The assessment must address the relevant actions of the National Recovery Plan for the Grey Nurse Shark and the draft NSW recovery plan for the species.

<u>*Assessment of likely impacts*</u>

For the east cost population of the grey nurse shark, the SIS must detail:

- The extent and nature of the existing activity
- The extent and nature of the proposed activity

- Discuss the potential impact the proposed activity may have on the east coast population of the grey nurse shark, including an assessment of impacts at all known grey nurse shark aggregation sites in NSW waters (Table E1.10), and an assessment of the impact of activity in the fishery on the grey nurse shark population in areas outside known aggregation sites. This assessment must include consideration of the separate components (method types) within the Ocean Trap and Line Fishery.

Ameliorative measures

In discussing alternatives to the proposal, and the measures proposed to mitigate any effects of the activity, consideration must be given to developing long-term management strategies to mitigate impacts at known grey nurse shark aggregation sites and outside known aggregation sites.

Any proposed monitoring plans for the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.

Table E1.9 Section 221K: Content of species impact statement

(1) A species impact statement must include a full description of the action proposed, including its nature, extent, location, timing and layout and, to the fullest extent reasonably practicable, the information referred to in this section.

(2) A species impact statement must include the following information as to threatened species and populations:

(a) a general description of the threatened species or populations known or likely to be present in the area that is the subject of the action and in any area that is likely to be affected by the action,

(b) an assessment of which threatened species or populations known or likely to be present in the area are likely to be affected by the action,

(c) for each species or population likely to be affected, details of its local, regional and State-wide conservation status, the key threatening processes generally affecting it, its habitat requirements and any recovery plan or threat abatement plan applying to it,

(d) an estimate of the local and regional abundance of those species or populations,

(e) a full description of the type, location, size and condition of the habitat (including critical habitat) of those species and populations and details of the distribution and condition of similar habitats in the region,

(f) a full assessment of the likely effect of the action on those species and populations, including, if possible, the quantitative effect of local populations in the cumulative effect in the region,

(g) a description of any feasible alternatives to the action that are likely to be of lesser effect and the reasons justifying the carrying out of the action in the manner proposed, having regard to the biophysical, economic and social considerations and the principles of ecologically sustainable development,

(h) a full description and justification of the measures proposed to mitigate any adverse effect of the action on the species and populations, including a compilation (in a single section of the statement) of those measures,

(i) a list of any approvals that must be obtained under any other Act or law before the action may be lawfully carried out, including details of the conditions of any existing approvals that are relevant to the species or population.

(4) A species impact statement must include details of the qualifications and experience in threatened species conservation of the person preparing the statement and of any other person who has conducted research or investigations relied on in preparing the statement.

(5) The requirements of subsections (2) and (3 - not included above as not applicable) in relation to information concerning the State-wide conservation status of any species or population, or any ecological community, are taken to be satisfied by the information in that regard supplied to the principal author of the species impact statement by NSW DPI, which information NSW DPI is by this subsection authorised and required to provide.

Table E1.10 Known grey nurse shark aggregation sites in NSW

Aggregation site	**Location**
Julian Rocks	(Byron Bay)
North & South Solitary Island	(Coffs Harbour)
Fish Rock & Green Island	(South West Rocks)
Mermaid Reef	(Diamond Head)
The Pinnacle	(Forster)
Sawtooth Rocks	(South of Forster)
Big and Little Seal Rocks	(South of Forster)
Edith Breaker	(South of Forster)
Broughton Island	(Port Stephens)
Magic Point	(Maroubra)
Bass Point	(Shell Harbour)
Tollgate Islands	(Batemans Bay)
Montague Island	(Narooma)

E1.5.1.3 Report structure and compliance

This SIS has been prepared in accordance with the requirements of sections 221J (the form of SIS), 221K(1) (the content of a SIS), 221K(2), 221K(4) and 221K(5) of the *Fisheries Management Act 1994*. It includes background information of the origins for the report (E1.5.1), details the relevant legislative requirements (E1.5.2), and outlines the structure by which those requirements are met (this section).

In accordance with section 221J(1), this SIS is in writing.

In accordance with section 221J(2c), as this SIS was prepared for the purposes of the *Environmental Planning and Assessment Act 1979*, it is signed by the principal author, Dr Philip Gibbs, and by the proponent of the activity, the Director-General of NSW DPI.

This SIS is structured in accordance with section 221K, in that:

- E1.5.2 cross-references the draft FMS, which includes a full description of the action proposed - section 221K(1) and pursuant to D-G's requirements under 'Matters to be addressed'
- E1.5.3.1 cross-references the specific sections within the EIS that includes a general description of the threatened species or populations known or likely to be present in the area - section 221K(2a)
- E1.5.3.2 cross-references the specific sections within the EIS that includes an assessment of which threatened species or populations are likely to be affected by the action - section 221K(2b)
- E1.5.3.3 cross-references and summarises the specific sections within the EIS that includes details of the conservation status, key threatening processes, habitat requirements and any recovery plan applying to the affected species - section 221K(2c) and pursuant to D-G's requirements under 'Matters to be addressed'
- E1.5.3.4 describes the affected species or populations, including:
  - an estimate of the local and regional abundance - section 221K(2d)
  - the type, location, size and condition of the habitat (including critical habitat)...and details of the distribution and condition of similar habitats - section 221K(2e)
  - assessment of the likely effect of the action on those species and populations - section 221K(2f) and pursuant to D-G's requirements under 'Matters to be addressed'.
- E1.5.3.5 describes feasible alternatives to the proposal and a justification for the proposal having regard to the biophysical, economic and social considerations - section 221K(g) and pursuant to D-G's requirements under 'Matters to be addressed'.
- E1.5.3.6 describes and justifies the ameliorative measures proposed in the draft FMS to reduce the risk to those species or populations - section 221K(h) and pursuant to D-G's requirements under 'Matters to be addressed'.
- E1.5.3.7 lists any approvals that are applicable to the proposal
- E1.5.4 details the qualifications and experience of the principal author and researchers
- The "Submission Certificate" contains the details and signatures of the statement's principal author and sponsor.

As previously discussed, both the draft FMS and its associated environmental impact assessment are unique in many respects, not least of all in that the proposal entails the coastal waters of NSW out to 80 nm and the modification of an existing activity. As such, the proposal (the draft FMS) and the description of its potential species-specific impacts are considerably lengthy and in the latter case are located in numerous places throughout the EIS. For brevity, sections E1.5.2 and 1.5.3 will use cross-referencing to other sections of this EIS.

E1.5.2 The proposal

A full description of the proposal is provided in Chapter D, the draft FMS. In the field of ecological assessment, there are three types of the disturbance commonly identified, namely pulse, press and catastrophic. Of these, this proposal would most likely be classed as a press disturbance, which means that it is a sustained or chronic disturbance to the environment that may cause a long-term response (PlanningNSW 2002). A pulse disturbance is an acute short-term episode that may cause a temporary response in population, and a catastrophic disturbance is a major destruction of habitat from which populations are unlikely to recover in that area because the habitat has been removed or irreparably damaged in some way. There is likely to be a combination of these types of disturbances occurring at any one time owing to the operation of the fishery on a local and regional basis, but in terms of cumulative impact assessment, the fishery represents a press disturbance to the east coast population of grey nurse shark.

The difficulty in trying to determine what the response will be is complicated in that the proposal is neither unique in that other forms of fishing simultaneously affect the grey nurse shark, and fishing is not the sole contributor to the disturbance. Other activities also play a significant role, in particular beach meshing and to a lesser extent ecotourism (i.e. scuba diving with the sharks) activities. The potential response of the environment, in this case specifically grey nurse sharks, will be discussed in section E1.5.3.4.

E1.5.3 Threatened species potentially affected by the proposal

E1.5.3.1 Threatened species in the area of the proposal

Table B2.32 lists the 58 threatened species or populations known or likely to be present in the coastal waters of NSW in which the proposal operates. Appendix B2 provides a detailed synopsis for each of the species listed in Table B2.32, including an assessment of the potential impacts on those species attributable to the existing fishery (pre-proposal). Table B2.32 also summarises the risks of the existing fishery that were discussed in Appendix B2.

E1.5.3.2 Threatened species likely to be affected by the proposal

Section E1.4, in determining how effectively the proposal could mitigate the risks to threatened species, concluded that grey nurse shark are likely to be significantly affected by the proposal. Black cod and to a lesser extent great white sharks may also be affected by the draft FMS, but the eight part test indicated that the potential effects on those species are not as significant as they are for grey nurse shark. Furthermore, very little is known about black cod and much of the information reported for the species is based on other members of the Serranidae family and unconfirmed reports by recreational divers. Many of those reports indicate that black cod are often found in similar habitats to grey nurse shark, including probable spawning sites for black cod at Fish Rock and in the Solitary Islands Marine Park (although neither the grey nurse shark aggregation site nor potential black cod spawning site are within sanctuary zones of the SIMP). In the absence of information to the contrary, it is highly likely that any measures that are designed to protect grey nurse shark are also likely to provide additional protection for black cod.

E1.5.3.3 Conservation status and threatening processes of the affected species

Appendix B2 details the conservation status, threatening processes, habitat requirements and relevant recovery plans for grey nurse shark. In summary, grey nurse sharks are listed as an endangered species under the FM Act, as a critically endangered (east coast) population under the EPBC Act, and are protected in NSW, Queensland and Victoria. Relevant listed Key Threatening Processes include Hook and Line Fishing, Shark (beach) Meshing (FM Act), and Entanglement in

Harmful Marine Debris (EPBC Act). Other threatening processes include incidental capture by recreational and commercial fishing, illegal shark finning, ecotourism and the aquarium trade. The species is found in or near sandy-bottomed gutters or rocky caves around inshore islands or reefs between 15 and 40 m depth, although they have been recorded from 200 m. The extent of such habitat along the NSW coast has not been quantified, although it is likely to be considerable and may in part account for historically higher numbers of sharks than are thought to exist today. The 16 sites that are still often frequented by grey nurse sharks (and are thus known as key aggregation sites) are discussed in E1.5.3.4.

E1.5.3.4 Abundance estimates, habitats and impact assessment

Mark-recapture (re-sighting) estimate of the total population

In 2003, NSW Fisheries estimated the size of the total population and of the time to quasi-extinction (when the population reaches 50 or fewer females – Otway *et al*. 2004) of grey nurse sharks along the east coast of Australia by using a standard, Petersen mark-recapture (re-sighting) technique and has used this information to reassess previous estimates from 1999 and 2000. To provide an estimate of the total population size (and examine the sharks movements) NSW Fisheries tagged twenty-four sharks ranging in size from 1.00 m to 2.61 m. Tagging was done at four sites: Tollgate Islands (Batemans Bay); Little Broughton Island (Port Stephens), Fish Rock (South West Rocks); South Solitary Island (Coffs Harbour) in NSW and at one site in Queensland, Flat Rock (North Stradbroke Island). Of the 24 tagged sharks, 20 individuals (i.e. 83.3%) have been re-sighted on at least one occasion within 1 year of tagging.

Abundances of grey nurse sharks were quantified in a 2-week long mark-recapture survey in June 2003 using underwater visual counts of sharks over a 15 minute period at sites along the NSW and southern Queensland coastlines. At each site, divers recorded the number of sharks, their size and sex, if the shark was tagged or not, and if tagged they recorded the tag number. During the June 2003 survey, 44 sites (15 currently recognised scuba diving sites and 39 other sites where grey nurse sharks had been sighted in the past) were sampled. Of these 44 sites, 20 (45.5%) had no grey nurse sharks present. The mark-recapture survey results were compared with results of the two previous winter surveys in 1999 and 2000. This was done to examine whether the grey nurse shark population was behaving differently and hence might affect the mark-recapture estimate.

The proportion of grey nurse sharks present or absent did not differ significantly among the winter surveys in 1999, 2000 and 2003. The proportions of sites sampled with grey nurse sharks present or absent did not differ between the northern and southern coastal sections over the 3 winter surveys. Finally, the proportion of sites sampled with grey nurse sharks present or absent did not differ significantly among the 3 winter surveys within the northern and southern coastal sections. These results were entirely consistent with the previous winter diver surveys indicating that the grey nurse shark population was not behaving differently and thus the mark-recapture estimate was based on a similar, representative sample of the entire population.

A total of 313 grey nurse sharks was counted by divers and spearfishers in the coastal waters of southeast Australia in June 2003. The total number observed was greater than both of the previous winter surveys in 1999 and 2000 (i.e. 207 and 292, respectively). Of the sharks observed, 224 (71.6%) occurred in the northern coastal section compared to 89 (28.4%) in the southern coastal section (Otway *et al*. 2004). The mark-recapture estimates, using probability distribution-based formulae, showed that the total population of grey nurse sharks in the coastal waters of southeast Australia was between 410 and 461 individuals with upper 95% confidence values ranging between 541 and 766 individuals. The mark-recapture estimates also indicate that 74 - 89% (mean = 81.5%) of reproductively mature individuals and 68 - 79% (mean = 73.5%) of all individuals (i.e. irrespective of size or sexual maturity) were likely to have been observed during the scuba diving surveys.

Deterministic demographic analyses in the absence of a total population estimate

In the absence of an estimate of the total population, several demographic analyses were done to examine the likelihood of the extinction of the grey nurse shark in southeast Australian waters (Otway *et al*. 2004). Age and stage-based deterministic analyses were used to estimate the time required for grey nurse sharks to reach quasi-extinction. Being deterministic (i.e. no natural, random fluctuations were used in the calculations), the analyses did not account for stochastic fluctuations that can drive a species to extinction at a greater rate, nor did they include the potential reductions in fecundity, growth-rate or longevity resulting from inbreeding. Consequently, the results presented in Otway *et al*. (2004) provide a "best-case" scenario and the times to quasi-extinction are likely to be less in reality.

The analyses incorporated the data from the 10 underwater surveys and estimates of mortality of grey nurse sharks accidentally caught and killed by various fishing techniques. The demographic analysis started with a range of population estimates (i.e. 300, 1000 & 3000 individuals), a realistic natural mortality rate (derived from marine ecological journals) and average annual fishing mortality rates as documented by NSW Fisheries from confirmed reports received over a 2 year period.

The age of reproductive maturity of 6 years established in the USA (Branstetter & Musick 1994) was used in these analyses. Quasi-extinction (Q_t) was defined as the time (in years) taken for the grey shark population to decline to a point where it comprised 50 or fewer females. The mortality rates used were: (1) the mortality rate as reported by fishers (i.e. 1 shark/month of which 75% were female); and (2) a mortality rate twice that reported (i.e. 2 sharks/month) to account for likely under-reporting of fishing-related mortality: a problem that is common to fisheries worldwide.

The analyses showed that quasi-extinction would occur in 13 - 16 years, 84 - 98 years and 289 - 324 year with the reported rate of fishing mortality (i.e. 1 shark/month) for initial population sizes of 300, 1000 and 3000 individuals, respectively. If under-reporting of fishing-related mortality is occurring and the rate of fishing mortality is twice the documented rate, then the time to "quasi extinction" would be 6 - 8 years, 45 - 53 years and 173 - 200 years for population sizes of 300, 1000 and 3000 individuals, respectively. The demographic analyses showed that the rate of growth of the grey nurse shark population is most sensitive to changes in the mortality of juvenile females followed by mature females in the early part of their reproductive life.

Revision of quasi-extinction estimates using the mark-recapture (re-sighting) estimates

As a realistic mark-recapture (re-sighting) population estimate has now been obtained (see above and Otway & Burke 2004), the age-based demographic analyses that formed the basis of the paper by Otway *et al*. (2004) were repeated to recalculate the times to quasi-extinction for the east coast grey nurse shark population. The calculations were done using: (1) the recent, known estimates of mortality of female grey nurse sharks (i.e. 9 females in the 12 months from November 2003 to October 2004); (2) updated information concerning the age at sexual maturity of female grey nurse sharks from research in the USA (Goldman 2002, Cailliet & Goldman 2004) and the results of autopsies of female sharks killed in NSW waters (Otway 2004, Otway unpub. data); and (3) recent data on the hooking rates of grey nurse sharks (Otway *et al*. 2003, Otway 2004).

The results of the deterministic, age-based demographic analyses of Otway *et al*. (2004) and the revised calculations are summarised below (Table E1.11) and show that quasi-extinction is likely to occur in 10 to 15 years given: (1) an age of reproductive maturity of 9 years (Goldman 2002, Cailliet & Goldman 2004, Otway unpub. data); and (2) that the rates of fishing-related mortality have not changed over the past few years. Given that the rates of hooking have most likely been underestimated, it is most probable that the rates of fishing-related mortality would also have been underestimated (Otway 2004). If this is true, then the times to quasi-extinction would be less than the reported 10 - 15 years.

Table E1.11 Summary of the times to quasi-extinction for grey nurse shark

Estimated number of GNS in total population No. of females	**Age at reproductive maturity (years)**	**Time to quasi-extinction (years)**	
		All fishing-related mortality reported	**50% of fishing-related mortality reported**
Otway *et al*. (2004) **300** 150	6	13	6
1000 500	6	84	45
3000 1500	6	289	173
Otway & Burke (2004) **461** 230	9	15	10

Source: based on the age-based demographic analyses of Otway *et al*. (2004) and the mark-recapture (re-sighting) population estimate (Otway & Burke 2004) and updated demographic data.

The mark-recapture estimates using probability distribution-based formulae showed that the total population of grey nurse sharks in the coastal waters of southeast Australia is between 410 and 461 individuals with upper 95% confidence values ranging between 541 and 766 individuals.

The mark-recapture estimates suggest that 74 - 89% (mean = 81.5%) of reproductively mature individuals and 68 - 79% (mean = 73.5%) of all individuals (i.e. irrespective of size or sexual maturity) were observed during the previous scuba diving surveys in the coastal waters of southeast Australia.

It is therefore likely that there are about 500 grey nurse sharks in southeast Australian waters. Of these, almost 74% were seen during the scuba diver surveys. Finally, a total population estimate of 500 suggests that the time to quasi-extinction is most likely to be 10 - 20 years (assuming that the previously documented fishing related mortality of 12 grey nurse sharks per annum, which includes 9 females, is correct).

Impact assessment

To predict and measure the effects of a proposal, it is important to identify the nature of the disturbance and how the components of the environment (in this case grey nurse sharks) may respond (PlanningNSW 2002). In section E1.5.2, the disturbance was identified as a press disturbance, as the proposal will be sustained or ongoing. The response of the grey nurse shark population needs to be considered in terms of its inertia, resilience and stability. Inertia is the ability of a population to withstand change to environmental perturbation, resilience is the ability of a population to recover once it has responded to a disturbance, and stability is the rate of that recovery (PlanningNSW 2002). The continual decline in the grey nurse shark east coast population indicates that it has low inertia, resilience and stability, and this is primarily due to its slow growth rate, late maturity and low reproductive yield of only one or two offspring every two years.

Mindful that the proposal is not the only cause of the disturbance (especially past disturbance particularly by spearfishers), and that it is not currently possible to elucidate or measure the effects of the proposal separate from other causes, the remainder of this section will attempt to predict the effects of the proposal. It will do this by describing the habitat at each of the 16 key aggregation sites, and by assessing the potential impact of the fishery (as proposed in the draft FMS) on grey nurse sharks at those sites. A lack of fishery-specific data means that it is not possible to quantify the actual impact of the OTLF on local aggregations and thus the cumulative impact on the population, however estimates of all fishery-related impacts were discussed in the previous section in relation to times to quasi-extinction. Instead, a qualitative assessment of the risk posed to local aggregations will be presented, based on the fishing methods that are currently conducted at each site and considering any mitigative measures proposed in the draft FMS. Spanner crab netting has not been included in the assessments as spanner crabs are not known to be part of the grey nurse shark diet and there are no reports of grey nurse sharks being caught in spanner crab nets.

The studies described above indicate that there are at least 13 key aggregation sites along the coast (Table E1.12 and Figure E1.1), and more recent surveys suggest that there are likely to be another three sites where grey nurse sharks frequently aggregate (Figure E1.1). The proportion of the estimated population and the frequency of use of the 13 better known key aggregation sites are listed in Table E1.12. Further work is required to provide similar estimates for the other three key aggregation sites represented in Figure E1.1 (i.e. Mermaid Reef, Edith Breaker and Sawtooth Rocks).

Table E1.12 Mean number of grey nurse sharks observed in 13 of 16 key aggregation sites along the NSW coast as a percentage of the total sampled population over 10 surveys.

Site	Nearest town	Bioregion	Mean percentage of sampled grey nurse shark population	Aggregation consistency (% usage)
Julian Rocks	Byron Bay	Tweed-Moreton	2.7	30
Pimpernel Rock*	Brooms Head	Tweed-Moreton	4.6	75
North Solitary Island	Coffs Harbour	Tweed-Moreton	2.5	40
South Solitary Island	Coffs Harbour	Tweed-Moreton	4.4	80
Fish Rock & Green Is.	South West Rocks	Manning Shelf	12.7	80
Cod Grounds*	Laurieton	Manning Shelf	11.8	100
Pinnacle	Forster	Manning Shelf	12.7	100
Big & Little Seal Rocks	Seal Rocks	Manning Shelf	14.0	80
Broughton Is.	Nelson Bay	Manning Shelf	9.4	90
Magic Point	Maroubra	Hawkesbury Shelf	3.5	55
Bass Point	Shellharbour	Batemans Shelf	1.0	10
Tollgate Island	Batemans Bay	Batemans Shelf	8.9	90
Montague Is.	Narooma	Batemans Shelf	1.3	20
TOTAL			89.5	

Source: Otway *et al*. 2003.* denotes Commonwealth waters. Note: 3 additional aggregation sites have been identified in NSW waters since the completion of the survey program (see Figure E1.1)

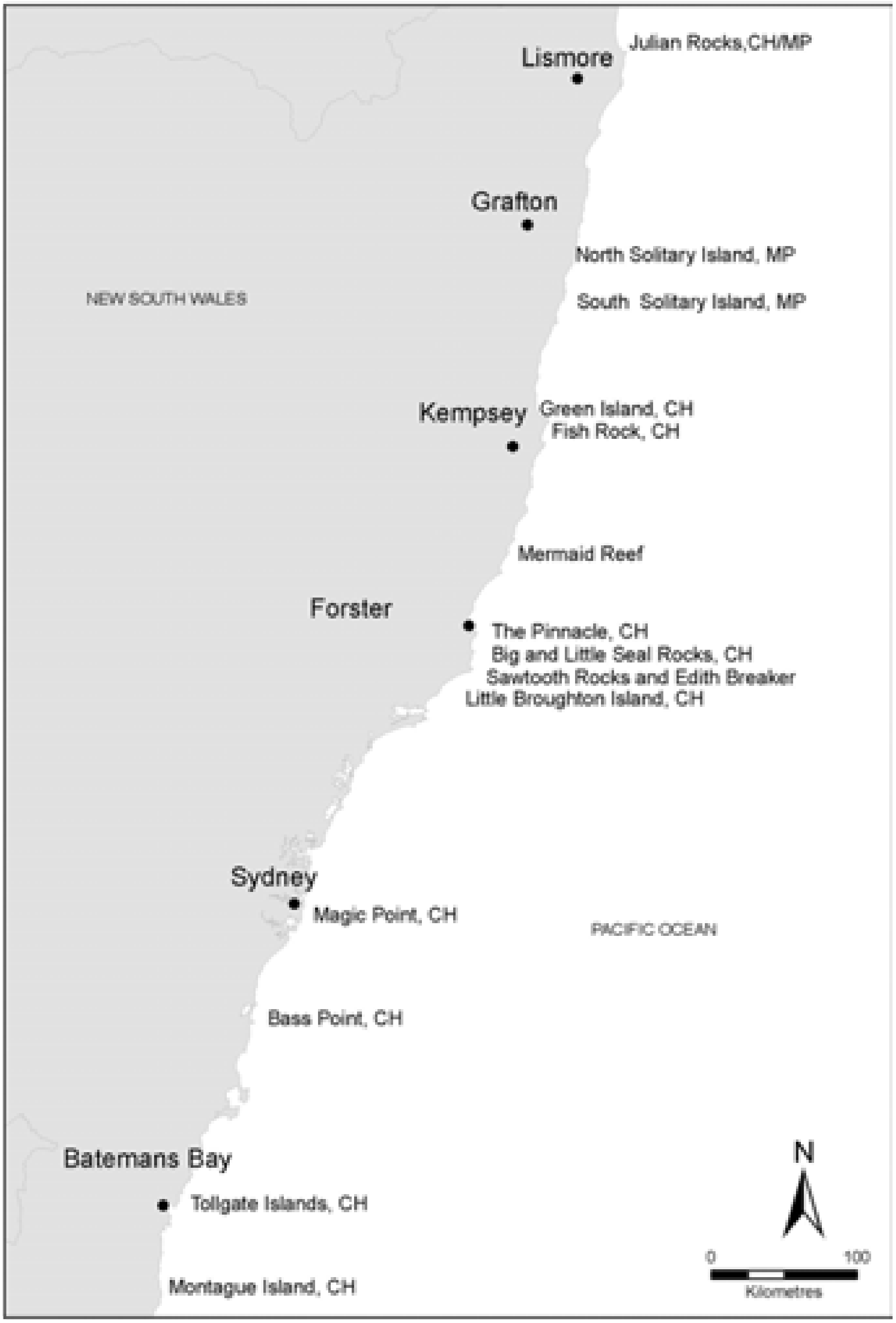

Figure E1.1 All known key aggregation sites for grey nurse shark in New South Wales waters.

Note: sites with CH and MP denote Critical Habitats and/or location within Marine Parks, respectively.

Julian Rocks – Byron Bay

Site description

Juan and Julian Rocks, collectively known as Julian Rocks, are located approximately 3 km north of Byron Bay. Grey nurse sharks are commonly sighted at four main sites at Byron Bay, with Julian Rocks providing the majority of sightings.

Approximately 2.7% of the total numbers of grey nurse sharks sampled have been observed at Julian Rocks. These aggregations consistently occur over the winter months, with aggregations of the sharks recorded during 30% of the surveys conducted between 1998-2001 (Otway & Parker, 2000, Otway *et al.* 2003). Although this site has been identified as being important to male grey nurse sharks (8.5% of the sampled male population have been sighted at this location), pupping has also been witnessed here, suggesting it is an important site for both sexes.

Julian Rocks was declared an aquatic reserve in 1982 and covered an area of about 80 hectares within a 500 m radius from a trig station located on the largest of the rocks (Juan). No commercial fishing or spearfishing was permitted within the aquatic reserve, although recreational line fishing was permitted. Julian Rocks was included in the Cape Byron Marine Park that was declared in 2004. The final zoning plan for the park was released in November 2005 and has seen the creation of 6,105 hectares of sanctuary zones in which all forms of fishing are prohibited and includes the waters surrounding Julian Rocks (the final zoning plan is anticipated to commence in April 2006). Fishing is also prohibited from 1 May to 31 December in area from 700 -1500 m north of Julian Rocks.

Importance of site to grey nurse sharks: Medium - Seasonal

Seasonality: Yes (May - December)

Current Protection:

- Grey Nurse Shark Critical Habitat Site
- Julian Rocks was an Aquatic Reserve from 1982 until its inclusion into the Cape Byron Marine Park in 2004

Fishing Activities

There was no commercial fishing permitted within the Julian Rocks Aquatic Reserve, and the final zoning plan for Cape Byron Marine Park, which is anticipated to commence in April 2006, has prohibited all forms of fishing in an area of 6,105 hectares between Lennox Head and Brunswick Heads.

Assessment of likely effect of draft FMS at Julian Rocks:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within this critical habitat site as commercial fishing has been prohibited within 500 m of Juan Rocks since 1982. The creation of the Cape Byron Marine Park has also resulted in the prohibition of setlining from within the park and the use of wire trace whilst anchored from within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging outside the sanctuary zones of the park. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation sites is considered to be a significant threat to the species.

Anemone Bay/The Steps – North Solitary Island

Site description

North Solitary Island is located in the northern section of the NSW Solitary Islands Marine Park. Grey nurse sharks have been encountered at several sites in this section of the Park. The Bay of Anemones is located on the north eastern tip of the Island and is characterised by a 30m deep gutter where the sharks are most frequently sighted. Relatively large aggregations of sharks have been recorded during 40% of the coastwide surveys, mainly over winter and spring (Otway & Parker 2000, Otway *et al.* 2003).

Approximately 2.5% of the total sampled population of grey nurse sharks have been observed at North Solitary Island. The majority of these sharks have been males, with an average of 4.2% of the sampled male population observed at this site (Otway & Parker 2000, Otway *et al.* 2003).

Under the current zoning plan for the park a Sanctuary Zone exists on the western side of the island that extends across Anemone Bay to the north-eastern tip of the island. No commercial or recreational fishing is permitted in this zone. The gutter primarily used by grey nurse sharks, however, is located just outside the sanctuary zone and the gutters lead east away from the sanctuary zone, limiting the potential effectiveness of the sanctuary zone (see map below).

Importance of site to grey nurse sharks: Medium

Seasonality: May to December

Current Protection:

- No setlining/droplining throughout the marine park
- The use of wire traces for bottom fishing is prohibited within 500 m of North Solitary Island. Wire trace is permitted whilst trolling while the vessel is underway.
- The use of fish traps is prohibited within 500 m of the island

Fishing Activities

Fish Trap:

Fish trapping is prohibited within 500 m of North Solitary Island. Fish trapping in the vicinity of North Solitary Island is considered to be minimal however there is some fish trapping in the marine park for species such as snapper and pearl perch. The impact of fish trapping on food species for grey nurse shark is not known however given the prohibition on fish traps within 500 m of the island the impact is considered to be minimal.

Assessment: Low Risk

Setlines/trotlines:

The use of setlines/trotlines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Driftline:

The use of driftlines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Handline:

Commercial handlining for kingfish, jewfish, snapper and teraglin is known to occur in the vicinity of the critical habitat site. Sharks at this site are often observed with hooks and lines trailing from their mouths and the hooking rate has been estimated as high as 30% (C. Bansemer pers. comm.).

Assessment: High Risk

Dropline:

The use of droplines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Trolling:

There is a considerable amount of trolling around the north eastern part of North Solitary Island as fishers target pelagic species including mackerel, kingfish and tuna. Many of the species that are caught whilst trolling are considered to form part of the grey nurse sharks diet and the grey nurse shark is known to utilise the upper part of the water column for travelling and feeding. There is also some risk that grey nurse sharks will target fish that are caught trolling and become incidentally hooked. Leadlining for kingfish is a popular commercial fishing activity at North Solitary Island when the kingfish are in season however this activity is considered to pose a low risk threat, as there have been no reports of grey nurse sharks being hooked on leadlines.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. It is not known how much fishing activity is conducted by jigging in the vicinity of the grey nurse shark aggregation site and in the absence of this information, this fishing activity is considered to be a risk to the grey nurse shark.

Assessment: Medium risk

Poling:

Pole fishing is not known to occur within the vicinity of North Solitary Island. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at North Solitary Island:

The draft FMS recommends modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within this critical habitat site as setlining is already prohibited within the park and wire trace is prohibited on bottom-set lines within 500 m of North Solitary Island. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation sites is considered to be a significant threat to the species.

Manta Arch – South Solitary Island

Site description

South Solitary Island is located in the southern section of the Solitary Islands Marine Park. Grey nurse shark have been seen at three main sites around the island: the 'Manta Arch', the 'Shark Gutters' and 'Buchannans Wall'. The Manta Arch and Shark Gutters are located at the northern tip of the Island. These sites provide a series of 18-25m deep gutters and a range of overhangs where sharks can be commonly encountered throughout the winter, spring and early summer months (Otway & Parker, 2000).

Aggregations have been consistently observed at these sites, with 80% of the surveys conducted between 1998 & 2001 recording relatively large numbers of sharks here. (Otway *et al.* 2003). Approximately 4.4% of the total sampled population of grey nurse sharks have been observed at South Solitary Island, the majority of which are male (7.6% of the sampled male population) (Otway and Parker, 2000, Otway *et al.* 2003).

Under the current zoning plan for the park a Sanctuary Zone exists on the western and northern sides of the island to 200m seaward from mean low water mark. No commercial or recreational fishing is permitted within this zone. However the grey nurse shark aggregation site (Manta Arch) is located outside the sanctuary zone and the gutter extends south east away from the sanctuary zone.

A tracking study conducted by the CSIRO in mid 2004 found that grey nurse sharks utilise an extensive area south of Manta Arch, this area is outside the sanctuary zone (B. Bruce, CSIRO, pers. comm.).

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- No setlining/droplining throughout the marine park
- The use of wire traces for bottom fishing is prohibited within 500 m of South Solitary Island. Wire trace is permitted whilst trolling while the vessel is underway.
- The use of fish traps is prohibited within 500 m of the island

Fishing Activities

Fish Trap:

Fish trapping is prohibited within 500 m of South Solitary Island. Fish trapping in the vicinity of South Solitary Island is considered to be minimal however there is some fish trapping in the Marine Park for species such as Snapper and Pearl Perch. The impact of fish trapping on food species for grey nurse shark is not known however given the prohibition on fish traps within 500 m of the island the impact is considered to be minimal.

Assessment: Low Risk

Setlines/trotlines:

The use of setlines/trotlines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Driftline:

The use of driftlines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Handline:

Commercial handlining for commercial fish species including kingfish, jewfish, snapper and teraglin is known to occur in the vicinity of the critical habitat site. The north-eastern region of South Solitary Island is very popular for commercial handline fishing and this is a significant threat to the sharks residing in the Manta Arch region. Many of the sharks at this site are offered observed with hooks and lines trailing from their mouths and observed hooking rates in 2003 were estimated as high as 40% (D. Harasti pers. comm.). However it is unknown if the hooks were from commercial or recreational fishing gear.

Assessment: High Risk

Dropline:

The use of droplines is prohibited within the Solitary Islands Marine Park.

Assessment: No risk

Trolling:

There is considerable amount of trolling around the north eastern region of South Solitary Island as fishers target pelagic species including mackerel, kingfish and tuna. Lead lining for species such as Kingfish and Bonito is also a common form of fishing around the northern part of South Solitary Island. Leadlining is considered to be a low risk activity as there have been no reports of grey nurse sharks being hooked with this fishing method. Many of the species that are caught whilst trolling are considered to form part of the grey nurse sharks diet and the grey nurse shark is known to utilise the upper part of the water column for travelling and feeding so there is some risk that grey nurse sharks could become hooked. There is also some additional risk that grey nurse sharks will target fish that are caught trolling and become incidentally hooked.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The extent of jigging fishing activity in the vicinity of the South Solitary grey nurse shark aggregation site is unknown, however this fishing activity is considered to be a risk to the grey nurse shark.

Assessment: Medium risk

Poling:

Pole fishing is not known to occur within the vicinity of South Solitary Island. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at South Solitary Island:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);

- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within this critical habitat site as setlining is already prohibited within the park and wire trace is prohibited on bottom-set lines within 500 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation sites is considered to be a significant threat to the species.

Fish Rock and Green Island – South West Rocks

Site description

Fish Rock and Green Island are located on the NSW mid north coast and both sites are very popular with divers, recreational and commercial fishers and spearfishers. South West Rocks is a well known area for diving with grey nurse sharks during winter and spring. There is considerable evidence that this site is not only a major grey nurse shark aggregation site, but also a significant site for interaction between the sharks and fishers. Hooking rates of over 50% have been observed at this site (NSW DPI unpublished data).

Green Island is a relatively shallow site at a depth of 15m, with a gutter on the eastern side. Large numbers of grey nurse sharks have been sighted in this gutter. Approximately 1.6% of the total sampled population of grey nurse sharks have been observed in this site, the majority of which were males. While this site is believed to be of secondary importance to Fish Rock, migration between the two sites has been observed (Otway and Burke 2004).

Grey nurse sharks frequent three sites around Fish Rock: the ‘Gutters’, Colorado Pass and the ‘Pinnacle’. The Pinnacle is located on the north eastern side of the island and is comprised of a pinnacle of rock and a series of gutters with sandy bottoms. The sharks are frequently sighted swimming through the 25m deep gutters around the pinnacle. Colorado pass runs along the eastern side of the rock and gets down to depths of 30 m. The Gutters is located on the southern end of the island. It comprises a series of gutters running east-west at a depth of 18m (Otway & Parker, 2000). However, divers can encounter grey nurse sharks at various other locations around the rock, they are not just confined to the three sites mentioned above.

Alongside the Cod Grounds, the Pinnacle at Forster and Seal Rocks, Fish Rock & Green Island are one of the most important sites on the east coast for consistently large aggregations of grey nurse sharks, with approximately 13% of the total sampled population observed in the area. Fish Rock is highly significant for male grey nurse sharks, with 17% of the sampled male population observed at this site, making it the largest aggregation site for males in the state. Sharks witnessed in this area routinely suffering signs of interaction with commercial and recreational fishing, such as imbedded hooks and scars.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- Both sites are listed as grey nurse shark critical habitat
- Spearfishing is restricted at Fish Rock to a species list of mainly pelagic species.

Fishing Activities

Fish Trap:

It is considered that there is very minimal fish trapping activity in the vicinity of Fish Rock and Green Island. Most fish trapping activities occur in deeper water sites that are further offshore.

Assessment: Low Risk

Setlines/trotlines:

The use of setlines/trotlines is prohibited within 1000 m of the critical habitat site. However setline fishing is known to occur in the South West Rocks region and sharks that move out from the critical habitat sites whilst feeding and moving between the sites will be at risk from incidental hooking. It is known that grey nurse sharks move between Fish Rock and Black Rock and there are no restrictions on commercial setlines at this site. Setlines are considered to be a major threat to the species and this form of fishing is believed to have had a significant impact on the east coast population of grey nurse sharks.

Assessment: High risk

Driftline:

The use of driftlines is prohibited within 1000 m of both critical habitat sites. The extent of drift line fishing in the vicinity of Fish Rock and Green Island is unknown. The use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handlining for commercial fish species including kingfish, jewfish, snapper and teraglin is known to occur in the vicinity of the critical habitat site. This form of fishing is considered to be a significant threat to grey nurse sharks as they are susceptible to baited hooks. The species that commercial handliners target are generally found in the same habitat areas as grey nurse sharks. There have been many reports of grey nurse sharks being caught incidentally on handlines and these sharks are often left with hooks in the jaw or in the oesophagus or stomach. These hooks can impact on the grey nurse shark by preventing its ability to feed or cause death through peritonitis and septicaemia.

Additionally, the species that are targeted by commercial handlining are known to be a significant component of the grey nurse shark diet, particularly jewfish and teraglin. The removal of these species from critical habitat areas could be having a detrimental impact on the food resources of the grey nurse shark.

Assessment: High Risk

Dropline:

The use of droplines is prohibited within 1000 m of the critical habitat sites. The extent of dropline fishing activity in the vicinity of both critical habitat sites is unknown. If dropline fishing does occur within 1.5 km of either critical habitat site this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod.

Assessment: Low risk

Trolling:

There is considerable amount of trolling around Fish Rock as commercial fishers target pelagic species including mackerel, kingfish and tuna. Many of the species that are caught whilst trolling are considered to form part of the grey nurse sharks diet and the grey nurse shark is known to utilise the upper part of the water column for travelling and feeding. There is also the additional risk that grey nurse sharks will target fish that are caught trolling and become incidentally hooked. Leadlining for kingfish is a very important commercial fishing method at Fish Rock and is considered to be a low risk activity as there have been no reports of grey nurse sharks being hooked with this fishing method.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The extent of jigging fishing activity in the vicinity of the Green Island and Fish Rock critical habitat sites is unknown however this fishing activity is considered to be a risk to the grey nurse shark.

Assessment: Medium risk

Poling:

Pole fishing is not known to occur within the vicinity of Fish Rock or Green Island. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Fish Rock and Green Island:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within the Green Island and Fish Rock critical habitat areas as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation sites is considered to be a significant threat to the species.

Mermaid Reef – Crowdy Head

Site description

Mermaid Reef is a large area of reef that is located just south of Diamond Head, which is south of Laurieton. There are two small bomboras that can be found on the reef that are exposed during low tide or large swell. Sandy gutters run out from these bomboras into water depths of 30 m and it is in these gutters that grey nurse sharks have been recorded. At this site grey nurse sharks can be found in the shallows (less than 10 m) around the most eastern bombora. It is generally the small juveniles found in the shallow water whilst the larger mature animals are found in the deeper sandy gutters.

Importance of site to grey nurse sharks: High. Up to 70 grey nurse sharks have been recorded at this site at one time (September 2003).

Seasonality: Year round. The largest aggregations of grey nurse sharks have been observed from August to November.

Current Protection:

- None.

Fishing Activities

Fish Trap:

Fish trapping is known to occur in the region however the extent of fish trapping on Mermaid Reef is unknown. It is known if commercial fishers set traps on the reefs where grey nurse sharks are known to reside. Species that are caught with fish traps on Mermaid Reef include drummer, goatfish, leatherjackets, morwongs, snapper, surgeonfish, sweep, tarwhine and trevally. The impact of fish trapping on food species for grey nurse shark is not known however given that large numbers of grey nurse sharks aggregate at Mermaid Reef the removal of their food source could have a detrimental impact on the population at this site.

Assessment: Medium risk.

Setlines/trotlines:

There are currently no restrictions on setline fishing within the vicinity of Mermaid Reef. Setline fishing is known to have a major impact on grey nurse sharks as sharks are often caught on setlines. It is believed that there is considerable under-reporting of grey nurse shark captures by commercial fishers using setlines. Any setline fishing within the vicinity of Mermaid Reef poses a serious threat to the grey nurse shark.

Assessment: High risk

Driftline:

The extent of drift line fishing in the vicinity of Mermaid Reef is unknown. The use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Handline fishers are known to target high value commercial species on and in the vicinity of Mermaid Reef. Species that are targeted include teraglin, snapper, jewfish and kingfish and these species are predominantly caught on baited lines, particularly using live baits. Grey nurse sharks are highly susceptible to being caught by fishing methods that use bait (dead or live). Anecdotal reports from commercial handline fishers in the Crowdy Head region is that they have caught up to 16 grey nurse sharks in the region in a single nights fishing. Handline fishing with bait in the vicinity of grey nurse sharks is considered to be a serious threat to the survival of the species.

Assessment: High risk

Dropline:

The extent of dropline fishing activity in the vicinity of Mermaid Reef is unknown. If dropline fishing does occur within 1.5 km of the reef then this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally occur deepwater offshore where fishers target species such as hapuku and bar cod.

Assessment: Low risk

Trolling:

Trolling is known to occur around Mermaid Reef as commercial fishers target species such as kingfish. The kingfish is known to form part of the grey nurse sharks diet and the removal of this species from a critical habitat site could be impacting on the food resources of the grey nurse shark. Grey nurse sharks have been observed chasing and feeding on kingfish within several critical habitat sites including Fish Rock and the Pinnacle at Forster. There is the risk that grey nurse sharks will target species such as kingfish and bonito that are caught trolling and become incidentally hooked causing injury and perhaps death.

Assessment: Low risk

Jigging:

Reports of hooking grey nurse sharks while jigging are rare, however commercial fishers from the south coast of New South Wales have reported hooking a small number of grey nurse sharks while jigging. The extent of jigging activity in the vicinity of Mermaid Reef is considered to be minimal however this fishing activity is considered to pose some risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of Mermaid Reef. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Mermaid Reef:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

Mermaid Reef currently has no protection as it is not listed as critical habitat. The limits on the number of traps and hooks proposed in the draft FMS, while potentially effective at capping overall effort levels, are not site specific and do not provide targeted protection for grey nurse sharks at this key aggregation site. The proposal to prohibit the use of wire traces on setlines will assist in allowing any sharks that take a baited hook to break away from the mainline, however, in most cases the shark would swim away with the hook and branch line still attached. The impact reduction due to the mandatory use of circle hooks on setlines is likely to be restricted as circle hooks are already widely used throughout the fishery. Further, sharks will still remain susceptible to being incidentally caught by methods of setlining, handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of the grey nurse shark aggregation site at Mermaid Reef is considered to be a significant threat to the species.

The Pinnacle – Forster

Site description

The Pinnacle is a pinnacle of rocks that rises approximately 24m above the sea bed in 46m of water, at the GPS coordinate of 152°36’00”E, 32°13’40”S. Grey nurse sharks have been sighted at various locations around this large area. The site has a few large gutters where grey nurse sharks (in large groups or individuals) are frequently seen hovering and swimming amongst the boulders (Otway & Parker, 2000). The use of this area by the sharks is extremely consistent, with aggregations recorded here during all (100%) of the surveys conducted between 1998 and 2001 (Otway *et al.* 2003).

Approximately 12.7% of the total sampled population of grey nurse sharks have been observed around the Pinnacles, suggesting that this site is consistently important as the largest aggregation site in the state. It is of high significance to both male and female grey nurse sharks with a large proportion of both sexes observed in this area (13.4% of the sampled male population and 11.3% of the sampled female population) (Otway *et al.* 2003). This may indicate the site is a possible location for mating activity.

Importance of site to grey nurse sharks: High

Seasonality: Year round.

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

Fishing utilising fish traps is not known to occur within 500 m of the Forster Pinnacle. Fish trapping is known to occur on some deepwater reefs that are located approximately over 700 m from the Pinnacle critical habitat site between the Pinnacle and Cape Hawke. Although fish trapping can reduce the food resources available for the grey nurse shark it is unlikely that fishing trapping in the region is having an impact on the grey nurse shark. The majority of the sharks found at the Forster Pinnacle are large mature animals that are known to feed on species such as kingfish and jewfish; fish traps target neither of these species.

Assessment: Low risk

Setlines/trotlines:

The use of setlines/trotlines is prohibited within 1000 m of the critical habitat site. However setline fishing is known to occur in the Forster region (Cape Hawke, Black Head) and sharks that move 1000 m out from the Pinnacle aggregation site whilst feeding and migrating between other aggregation sites in the area (Latitude Rock, Seal Rocks region) will be at risk from incidental hooking. It is known that grey nurse sharks move between the Forster Pinnacle and Latitude Rock and there are no restrictions on commercial setlines at this site. Setlines are considered to be a major threat to the species and this form of fishing is believed to have had a significant impact on the east coast population of grey nurse sharks. Setline fishing in the Forster region is considered to be a significant threat to the survival of the grey nurse sharks.

Assessment: High risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Pinnacle critical habitat site. The extent of drift line fishing in the vicinity of the Forster Pinnacle is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

In the past commercial handlining for species such as kingfish, jewfish, snapper and teraglin was a major component of fishing activity at the Forster Pinnacle. Since the introduction of the grey nurse shark critical habitat regulations in December 2002 this form of fishing has probably reduced as the use of handlines with baited hooks is prohibited from anchored vessels. It is very difficult to fish the Pinnacle without being anchored as the current and swell move fishing boats off the reef. Although fishing from anchored vessels with bait is prohibited in the critical habitat site there are concerns that this activity is being undertaken at night when it is difficult to enforce compliance. There are also several other sites in the Forster region that grey nurse sharks are known to aggregate (Cape Hawke, Latitude Reef, the Barge) and grey nurse sharks that move from the Pinnacle into these sites are at risk from being incidentally caught by commercial handline fishing.

Assessment: High risk

Dropline:

The extent of dropline fishing activity in the vicinity of the Forster Pinnacle critical habitat site is not known. Dropline fishing is also prohibited within 1000 m of the critical habitat site. If dropline fishing does occur near the Pinnacle then this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. This form of fishing is not considered to be a significant threat to grey nurse sharks.

Assessment: Low risk

Trolling:

Some trolling is known to occur around the Forster Pinnacle as commercial fishers target species such as kingfish. The kingfish is known to form part of the grey nurse sharks diet and the removal of this species from a critical habitat site could be impacting on the food resources of the grey nurse shark. There is the risk that grey nurse sharks will target kingfish that are caught trolling and become incidentally hooked causing injury and perhaps death.

Assessment: Low risk

Jigging:

The Forster Pinnacle critical habitat site is a major site for commercial jigging, particularly for bonito and also for trevally when in season. Commercial fishers anchor their vessels on the Pinnacle and then use artificial jigs to capture bonito. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. Commercial fishers from the south coast of New South Wales have reported a small number of grey nurse sharks being caught whilst jigging. It is likely that this fishing activity poses some risk to the grey nurse shark as it is conducted directly on top of the critical habitat site and sharks may be incidentally caught.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Pinnacle. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at the Pinnacle:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within the Pinnacle critical habitat as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of the grey nurse shark aggregation site at the Forster Pinnacle is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Manning Shelf Marine Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at the Pinnacle is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Big and Little Seal Rock – Seal Rocks

Site description

Big Seal and Little Seal are two islands offshore from Sugarloaf Point at Seal Rocks. Big Seal is the most renowned area for aggregating grey nurse sharks. It is a barren rocky outcrop that has extensive surrounding reefs. Several decades ago the species occupied this site in large aggregations and sharks were observed throughout the year. The main site is a large overhang on the north west corner where a number of sharks can be seen milling around, hovering under the overhang or swimming along a nearby gutter at a depth of 20 m (Otway & Parker, 2000). Sharks can generally be found all around the rock, particularly from December through to May.

Little Seal Rock is a barren rock outcrop with extensive surrounding reef, offshore from Sugarloaf Point at Seal Rocks (Otway & Parker, 2000). It is known that grey nurse sharks regularly migrate between these two sites, and other sites in the Seal Rocks area including Sawtooth Rocks, Edith Breaker and White Top Rock.

The proportion of grey nurse sharks, which periodically inhabit Big and Little Seal Rock, is 14% of the total sampled population, making it the largest and one of the most consistent sites for aggregation in the state (Otway *et al.* 2003). Historically, Big Seal has been known to be significant for the species, with a number of habitat types known to be preferred by the species existing within this area, including overhangs and deep sandy bottomed gutters.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

Fish trapping is not known to be a major fishing method in the Big and Little Seal Rocks critical habitat site. Fish trapping may occasionally occur for species such as snapper and morwong however it is not considered to be a common fishing method around Seal Rocks. The impact on the grey nurse shark and their food resources is considered to be minor.

Assessment: Low risk

Setlines/trotlines:

Seal Rocks is a very popular region for commercial fishers using setlines, predominantly to catch species such as wobbegong sharks and snapper. It is known that grey nurse sharks have previously been hooked in this region by setlines and the Seal Rocks region is probably the most important grey nurse shark critical habitat site on the east coast of Australia.

Assessment: High risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Seal Rocks critical habitat site. The extent of drift line fishing in the vicinity of the Big and Little Seal Rock is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handlining for commercial fish species including kingfish, jewfish, snapper and teraglin is known to occur in the vicinity of Big and Little Seal Rocks. This form of fishing is considered to be a significant threat to grey nurse sharks as they are susceptible to being caught with baited hooks. The species that commercial handliners target (see above) are generally found in the same habitat areas as grey nurse sharks. There have been many reports of grey nurse sharks being caught incidentally on handlines and these sharks are often left with hooks in the jaw or in the oesophagus or stomach. These hooks can impact on the grey nurse shark by preventing its ability to feed or cause death through peritonitis and septicaemia.

Additionally, the species that are targeted by commercial handlining are known to be a significant component of the grey nurse shark diet, particularly jewfish and teraglin. The removal of these species from critical habitat areas could be having a detrimental impact on the food resources of the grey nurse shark. The use of handline fishing with baited hooks in the Seal Rocks region is considered to be a significant threat to grey nurse sharks.

Assessment: High Risk

Dropline:

The use of droplines is prohibited within 1000 m of the Seal Rocks critical habitat site. The extent of dropline fishing activity in the vicinity of Big and Little Seal Rock is unknown. If dropline fishing occurs within 1.5 km (which is the known foraging range of grey nurse sharks) at either critical habitat site this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. It is not considered to be a significant threat in the Seal Rocks critical habitat site.

Assessment: Low risk

Trolling:

Trolling is known to occur around Seal Rocks as commercial fishers target species such as kingfish, however trolling is seasonal (generally over the summer months when the water is warmer and large kingfish move into the region. The kingfish is known to form part of the grey nurse sharks diet and the removal of this species from a critical habitat site could be impacting on the food resources of the grey nurse shark. Grey nurse sharks have been observed chasing and feeding on kingfish within several critical habitat sites including Fish Rock and the Pinnacle at Forster. There is the risk that grey nurse sharks will target kingfish that are caught trolling and become incidentally hooked causing injury and perhaps death.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. The extent of jigging fishing activity in the Seal Rocks critical habitat site is considered to be low, however this fishing activity is considered to be a risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Seal Rocks critical habitat site. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Big and Little Seal Rocks:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery on grey nurse sharks in Seal Rocks critical habitat site and vicinity as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the sites. Sharks will still remain susceptible to being incidentally caught in the critical habitat site by methods of handlining, trolling and jigging and when they move about the Seal Rocks region are highly susceptible to setlines. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of the grey nurse shark aggregation site at Seal Rocks is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Manning Shelf Marine Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at Seal Rocks is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Sawtooth Rocks – Seal Rocks

Site description

Sawtooth Rocks is located on the eastern edge of Sugarloaf Point at Seal Rocks. There are a series of rocks that run out to sea with several gutters running between the rocks. Grey nurse sharks can be found aggregating around these gutters, particularly on the south-eastern corner where there is a small cave. Juvenile grey nurse sharks can be predominantly seen at this site and the largest numbers are known to occur from January through to May.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- None

Fishing Activities

Fish Trap:

Fish trapping is not known to be a major fishing method within the vicinity of the Sawtooth rocks aggregation site. Fish trapping may occasionally occur for species such as snapper and morwong however it is not considered to be a common fishing method around Sawtooth Rocks. The impact on the grey nurse shark and their food resources is considered to be minor.

Assessment: Low risk

Setlines/trotlines:

Commercial fishers fishing in the Seal Rocks region are known to use setlines to predominantly catch species such as the wobbegong shark and snapper. It is known that grey nurse sharks have previously been hooked in this area by setlines and the Seal Rocks region is probably the most important grey nurse shark critical habitat site on the east coast of Australia. The extent of setline fishing around Sawtooth rocks is not known however it is considered to be high.

Assessment: High risk

Driftline:

The extent of drift line fishing in the vicinity of Sawtooth Rocks is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, jewfish and snapper is known to occur in the waters around Seal Rocks and within the vicinity of Sawtooth Rocks. The actual extent of commercial handline fishing within 1000 m of Sawtooth Rocks is unknown however this form of fishing is considered to be a significant threat to grey nurse sharks and is likely to result in incidental capture of the species. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked.

Assessment: Medium risk

Dropline:

The extent of dropline fishing activity in the vicinity of Sawtooth Rocks is unknown. If dropline fishing occurs within 1.5 km (which is the known foraging range of grey nurse sharks) of Sawtooth Rocks then this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. It is not considered to be a significant threat to sharks aggregating around Sawtooth Rocks.

Assessment: Low risk

Trolling:

Commercial trolling is considered to be a minor fishing method in the waters around Sawtooth Rocks. As the trolling effort is minimal it is unlikely that this form of fishing will significantly impact on the grey nurse shark to sharks aggregating around Sawtooth Rocks.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. The extent of jigging fishing activity within close proximity of Sawtooth Rocks (within 1000 m) is considered to be minimal.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Sawtooth Rocks. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Sawtooth Rocks:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed..

Sawtooth Rocks currently has no protection as it is not listed as critical habitat. The limits on the number of traps and hooks proposed in the draft FMS, while potentially effective at capping overall effort levels, are not site specific and do not provide targeted protection for grey nurse sharks at this key aggregation site. The proposal to prohibit the use of wire traces on setlines will assist in allowing any sharks that take a baited hook to break away from the mainline, however, in most cases the shark would swim away with the hook and branch line still attached. The impact reduction due to the mandatory use of circle hooks on setlines is likely to be restricted as circle hooks are already widely used throughout the fishery. Sharks will still remain susceptible to being incidentally caught by methods of setlining and handlining and these two fishing methods pose the greatest risk to the grey nurse shark. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of the grey nurse shark aggregation site at Sawtooth Rocks is considered to be a significant threat to the species.

Edith Breaker – Seal Rocks

Site description

Edith Breaker is located several kilometres south of Sugarloaf Point at Seal Rocks. The top of the reef is quite shallow and the rocky reef drops down to depths of at least 40 m. Grey nurse sharks can be found aggregating at various locations on the reef and it is believed the same sharks move back and forth to Big and Little Seals Rocks as well as Sawtooth Rocks and possibly Broughton Island.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- None

Fishing Activities

Fish Trap:

Fish trapping is known to occur on the reefs of the Edith Breaker aggregation site and trapping is primarily for species such as snapper and morwong. The impact on the grey nurse shark and their food resources is considered to be minor.

Assessment: Low risk

Setlines/trotlines:

Commercial fishers fishing in the Seal Rocks region are known to use setlines to predominantly catch species such as the wobbegong shark and snapper. It is known that grey nurse sharks have previously been hooked in this area by setlines and the Seal Rocks region is probably the most important grey nurse shark critical habitat site on the east coast of Australia. The extent of setline fishing around Edith Breaker rocks is not known however it is considered to be high. Grey nurse sharks that aggregate at this site are at significant risk of being caught on setlines.

Assessment: High risk

Driftline:

The extent of drift line fishing in the vicinity of Edith Breaker is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, jewfish and snapper is known to occur in the waters around Seal Rocks and within the vicinity of Edith Breaker. Edith Breaker has previously been a popular spot for commercial fishers operating out of Seal Rocks however the fishing effort at the site is unknown. The actual extent of commercial handline fishing within 1000 m of Edith Breaker is undetermined however this form of fishing is considered to be a significant threat to grey nurse sharks and is likely to result in incidental capture of the species. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked.

Assessment: Medium risk

Dropline:

The extent of dropline fishing activity in the vicinity of Edith Breaker is unknown. If dropline fishing occurs within 1.5 km (which is the known foraging range of grey nurse sharks) of Edith Breaker then this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. It is not considered to be a significant threat to sharks aggregating around Edith Breaker.

Assessment: Low risk

Trolling:

The fishing effort for commercial trolling around Edith Breaker is unquantified. Commercial fishers may troll around the site for pelagic species such as tuna, mackerel and kingfish. Trolling is not considered to be a significant threat to grey nurse sharks however it does pose some risk as grey nurse sharks may take bait trolled around the surface or become hooked whilst trying to feed on a fish that has been hooked.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. The extent of jigging fishing activity within close proximity of Edith Breaker (within 1000 m) is not known.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Edith Breaker. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Edith Breaker:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and

- Recording the length of time and location of gear deployed.

Edith Breaker currently has no protection as it is not listed as critical habitat. The limits on the number of traps and hooks proposed in the draft FMS, while potentially effective at capping overall effort levels, are not site specific and do not provide targeted protection for grey nurse sharks at this key aggregation site. The proposal to prohibit the use of wire traces on setlines will assist in allowing any sharks that take a baited hook to break away from the mainline, however, in most cases the shark would swim away with the hook and branch line still attached. The impact reduction due to the mandatory use of circle hooks on setlines is likely to be restricted as circle hooks are already widely used throughout the fishery. Further, sharks will still remain susceptible to being incidentally caught by methods of setlining, handlining, trolling and jigging. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of the grey nurse shark aggregation site at Mermaid Reef is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Manning Shelf Marine Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at Edith Breaker is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Little Broughton Island – Port Stephens

Site description

There are several sites at Broughton and Little Broughton Islands that have gutters and overhangs where grey nurse sharks have been seen. These include sites known as Looking Glass, Cod Rock, east head and the shark gutters at Little Broughton Island. The sharks are often observed throughout the year, however they are especially prevalent from late summer to winter when large aggregations consistently occur. These aggregations have been recorded during 90% of the surveys conducted between 1998 and 2001 (Otway & Parker, 2000, Otway *et al.* 2003).

Approximately 9.5% of the total sampled population of grey nurse sharks have been observed at Little Broughton Island in the site referred to as the shark gutters. This site is believed to be a highly important site for females, with 13.7% of the sampled female population observed in this area (Otway *et al.* 2003). This suggests it is one of the most significant aggregation sites for female grey nurse sharks in the state.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

Fish trapping is not known to occur within the Little Broughton Island critical habitat site however it does occur in other locations around Broughton Island. The impact of fish trapping on the food resources for the grey nurse shark at Broughton Island is considered to be minor.

Assessment: Low risk

Setlines/trotlines:

Broughton Island is an important area for commercial setline fishing for wobbegong shark species. A couple of commercial fishers regular use setlines to target wobbegong sharks around Broughton Island, however the use of setlines is prohibited within 1000 m of the grey nurse shark critical habitat site. Grey nurse sharks can be found outside the critical habitat at various locations around Broughton Island including Looking Glass, Cod Rock and East Head. Sharks that move around the island are highly susceptible to capture on baited setlines. Setline fishing is considered to be a significant threat to the grey nurse shark and the proposed actions in the draft FMS are unlikely to negate this threat.

Assessment: High risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Little Broughton Island critical habitat site. The extent of drift line fishing in the vicinity of Broughton Island is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, jewfish and snapper is known to occur in the waters around Broughton Island. The majority of the commercial handline fishing is known to occur outside the 1000 m critical habitat zone however it does occur in other areas where grey nurse sharks are known to occur. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked.

Assessment: Medium/High risk

Dropline:

The use of droplines is prohibited within 1000 m of Little Broughton Island critical habitat site. The extent of dropline fishing activity in the vicinity of Broughton Island is unknown. If dropline fishing occurs within 1.5 km (which is the known foraging range of grey nurse sharks) of the critical habitat site then this form of fishing could pose a risk to the grey nurse shark. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. It is not considered to be a significant threat in the Little Broughton Island critical habitat site.

Assessment: Low risk

Trolling:

Commercial trolling is considered to be a minor fishing method in the waters around Broughton Island. As the trolling effort is minimal it is unlikely that this form of fishing will significantly impact on the grey nurse shark within the Little Broughton island critical habitat site and region.

Assessment: Low risk

Jigging:

Commercial fishers from the south coast of New South Wales have reported grey nurse sharks being caught whilst jigging. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. The extent of jigging activity in the Little Broughton Island critical habitat site is considered to be minimal however this fishing activity is considered to some risk to the grey nurse shark if carried out in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Little Broughton Island critical habitat site. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Little Broughton Island:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery on grey nurse sharks in the Little Broughton Island critical habitat site and vicinity as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught in the critical habitat site by methods of handlining, trolling and jigging and when they move about Broughton Island they become highly susceptible to setlines. Any form of fishing that utilises hooks (particular with bait) in the vicinity of the grey nurse shark aggregation site at Little Broughton Island is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Manning Shelf Marine Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at the Little Broughton Island is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Magic Point – Sydney

Site description

Magic Point consists of large cave/overhang and nearby gutter like formations that are part of the reef system extending from the headland. These features occur at a depth of around 14 m. From 1998 to 2003 grey nurse sharks have regularly been seen at this site, with the largest numbers occurring over the warm summer months. Aggregations have been observed here during 55.6% of the surveys conducted between 1998 and 2001, especially during winter (Otway & Parker, 2000, Otway *et al.* 2003).

Approximately 3.5% of the total sampled population of grey nurse sharks have been observed at Magic Point. Slightly higher numbers of female sharks have been observed in this site (4.1% of the sampled female population).

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

The use of fish traps is not considered to be a major fishing method within the Magic Point critical habitat site. Fish trapping may occasionally occur for species such as bream and morwong however it is not considered to be a common fishing method around Magic Point. The impact on the grey nurse shark and their food resources is considered to be minor.

Assessment: Low risk

Setlines/trotlines:

Setline fishing is known to occur in the Sydney region for species such as the wobbegong shark. The use of setlines is prohibited within 1000 m of the Magic Point critical habitat site however setline fishing is known to occur in the vicinity of the critical habitat site. Sharks that move out the Magic Point critical habitat site whilst foraging for food are at risk from being caught on a setline.

Assessment: Medium risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Magic Point critical habitat site. The extent of drift line fishing in the vicinity of Magic Point is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, jewfish and snapper is known to occur in the waters of the Magic Point region. However, the majority of the commercial handline fishing is known to occur outside the 1000 metre critical habitat zone. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked and they are susceptible to being caught using this fishing method.

Assessment: Medium risk

Dropline:

The use of droplines is prohibited within 1000 m of the Magic Point critical habitat site. The extent of dropline fishing activity in the vicinity of Magic Point is considered to be negligible. Dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and bar cod. It is not considered to be a threat to grey nurse sharks in the Magic Point critical habitat site.

Assessment: Low risk

Trolling:

Commercial trolling is considered to be a minor fishing method in the Magic Point critical habitat site. As the trolling effort is minimal it is unlikely that this form of fishing will significantly impact on the grey nurse shark within the Magic Point critical habitat site and region.

Assessment: Low risk

Jigging:

The extent of jigging activity in the Magic Point critical habitat site is considered to be negligible however this fishing activity is considered to be a risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Magic Point critical habitat site as it is very close to shore. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be caught using this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Magic Point:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery in the Magic Point critical habitat site and vicinity as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught in the critical habitat site by methods of handlining, trolling and jigging and when they move about the Magic Point/Maroubra region they become highly susceptible to setlines. Any form of fishing that utilises hooks (particular with bait) in the vicinity of the grey nurse shark aggregation site at Magic Point is considered to be a significant threat to the species.

Bass Point – Shellharbour

Site description

Grey nurse sharks have been observed at two main sites located at Bass Point, near Shellharbour. Aggregations have been recorded at these sites during 10% of the surveys conducted between 1998 and 2001, mainly between December and June (Otway *et al.* 2003). The Gutter is a reef system extending off the northern most tip of Bass Point near Lou's Reef with a deep sand-filled gutter that reaches a depth of 38 m. The Arch and Cave are located on the southern side of Bass Point and are part of a reef system that reaches a depth of 30 m. Grey nurse sharks are observed swimming or hovering inside or near the Cave or Arch. These sites are dived by recreational scuba divers throughout the year.

Approximately 1% of the total sampled population of grey nurse shark have been observed at Bass Point (1998 – 2001). An equal proportion of the sampled male and female populations aggregate at this site (Otway *et al.* 2004). However, no grey nurse sharks have been observed at this site since 2000 and this site is considered to be the least important critical habitat site on the east coast.

A ‘no take’ aquatic reserve exists in Bushrangers Bay at Bass Point, however this is not believed to incorporate any important grey nurse shark habitat. Grey nurse sharks have occasionally been reported inside Bushranger Bay however this is considered to be a rare occurrence.

Importance of site to grey nurse sharks: Low **-** Rare

Seasonality: Occasionally over summer

Current Protection:

- Grey nurse shark critical habitat
- Bushrangers Bay Aquatic Reserve

Fishing Activities

Fish Trap:

The use of fish traps is not considered to be a major fishing method within the Bass Point critical habitat site however it is known to occur in the Shellharbour region for species such as bream, snapper and morwong. The impact on the grey nurse shark and their food resources in the Bass Point region is considered to be negligible.

Assessment: No risk

Setlines/trotlines:

Setline fishing is known to occur in the Shellharbour region for species such as the wobbegong shark. The use of setlines is prohibited within 1000 m of the Bass Point critical habitat site however setline fishing is known to occur in the vicinity of the critical habitat site. However, given the very rare occurrence of grey nurse sharks at the Bass Point critical habitat site it is unlikely that sharks will interact with this fishing method.

Assessment: Low risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Bass Point critical habitat site. The extent of drift line fishing in the vicinity of Bass Point is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, jewfish and snapper is known to occur in the waters of the Bass Point region. However, the majority of the commercial handline fishing is known to occur outside the 1000 metre critical habitat zone. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked and they are susceptible to being caught using this fishing method. However, given the very rare occurrence of grey nurse sharks at the Bass Point critical habitat site it is unlikely that sharks will interact with this fishing method.

Assessment: Low risk

Dropline:

The use of dropline as a fishing method is prohibited within 1000 m of the Bass Point critical habitat site. The extent of dropline fishing activity in the vicinity of Bass Point is considered to be negligible, as dropline fishing is known to generally to occur in deepwater offshore. It is not considered to be a threat to grey nurse sharks in the Bass Point critical habitat site.

Assessment: Low risk

Trolling:

Commercial trolling is considered to be a minor fishing method in the Bass Point critical habitat site. The commercial catch from trolling in this site is unknown however it is not considered to be major. As the trolling effort is minimal it is unlikely that this form of fishing will significantly impact on the grey nurse shark within the Bass Point critical habitat site and region.

Assessment: Low risk

Jigging:

The extent of jigging fishing activity in the Bass Point critical habitat site is considered to be negligible however this fishing activity is considered to be a risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Bass Point critical habitat site as it is very close to shore. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be impacted on by this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Bass Point:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery in the Bass Point critical habitat site and vicinity as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging within the critical habitat and to setlining outside it. However, the Bass Point critical habitat site is thought to be of minor significance to grey nurse sharks relative to the other critical habitat sites as they have not been recorded at Bass Point for the past five years.

Tollgate Islands – Batemans Bay

Site description

The Tollgate Islands are located at the mouth of Batemans Bay on the New South Wales south coast. Grey nurse sharks are most commonly observed at the "Tollgate Islands Shark Gutter" during summer and autumn. "The Gutter" is on the north-eastern tip of the Island and reaches a maximum depth of 18 m. Sharks consistently aggregate at this site, with 90% of surveys conducted between 1998 and 2001 recording relatively high numbers of sharks (Otway *et al.* 2003). This site is considered the most important site in waters south of Seal Rocks.

Approximately 8.9% of the total sampled population of grey nurse sharks have been observed at Tollgate Islands. The site is the most important known aggregation site for female sharks, with 15.4% of the sampled female population observed here. It is likely that a number of these females may be gestating (pregnant) during these periods. Grey nurse sharks have been witnessed giving birth in this site and small pups have been observed.

Importance of site to grey nurse sharks: High

Seasonality: Year round

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

The use of fish traps is not considered to be a major fishing method in the vicinity of the Tollgate Islands critical habitat site however it is known to occur in the Batemans Bay region for species such as bream, snapper and morwong. The impact on the grey nurse shark and their food resources around the Tollgate Islands is considered to be negligible.

Assessment: No risk

Setlines/trotlines:

Setline fishing is known to occur in the Batemans Bay region for species such as the wobbegong shark. Setline fishing is prohibited within 1000 m of the Tollgate Islands critical habitat site however setline fishing is known to occur in the vicinity of the critical habitat site. There are several reefs around the Tollgate Islands where setline fishing is known to occur. In 2004 tracking research was conducted at the Tollgate Islands and this work found that grey nurse shark roam up to 1.2 km from the aggregation gutter and that they move around the western side of the island where setline fishing is permitted. Their large foraging range increases the risk of them being caught on setlines that are set in the vicinity of the Tollgate Islands.

Assessment: Medium risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Tollgate Islands critical habitat site. The extent of drift line fishing in the vicinity of Tollgate Islands is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handline fishing for species such as kingfish, tuna, jewfish and snapper is known to occur in the vicinity of the Tollgate Islands. However, the majority of the commercial handline fishing is known to occur outside the 1000 metre critical habitat zone. Any fishing with a baited hook poses a threat to the grey nurse shark being incidentally hooked and they are susceptible to being caught using this fishing method. Given that the sharks move out to 1 km from the Tollgates aggregation site they could become at risk of being caught on handlines that are being used in the region.

Assessment: Medium risk

Dropline:

The use of droplines is prohibited within 1000 m of the Tollgate Islands critical habitat site. The extent of dropline fishing activity in the vicinity of the Tollgate Islands is considered to be negligible, as dropline fishing is known to generally to occur in deepwater offshore. It is not considered to be a threat to grey nurse sharks in the Tollgate Islands critical habitat site.

Assessment: Low risk

Trolling:

Commercial trolling is considered to be a minor fishing method in the Tollgate Islands critical habitat site. The commercial catch from trolling in this site is unknown however it is not considered to be major. As the trolling effort is minimal it is unlikely that this form of fishing will significantly impact on the grey nurse shark within the Tollgate Islands critical habitat site and region.

Assessment: Low risk

Jigging:

The extent of jigging fishing activity in the Tollgate Islands critical habitat site is considered to be negligible however this fishing activity is considered to be a risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing is not known to occur within the vicinity of the Tollgate Islands critical habitat site as the waters around the island are shallow and it's not a known location for schools of tuna to occur. Pole fishing generally occurs in deep open water when schools of tuna are found. It is unlikely that grey nurse sharks would be impacted on by this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Tollgate Islands:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within the Tollgate Islands critical habitat area as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging within the critical habitat site and when they move about the Tollgates Island region they become highly susceptible to setlines. The current prohibition on setlines is only on the eastern side of the island, however, tracking of the sharks has found that they move into the western side where setlining is allowed to occur. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation site at Tollgate Islands is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Batemans Shelf Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at the Tollgate Islands is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Montague Island – Narooma

Site description

Grey nurse sharks are observed at several sites around Montague Island off Narooma. The main site is called the "Shark Gutters" and is located on the northern tip of Montague Island and comprises a reef with a series of sand-filled gutters at depths of approximately 18 m. This gutter is near the Australian and New Zealand fur seal colonies. Some of the other sites that grey nurse sharks can be found at include the "Bubble Cave", the "Pinnacles" and "The Gut" that are located on the western side of the island. Aggregations of grey nurse sharks consistently occur at Montague Island particularly during late summer and early autumn, with 20% of surveys conducted between 1998 and 2001 recording significant numbers of sharks (Otway *et al*. 2003).

Importance of site to grey nurse sharks: Low

Seasonality: November to April

Current Protection:

- Grey nurse shark critical habitat

Fishing Activities

Fish Trap:

The use of fish traps is not considered to be a major fishing method in the vicinity of Montague Island critical habitat site. Fish trapping is known to occur in the Narooma region for species such as leatherjackets, snapper and morwong. The impact on the grey nurse shark and their food resources around Montague Island is considered to be negligible.

Assessment: No risk

Setlines/trotlines:

Setline fishing is known to occur in the Narooma region for species such as wobbegong sharks and gummy sharks. Setline fishing is prohibited within 1000 m of Montague Island to minimise the impact on the grey nurse shark however setline fishing is known to occur in the vicinity of the critical habitat site. The setline fishing prohibition around Montague Island is seasonal from 1 November to 30 April. There are several large reef systems located within the vicinity of Montague Island that are important areas for commercial fishing and setline fishing is commonly used on these refs. Grey nurse sharks are known to occur on some of these reefs and are susceptible to being caught on and baited hooks that are set on the reefs. Research has found that grey nurse sharks will roam large distances from their aggregation sites and sharks that move from the Montague Island critical habitat site to feed are at risk of being caught on setlines.

Assessment: Medium risk

Driftline:

The use of driftlines is prohibited within 1000 m of the Montague Island critical habitat site. The extent of drift line fishing in the vicinity of Montague Islands is unknown however the use of this fishing method in the region is considered to be minimal and interactions with grey nurse sharks are unlikely.

Assessment: Low risk

Handline:

Commercial handlining for commercial fish species such as kingfish and snapper are known to occur in the vicinity of the Montague Island critical habitat site. When the conditions are ideal (i.e. the current is running from the north) commercial fishers use leadlines around the northern section of the island to capture kingfish (see under trolling below).

Commercial handline fishing with bait is a common form of fishing around the island for species such as kingfish, snapper and benthic fish species. This form of fishing is considered to be a significant threat to grey nurse sharks, as they are susceptible to baited hooks. The species that commercial handliners target are generally found in the same habitat areas as grey nurse sharks. There have been many reports of grey nurse sharks being caught incidentally on handlines and these sharks are often left with hooks in the jaw or in the oesophagus or stomach. These hooks can impact on the grey nurse shark by preventing its ability to feed or cause death through peritonitis and septicaemia.

Assessment: High Risk

Dropline:

The use of droplines is prohibited within 1,000 m of the Montague Island. The extent of dropline fishing activity in the vicinity of Montague Island is unknown. If dropline fishing occurs within the likely foraging range of grey nurse sharks (within approximately 1 km) then this form of fishing would pose a risk. However, dropline fishing is known to generally to occur in deepwater offshore where fishers target species such as hapuku and blue-eye.

Assessment: Low risk

Trolling:

There is considerable amount of trolling around Montague Island as commercial fishers target pelagic species including mackerel, kingfish and tuna. Many of the species that are caught whilst trolling are considered to form part of the grey nurse sharks diet and the grey nurse shark is known to utilise the upper part of the water column for travelling and possibly for feeding. There is also some risk that grey nurse sharks will target fish that are caught trolling and become incidentally hooked. Leadlining for kingfish is a popular commercial fishing activity at Montague Island when the kingfish are in season. Leadline fishing is not considered to be a significant threat to the grey nurse shark as there are no reports of the sharks being hooked using this method and the baits are generally set up off the bottom and are generally too small for a grey nurse shark to feed on.

Assessment: Low risk

Jigging:

The extent of jigging fishing activity in the vicinity of Montague Island is unknown, however commercial fishers have indicated that they occasionally jig fish using artificial lures. The potential for grey nurse sharks being caught is dependent on the type of jig that is being used. Commercial fishers that fish around Montague Island have previously reported catching a couple of grey nurse sharks whilst using artificial jigs. It is likely that this fishing activity poses some risk to the grey nurse shark if operated in the vicinity of the critical habitat site.

Assessment: Low risk

Poling:

Pole fishing may occasionally be employed around Montague Island to catch tuna. This form of fishing is not considered to be a threat to grey nurse sharks as the tuna are caught on the surface and away from the known aggregation site. It is unlikely that grey nurse sharks would be impacted on by this fishing method.

Assessment: No risk

Assessment of likely effect of draft FMS at Montague Island:

The draft FMS recommends several modifications to setline fishing gear to reduce the impact of the fishery on the grey nurse shark. These modifications include:

- Limits on the number, type and size of hooks deployed (including the mandatory use of circle hooks);
- Prohibiting the use of wire trace on bottom setlines; and
- Recording the length of time and location of gear deployed.

It is unlikely that any of the above modifications recommended in the draft FMS will reduce the impact of the fishery within the Montague Island critical habitat area as setlining and the use of wire trace whilst anchored is already prohibited within 1000 m of the site. Sharks will still remain susceptible to being incidentally caught by methods of handlining, trolling and jigging within the critical habitat site and when they move about the island and adjacent reefs they become highly susceptible to setlines. Any form of fishing that utilises hooks (particularly with bait) in the vicinity of grey nurse shark aggregation site at Montague Island is considered to be a significant threat to the species.

It should be noted that in November 2005, the NSW Government announced the declaration of a new marine park in the Batemans Shelf Bioregion, with a zoning plan expected to be developed in the first half of 2006. If the key aggregation site at Montague Island is incorporated within a sanctuary zone and a sufficient buffer zone from line fishing is implemented, then this would substantially reduce the risk of the fishery impacting on grey nurse sharks at this site.

Regional Summary of the Biophysical Impact Assessment of the draft FMS

Studies to date indicate that the east coast population of grey nurse shark is probably comprised of less than 500 individuals, and the most recent estimates are of between 410 - 461 sharks. There is currently no published data to quantitatively determine the number of sharks killed among or within the various commercial and recreational fishing sectors each year, although several were reported as killed due to some form of hook and line fishing between October 2001 and September 2002 (N. Otway and B. Talbot, NSW DPI, pers. comm.). Although the number of deaths attributable to the OTLF is unknown, given the significant spatial, temporal and methodological overlap between the OTLF and grey nurse sharks, it is probable that the fishery is contributing in some part to the fishing-related mortality of grey nurse sharks. This section of the SIS has done a site-specific impact assessment of the draft FMS and concludes that despite the proposed mitigative measures, it is unlikely to substantially reduce the number of deaths caused by the OTLF. On that basis, the high risk posed to the species by the existing fishery remains.

E1.5.3.5 Alternatives to the proposal

Introduction

The purpose of this section, as outlined in the Director-General’s requirements, is to “describe any feasible alternatives to the actions proposed in the draft FMS that are likely to be of a lesser effect, and the reasons justifying the carrying out of the action, having regard to the biophysical, economic and social considerations and the principles of ESD”. It is important to note that within this assessment, an alternative with ‘lesser effect’ is interpreted as one which is likely to result in a smaller impact on the grey nurse shark population than that which is proposed in the draft FMS.

It should be noted that the alternatives being considered in this section relate only to alternative ways of managing the impacts of the OTLF on grey nurse shark, not alternative ways of addressing impacts by any other activities on grey nurse shark. Those other activities will, however, be considered when assessing the efficacy of any alternatives to the protective measures in the draft FMS.

Description of the alternatives identified for consideration

Mindful of the existence of the ten existing critical habitats, as well as some other key aggregation sites that are not currently listed as critical habitats, the feasible alternatives will be focussed in those areas that are significant for the grey nurse shark.

For the purposes of this assessment, feasible alternatives to the protective measures of the draft FMS are to:

1. prohibit all OTLF methods in existing critical habitat sites and other key aggregation sites
2. prohibit the high and medium risk OTLF methods from existing critical habitat sites and other key aggregation sites

Method of assessment of the alternatives against the draft FMS

In this section the alternatives proposed above are assessed against the draft FMS having regard to the biophysical, economic and social considerations and the principles of ESD.

Biophysical impacts

As outlined in E1.5.3.4, there are a number of methods of the fishery that pose a risk to grey nurse sharks. In Table E1.13, the fishery methods are ranked from what is considered to be the most significant threat to the lowest threat. Under Alternative 1 outlined above, all methods in Table E1.13 would be prohibited, and under Alternative 2, the high and medium risk methods could be prohibited. The high risk methods are setlining and handlining (with or without wire trace), and the medium risk methods are drift fishing with bait and trolling with bait.

Table E1.13 Assessment of risks posed to grey nurse sharks by fishing methods of the OTLF

	Fishing method	**Direct threat to sharks**	**Threat to food resource**
highest	Commercial setline fishing	High	Medium
threat	Commercial handline bottom fishing with bait	High	High
	Commercial driftline fishing and trolling with bait	Medium	Medium
↓	Commercial leadlining (with bait)	Low	High
	Commercial jigging and trolling (artificial lures)	Low	Medium
lowest	Commercial fish trapping	Negligible	Medium
threat	Spanner crab netting	Negligible	Negligible

Notes: “Direct threat to the sharks” refers to the risk of the grey nurse shark being hooked or caught. The “threat to the food resources” is the removal of food species considered part of the diet of grey nurse sharks.

As outlined in E1.5.3.4, the known aggregation and critical habitat sites are of key importance to the east coast grey nurse shark population for foraging, mating and pupping. Over 70% of the total estimated population can be found within these areas at any one time. Many of these sites are also the focus of a high level of OTLF fishing activity. Consequently, Alternative 1 (the removal of all OTLF methods in aggregation/critical habitat areas that pose a direct threat of incidental capture to grey nurse sharks or removal of their food resources) provides the highest practical level of protection from the OTLF and the best chance for the stabilisation of the grey nurse shark population. It is important to note that implementation of such measures through the draft FMS for the OTLF does not prevent recreational fishers from Hook and Line Fishing in the key aggregation sites, a recognised Key Threatening Process for the species.

Under Alternative 2 (the removal of OTLF methods in aggregation/critical habitat areas that have a high or medium risk of direct impact on grey nurse sharks), incidental hooking rates would be lowered and there would be some protection of food resources. This approach is likely to significantly slow the decline in the grey nurse shark population and make extinction unlikely within the next few decades.

<u>Economic and social impacts</u>

There are positive (in the form of benefits) and negative (in the form of costs) economic impacts from the changes to gear controls and/or critical habitat site closures described above. Benefits include spill over effects that may result from protection of stocks within the critical habitat site. Costs are both direct (lost income from restrictions) and indirect (lost opportunity to fish in the critical habitat site for fishers not currently using the area). There are also flow-on effects in the form of costs and benefits to the local economy. These flow-on effects are likely to be greatest where fishing makes a significant contribution to regional expenditure, employment and income.

Social impacts resulting from flow-ons will be both positive and negative. The extent of impacts will depend on the importance of fishing to the local economy, where fishing related expenditure is being undertaken and where fish are being sold. Other positive impacts include the benefits to society from knowing that grey nurse shark will be conserved (i.e. existence values).

Fishers who have reported catch in the critical habitat site over the last five years are directly affected by critical habitat sites. Ocean Trap and Line fishers who have never fished in a critical habitat site, but have the ability to do so, are indirectly affected as they have lost this opportunity as a result of the critical habitat site.

If directly affected fishers were bought out of fishing industry altogether (i.e. all entitlements associated with their fishing business were removed), there is unlikely to be negative flow-ons to indirectly affected fishers. However, if only the OTL entitlements were bought out, there may be negative consequences if effort in the remaining fisheries in which they were engaged increases. If no entitlements were removed, there would be an even greater negative impact in the form of increases in fishing effort on grounds outside the critical habitat sites.

<u>Approach to assessment</u>

The two alternatives proposed above are assessed against the draft FMS in terms of biophysical, economic and social impacts. Biophysical risks have been evaluated in the context of existing regulations within each zone. The approach taken to estimate economic impacts was to examine changes in producer surplus (net profits derived from fishing activities) and assess the impact in terms of high, medium or low. High impacts are those which pose a threat to the economic viability of the fishing business directly affected by the changes. Similarly, social effects are considered in this way, if the risk to the fishing business is high, then there exists a high risk to the social contribution of those fishers to the community. It should be noted that these risks are not put in context of the fishing industry or community as a whole. Additionally, the alternatives are considered in light of ESD considerations.

Data on the direct impacts of critical habitat sites and key aggregation sites in the form of lost income to commercial fishers required site specific data. Some data on catches, number of fishers using critical habitat sites and key aggregation sites and lost producer surplus were collected in a report undertaken by Hassall and Associates in 2004 (hereafter referred to as the Hassall report). However, data on proportion of income from critical habitat sites and key aggregation sites were not collected for the Hassall report, nor was gear-specific catch and income data which is required to more accurately assess Alternative 2. To enable a more accurate assessment for this SIS, data were collected in February 2005 using a telephone survey of fishers who were known to fish in the critical habitats (including buffer zones) and key aggregation sites. Fishers were asked questions about their catches from the critical habitat site or key aggregation site, proportion of incomes, types of gear used etc.

Due to the size of the sample collected, it is likely that the data collected for some sites does not represent the commercial fishing industry's entire activities at those sites. Further, due to data aggregation methods used in the survey, setline fishing includes dropline fishing. The data collected through the survey is used in conjunction with the data collected by Hassall and Associates to provide an estimate of the potential socio-economic impacts of the two different alternatives and the proposed action in the draft FMS.

Indirect effects are calculated as the number of OTL fishers who recorded catches over the last five years in the ocean zones in which the critical habitat sites or key aggregation sites are contained.

Assessment of the alternatives against the draft FMS

The draft FMS is predicted to lead to only a minor improvement in the level of protection afforded to the grey nurse shark in the short term, however, the socio-economic impact on fishers through, for example, reduced incomes, should be low. This is the case for both existing critical habitat sites and other key aggregation sites. As the effect of the draft FMS at each critical habitat and key aggregation site is the same, i.e. high biophysical (grey nurse shark) impact and low socio-economic impact, the potential impacts of the draft FMS are not presented in the tables below.

Within the tables the following abbreviations are used when referring to risk: N = negligible, L = low, M = moderate and H = high. The following key also applies to the superscripted numbers in each of the tables from E1.13 to E1.27. Table-specific keys are provided for tables E1.28 - E1.30.

1. This figure represents the minimum number of fishers likely to be affected (taken from the Hassall report)
2. Average percentage of income from the OTLF (from telephone survey)
3. The average income for fishers in the relevant Ocean Zone (taken from the Hassall report)
4. Average percentage of income derived from the site (from telephone survey)
5. Calculated using: 20% x average income x percentage of income affected x number of affected fishers (derived from Hassall report and telephone survey)

Existing critical habitat sites

For each of the 10 grey nurse shark critical habitat sites, the two alternatives will be assessed in terms of their potential biophysical and socio-economic impacts.

1. Julian Rocks

The marine area surrounding Julian Rocks was declared an Aquatic Reserve in 1982, and in November 2005 was included in a sanctuary zone within Cape Byron Marine Park (and is anticipated to commence in April 2006). Only handlining was permitted within the 500 m area of the aquatic reserve (its classification at the time of the survey), and none of the commercial fishers contacted during the telephone survey reported any fishing activity in the reserve, consistent with the findings of the Hassall report. The economic effects of the different alternatives and the draft FMS on the fishing industry are therefore negligible (Table E1.14). Further, the risk to the shark and its food resources are negligible for both alternatives.

Table E1.14 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Julian Rocks

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	0	0	$30,290	0	0	0	52	N	N
2	N	N	0	0	$30,290	0	0	0	52	N	N

2. Fish Rock

The telephone survey data suggests that handlining, trolling with bait, drifting with bait and trolling with lures occurs at this site. Handlining, trolling with bait and drifting with bait could all be affected under Alternative 2 (Table E1.15). Of the 33.8% of income that could be affected, trolling accounts for 25.3% and drifting with bait 8.4%. No catch was reported in the telephone survey for handlining so it was not possible to apportion a percentage of affected income to that method.

Table E1.15 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Fish Rock

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	3	100%	$24,226	67.5%	$9,812	$140,165	37	H	H
2	M	M	3	100%	$24,226	33.8%	$4,906	$70,082	37	H	H

3. Green Island

The telephone survey data suggests that handlining, trolling with lures and drifting with bait occurs at this site. Handlining and drifting with bait could be affected under Alternative 2 (Table E1.16). Of the 0.6% of income that could be affected, drifting with bait accounts for all of it as no catch was reported in the telephone survey for handlining so it was not possible to apportion a percentage of affected income to that method. The survey indicated that trolling with lures was the most common method practiced at this site, hence the low socio-economic impact under Alternative 2.

Table E1.16 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Green Island

Alternative	**Potential impacts**									
	Biophysical		**Economic**							**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	3	100%	$24,226	12.5%	$1,817	$25,956	37	M	M
2	M	M	3	100%	$24,226	0.6%	$91	$1,298	37	L	L

4. The Pinnacle

The telephone survey data suggests that jigging, trolling with lures, handlining and trolling with bait occurs at this site. Handlining and trolling with bait could be affected under Alternative 2 (Table E1.17). Of the 1.5% of income that could be affected, handlining accounts for all of it as no catch was reported in the telephone survey for trolling with bait, so it was not possible to apportion a percentage of affected income to that method.

Table E1.17 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at The Pinnacle

Alternative	**Potential impacts**									
	Biophysical		**Economic**							**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	6.5	71%	$15,772	3.0%	$615	$8,787	52.5	L	L
2	M	M	6.5	71%	$15,772	1.5%	$308	$4,394	52.5	L	L

5. Big and Little Seal Rocks

Only trapping was reported for this site, thus only affected by Alternative 1 (Table E1.18).

Table E1.18 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Big and Little Seal Rocks

Alternative	**Potential impacts**									
	Biophysical		**Economic**							**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	6	50%	$15,772	1.0%	$189	$2,704	46	L	L
2	M	M	6	50%	$15,772	0.0%	$-	$-	46	L	L

6. Little Broughton Island

There were no telephone survey responses collected on the proportion of income per fishing method for this site. Thus, even with an estimate of the average income derived from the fishery, it is not possible to determine the socio-economic impacts of the alternatives at this site (Table E1.19).

Table E1.19 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Little Broughton Island

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	3	n.a.	$15,772	n.a.	$-	$-	56	n.a	n.a
2	M	M	3	n.a.	$15,772	n.a	$-	$-	56	n.a	n.a

7. Magic Point

There were no telephone survey responses collected on the proportion of income per fishing method for this site. Thus, even with an estimate of the average income derived from the fishery, it is not possible to determine the socio-economic impacts of the alternatives at this site (Table E1.20).

Table E1.20 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Magic Point

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	3	n.a	$28,998	n.a	$-	$-	54	n.a	n.a
2	M	M	3	n.a	$28,998	n.a	$-	$-	54	n.a	n.a

8. Bass Point

The telephone survey data suggests that handlining, trolling with bait, trolling with lures and fish trapping occurs at this site. Handlining and trolling with bait could be affected under Alternative 2 (Table E1.21). Of the 1.3% of income that could be affected, handlining accounts for 0.65% and trolling with bait a further 0.65%.

Table E1.21 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Bass Point

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	3	60%	$28,998	2.5%	$435	$6,214	54	L	L
2	M	M	3	60%	$28,998	1.3%	$217	$3,107	54	L	L

9. Tollgate Island

There were no telephone survey responses collected on the proportion of income per fishing method for this site (Table E1.22). Thus, even with an estimate of the average income derived from the fishery, it is not possible to determine the socio-economic impacts of the alternatives at this site.

Table E1.22 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Tollgate Island

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	8	n.a.	$49,365	n.a.	$-	$-	31	n.a.	n.a.
2	M	M	8	n.a.	$49,365	n.a	$-	$-	31	n.a	n.a

10. Montague Island

The telephone survey data suggests that handlining, trolling with lures, trolling with bait, droplining, setlining, poling and fish trapping occurs at this site, although proportion of income per fishing method was not provided for poling, trolling with bait, or trapping. The 40% of income that could be affected under Alternative 2 is comprised of 30% droplining/setlining and 10% handlining.

Table E1.23 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Montague Island

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	15	67%	$49,365	62.0%	$91,819	$1,311,699	24	H	H
2	M	M	15	67%	$49,365	40.3%	$59,682	$852,604	24	H	H

<u>Recently identified key aggregation sites</u>

1. Mermaid Reef

The telephone survey data suggests that handlining, trolling with lures, drifting with bait, droplining, setlining, and fish trapping occurs at this site. The two lower risk methods, fish trapping and trolling with lures, account for half of the income reported for this site. The 30% of income that could be affected under Alternative 2 is comprised of 21.6% from handlining, 6% from drop/setlining and 2.4% from drifting with bait (Table E1.24).

Table E1.24 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Mermaid Reef

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	7	92%	$20,623	60.0%	$17,323	$247,476	28	H	H
2	M	M	7	92%	$20,623	30.0%	$8,662	$123,738	28	H	H

2. Edith Breaker

The telephone survey data suggests that both handlining and drop/setlining take place at Edith Breaker and would be prohibited under both alternatives (Table E1.25). Prohibiting handlining would affect 1.25% of income, and prohibiting drop/setlining would affect a further 3.8% of income.

Table E1.25 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Edith Breaker

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	6	60%	$15,722	5.0%	$943	$13,476	53	L	L
2	M	M	6	60%	$15,722	5.0%	$943	$13,476	53	L	L

3. North Solitary Island

Part of this site is listed as a sanctuary zone in the Solitary Islands Marine Park, but the sanctuary zone does not include the key aggregation site for grey nurse sharks. As such, some commercial fishing activities such as handlining, trolling and jigging take place, as does recreational fishing.

The only fishing method reported in the telephone survey of commercial fishers was handlining (Table E1.26). As such, the effect of prohibiting handlining is reported in the table, which would be prohibited under both alternatives. The other high risk method, i.e. setlining, is already prohibited throughout Solitary Islands Marine Park.

Table E1.26 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at North Solitary Island

Alternative	Potential impacts										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	12	92.0%	$24,226	1.0%	$581	$8,306	28	L	L
2	M	M	12	92.0%	$24,226	1.0%	$581	$8,306	28	L	L

4. South Solitary Island

As with North Solitary, South Solitary Island is part of the SIMP but the key aggregation site is not part of a sanctuary zone. Handlining, trolling with lures, trolling with bait, and leadlining take place at South Solitary Island, with most of the income coming from the lower risk methods of trolling with lures (45%) and leadlining (30%), hence the larger effect under Alternative 1 (Table E1.27).

Table E1.27 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at South Solitary Island

Alternative	Potential impacts										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	12	100%	$24,226	87.5%	$50,875	$726,780	28	H	H
2	M	M	12	100%	$24,226	24.1%	$13,991	$199,865	28	H	H

5. Sawtooth Rocks

There were no telephone survey responses collected on the proportion of income per fishing method for Sawtooth Rocks (Table E1.28). Thus, even with an estimate of the average income derived from the fishery, it is not possible to determine the socio-economic impacts of the alternatives at this site.

Table E1.28 Potential impacts of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at Sawtooth Rocks

Alternative	Potential impacts										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	6	n.a.	$15,722	87.5%	$-	$-	53	n.a	n.a
2	M	M	6	n.a.	$15,722	24.1%	$-	$-	53	n.a	n.a

<u>Totals</u>

The total number of fishers directly affected is likely to be an overestimate given that fishers may use several of the critical habitat sites. The total number of fishers indirectly affected is also likely to be an overestimate because it is the sum of all fishers indirectly affected and thus may include some double counting across the Ocean Zones used in commercial fisheries management in NSW. On the other hand, the total lost surplus is likely to be an underestimate as not all directly affected fishers responded in the telephone survey.

1. Existing critical habitat sites

Table E1.29 Potential cumulative impact of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at seven of the ten existing critical habitats

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	50.5	64%	$28,278	21.2%	$104,687	$1,495,525	444	H	H
2	M	M	50.5	64%	$28,278	11.1%	$65,204	$931,485	444	M	M

1 = This figure represents the minimum number of fishers likely to be affected.

2 = Average percentage of income from OTLF from survey

3 = The average income for fishers in relevant Ocean Zones

4 = Average percentage of income derived from the site

5 = Sum of producer surplus loss from the 7 critical habitat sites for which data was provided

6 = Sum of present value loss from the 7 critical habitat sites for which data was provided

2. Recently identified key aggregation sites

Table E1.30 Potential cumulative impact of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at other key aggregation sites

Alternative	**Potential impacts**										
	Biophysical		**Economic**								**Social**
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	37	86%	$21,199	38.4%	$69,723	$996,038	137	H	H
2	M	M	37	86%	$21,199	15.0%	$24,177	$345,385	137	H	H

1 = This figure represents the minimum number of fishers likely to be affected (taken from Hassall report)

2 = Average percentage of income from OTLF from the telephone survey

3 = The average income for fishers in relevant Ocean Zones (taken from Hassall report)

4 = Average percentage of income derived from the site from the telephone survey

5 = Sum of producer surplus loss from the 4 aggregation sites for which data was provided

6 = Sum of present value loss from the 4 key aggregation sites for which data was provided

3. All sites combined

Table E1.31 Potential cumulative impact of implementing alternative measures (than those in the draft FMS) to protect grey nurse sharks at seven of the ten existing critical habitats and five other key aggregation sites

Alternative	Potential impacts										
	Biophysical		Economic								Social
	Direct threat to sharks	Threat to food resource	No. of affected fishers[1]	% of total fishing business income from OTL[2]	Average income OTL[3]	% of total[4] income affected	Lost Producer Surplus[5]	Present Value (7%)	Number of fishers indirectly affected	Overall impact on fishing businesses	Overall impact on local area
1	N	N	87.5	75%	$24,739	29.8%	$174,409	$2,491,563	581	High	High
2	M	M	87.5	75%	$24,739	13.0%	$89,381	$1,276,869	581	Medium	Medium

1 = This figure represents the minimum number of fishers likely to be affected (taken from the Hassall report)

2 = Average percentage of income from OTLF from the telephone survey

3 = The average income for fishers in relevant Ocean Zones

4 = Average percentage of income derived from the site (taken from the Hassall report)

5 = Sum of producer surplus loss from the critical habitat sites and key aggregation sites for which data was provided

6 = Sum of present value loss from the critical habitat sites and key aggregation sites for which data was provided

E1.5.3.6 Ameliorative measures of and justification for the proposal

Acknowledging the high risk that the existing fishery poses to grey nurse shark, the draft FMS proposes numerous new management actions to help mitigate those risks. The relevant responses (and performance measures) are summarised in Table E1.32, and the full details can be found in section D3 of the draft FMS.

It is important to note that the actions outlined in Table E1.32 are additional to the existing protection measures already implemented and/or announced by the NSW Government, namely its status as a protected species, the ten declared critical habitat areas and associated fishing restrictions, the artificial breeding program and the two new marine parks in the Manning Shelf and Batemans Shelf bioregions.

As evidenced in Table E1.32, the draft FMS contains proposals to implement several immediate actions aimed at further reducing the impact of the OTL fishery on grey nurse sharks, specifically the mandatory requirement to use circle hooks on all unattended lines (MR3.1(c)(i)) and the prohibition of wire traces on bottom setlines (MR3.1(c)(ii)). These proposed additional actions have been assessed as leading to a minor reduction in the risk the fishery poses to grey nurse sharks as they may assist in reducing incidental hooking rates and/or incidences of gut hooking.

Other stated actions, such as the proposed observer program (MR1.2(a)) and the threatened species reporting system (MR3.1(a)), will not have a direct influence on preventing incidental hooking of the sharks, but will be important to facilitate the ongoing evaluation of interactions between the fishery and the species.

The draft FMS contains two proposals which involve further investigation or consultation. Namely, the proposal to investigate the effectiveness of the use of circle hooks for all attended line fishing methods (MR3.1(c)(iii)), and working with Ocean Trap and Line fishers to develop appropriate arrangements to close key grey nurse shark areas to commercial fishing (MR 3.1(c)(iv)). The former of these proposals has the potential, subject to the outcome of the investigation, to lead to a minor reduction in the risk to grey nurse shark, particularly individuals that move out from the aggregation sites to forage or when travelling between sites. The latter is a commitment that has the potential to result in a significant reduction in the level of risk posed by the fishery to the species. However, until specific closed areas are agreed upon, this SIS is unable to acknowledge an immediate reduction in risk due to this component.

Table E1.32 Ameliorative measures proposed in draft FMS to reduce risks to grey nurse shark

Management Response 1.2(a)	
Design and implement an industry funded scientific observer program to document the degree of interaction of commercial designated fishing activities, including the OTLF, with non-retained and threatened species	
Management Response 3.1(a)	
Modify, in consultation with Ocean Trap and Line MAC, the mandatory reporting arrangements to enable the collection of information on interactions with or sightings of threatened or protected marine species and interactions with other threatened or protected species	
Management Response 3.1(b)	
Implement, in consultation with the Ocean Trap and Line Management Advisory Committee, the provisions of any relevant threatened species recovery plans, threat abatement plans, or other similar management arrangements designed to protect critical habitat areas	
Management Response 3.1(c)	
Implement changes to reduce or prevent the impact of the OTLF on grey nurse sharks, including: i) the exclusive use of circle hooks for all unattended line fishing methods ii) prohibiting the use of wire trace on bottom setlines iii) investigating the effectiveness of the use of circle hooks for all attended line fishing methods, and iv) working with Ocean Trap and Line fishers to develop appropriate arrangements to close key grey nurse shark areas to commercial fishing, consistent with broader management arrangements for grey nurse sharks	
Performance Measure no. 1 under Goal 3	
Performance Indicator:	Interactions which may threaten the survival of a threatened species, population or ecological community
Trigger Point for Review:	Any interaction which may threaten the survival of a threatened species, population or ecological community
Performance Measure no. 3 under Goal 3	
Performance Indicator:	Number of grey nurse sharks caught by the OTLF
Trigger Point for Review:	Trigger point to be determined once baseline data collected through observer program and catch reporting system

The strongest component of the draft FMS in relation to grey nurse shark is the direct link to and consistency with the threatened species recovery planning process and Marine Parks zoning process (MR3.1(b)). The management response provides a commitment to modify the fishing activity and/or the management strategy, in accordance with the requirements of any threatened species recovery plans, threat abatement plans, management arrangements for critical habitat areas or, following the recent amendments to the threatened species legislation, in the absence of a recovery plan any actions outlined in a Priorities Action Statement. This linkage is of the utmost importance because it ensures that the OTL fishery makes the changes that are deemed necessary following an appraisal of the relative impacts on grey nurse shark populations from all possible sources. It also avoids a potentially disproportionate attribution of management action (and the associated costs) to a single sectoral user group.

The development of the recovery arrangements for grey nurse shark will need to have regard to the range of biophysical and socio-economic implications (relative and cumulative) of any proposed recovery actions, as well as the principles of ESD (NB: the principles of ESD are outlined in section D2.1 of the EIS).

While they were given limited weight in this assessment, in addition to the above, a range of broader management responses in the draft FMS (e.g. those relating to fisher education - e.g. species identification, promoting improved practices through the code of practice and improved fisher reporting) should support the more direct measures proposed for the species under the draft FMS or implemented in the future through the threatened species management process.

Further the impact of the OTL fishery on grey nurse aggregation sites is also being mitigated through the marine park planning process. The aggregation site at Julian Rocks has been given a high level of protection by the establishment of a permanent sanctuary zone, which is augmented by a fishing closure over adjacent reefs during the months when grey nurse sharks normally occupy the area. Zoning plans for the recently declared Port Stephens-Great Lakes and Batemans marine parks are planned for completion during 2006. Both marine parks include major aggregation sites, which contain approximately half the total sampled grey nurse shark population (see Table E1.11). It is likely that all sites within marine parks will receive higher levels of protection through the zoning process, noting that the details of such zones are subject to a specific marine park planning and consultative process. There are however, a number of major aggregation sites that are not included in declared or announced marine parks, such as Fish Rock near South West Rocks and Mermaid Reef near Laurieton. It is also possible that there are a small number of major aggregation sites that are yet to be discovered.

Overall, the immediate proposals in the draft FMS may lead to a minor reduction in the risk posed by the fishery to grey nurse sharks, but the overall risk to the species is still considered 'High' in all areas outside existing Marine Park sanctuary zones.

The alternative proposals presented in this SIS have been assessed as providing a significant reduction in biological risk to grey nurse sharks for Alternative 1 and 'Medium' reduction in biological risk for Alternative 2, but with a corresponding assessment of 'High' and 'Medium' economic and social impacts, respectively, to OTL fishers.

The socio-economic impact at the State level on coastal communities is minor. However, the socio-economic impact on the estimated 87 directly affected OTL fishers varies from high to medium dependant on the percentage of income derived from fishing within the identified grey nurse aggregation sites. The estimated 581 indirectly affected OTL fishers are effected at a low to negligible level.

Acknowledging the minimal reduction in risk for the biophysical factors in the draft FMS and the significant socio-economic impacts on OTL fishers of the alternatives, the draft FMS is the preferred option at this stage.

E1.5.3.7 Relevant approvals

Commercial fishers operating in the OTLF must hold commercial fishing licences issued under the *Fisheries Management Act 1994* with the appropriate fishery endorsements. The six endorsements types available in the fishery are detailed in Table D4.1 of section D4.1.3 of the EIS. The *Environmental Planning and Assessment Act 1979* and associated regulations also require a determination to be made with respect to the activity prior to 1 June 2006 in order to validate the commercial fishing entitlements issued for the fishery.

E1.5.4 Qualifications and experience of authors

Principal author - Philip Gibbs (PhD)

Dr Gibbs has 30 years research experience in fisheries science, the environmental ecology of freshwater streams, rivers, estuaries and nearshore marine waters, and the conservation of fishes and aquatic habitats. He has authored or co-authored in excess of 60 publications in a range of peer reviewed journals, books and technical reports.

He is currently a member of the following professional organisations: NSW Fisheries Threatened Species Scientific Committee; Visiting Fellow University of New South Wales School of Biological, Earth and Environmental Sciences; Member National Fisheries ESD Reference and Working Groups; Royal Zoological Society of New South Wales; Australian Society for Fish Biology; Coast and Wetland Society.

Dr Gibbs is currently employed by the NSW DPI, Science and Research Division as the Principal Fisheries Scientist, Coastal Conservation.

Andrew Goulstone (BAppSc (Fisheries Management & Aquaculture))

Mr Goulstone has 12 years experience in the fields of fisheries licensing, policy development and management of wild harvest fisheries. He has authored one FAO technical paper publication (peer reviewed), co-authored two FAO technical papers (peer reviewed), and prepared numerous articles for publication in fishing industry magazines, departmental Fishnotes, management plans and strategies, and other educational material.

Mr Goulstone is currently employed by the NSW DPI, Agriculture, Fisheries and Regional Relations Division as the Principal Manager, Management Planning.

Marcel Green (BAppSc)

Mr Green has 13 years experience in the field of environmental impact assessment, threatened species research and conservation, and recreational and commercial fisheries research. He has authored or co-authored in excess of 20 publications in a range of EIS, REF, SIS, technical reports and educational media.

Mr Green is an Executive Council member of the Australian Society for Fish Biology, and is currently employed by the NSW DPI, Agriculture, Fisheries and Regional Relations Division as Senior Manager, Environmental Assessments.

Jessica Hartmann (PhD)

Dr Hartmann has 10 years experience in the field of natural resource economics, marine park planning and commercial fisheries management and restructuring programs. Dr Hartmann has authored or co-authored in excess of 40 publications in a range of peer-reviewed journals, books and technical reports.

Dr Hartmann is a member of the International Institute of Fisheries Economics and Trade and the Australian Agricultural and Resource Economic Society and at the time of preparing this report was employed by the NSW DPI, Agriculture and Fisheries Division as the Principal Fisheries Economist.

Bill Talbot (MSc)

Mr Talbot has 13 years experience in the field of threatened species conservation, native fish conservation, recovery planning, environmental impact assessment, fisheries research and recreational and commercial fisheries management.

Mr Talbot has authored or co-authored in excess of 20 publications in a range of peer-reviewed journals, books and technical reports. His role within NSW Fisheries/NSW DPI has also been to produce over 30 educational publications on threatened and protected species.

Mr Talbot is a member of the Australian Society for Fish Biology, and is currently employed by the NSW DPI, Agriculture, Fisheries and Regional Relations Division as Group Manager, Fisheries Ecosystems.

SUBMISSION CERTIFICATE

This Species Impact Statement has been prepared under section 115N(2) of the *Environmental Planning and Assessment Act 1979*

SPECIES IMPACT STATEMENT PREPARED BY

Name of Principal Author: Philip Gibbs

Qualifications: PhD

Address: PO Box 21
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in respect of: The Draft Fisheries Management Strategy for the NSW Ocean Trap and Line Fishery

SPONSOR

Name: Anthony Hurst

Address: PO Box 21
CRONULLA NSW 2230

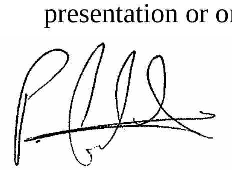
PROPOSED ACTIVITY The operation of the NSW Ocean Trap and Line Fishery in accordance with the draft Fishery Management Strategy for said fishery

Location of Proposed Activity NSW coastal waters out to 80 nm

AUTHOR'S CERTIFICATE I, Philip Gibbs, certify that I have prepared the contents of this Species Impact Statement and to the best of my knowledge:

- it is in accordance with sections 221J and 221K of the *Fisheries Management Act 1994* and the Director-General's Requirements notified to me in accordance with section 221L of the *Fisheries Management Act 1994.*
- and it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Signature:



Name: Philip Gibbs

SPONSOR'S CERTIFICATE I, Anthony Hurst, Acting Director, Fisheries Management with the NSW Department of Primary Industries, certify that I am acting as the sponsor for this Species Impact Statement on behalf of the persons entitled to be allocated shares in the NSW Ocean Trap and Line Fishery (the proponents), in accordance with section 221J(2)(c) of the *Fisheries Management Act 1994*.

Signature:

Name: Anthony Hurst

E2 Biophysical Environment

Some of the management responses in the FMS could contribute towards minimising any impacts on the biophysical environment from the OTLF and it is expected that the draft FMS will not result in any major increase in impacts on water quality, noise and light or greenhouse gas emissions (including air quality). Collecting data on the number of fish traps lost during fishing and implementing appropriate management action if necessary (MR 1.1(b)) makes provision for action if necessary, to reduce any impacts of trap loss. Furthermore, management responses that will cap the level of effort in the fishery (e.g. those listed under Objective 2.3) may prevent any biophysical impacts from increasing in future. Given that impacts on the biophysical environment were considered to be negligible under the current management of the fishery, the management responses proposed in the FMS are adequate.

E3 Economic Implications of the Draft FMS

This section was prepared by Dominion Consulting Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Appendix B3.

The OTLF Management Strategy (draft FMS) proposes a number of management responses to address the key issues in the fishery. As required by the DP guidelines, these responses were assessed to outline potential changes in the economic viability of ocean trap and line operators with a focus on assessing:

- the ability of fishers to pay increased management costs;
- the likely changes in patterns of investment;
- the likely changes in employment;
- the likely changes in economic returns to fishers; and
- the likely changes in overall risks to the economic viability of the fishery.

E3.1 Potential Change in Economic Viability of Ocean Trap and Line Operators

The draft FMS includes a commitment to implement category 1 share management provisions. A move to category 1 shares will provide fishers with more secure access rights, which will provide fishers with greater incentives to improve the performance of their fishing businesses and stewardship of the resource. This regime may also provide fishers with greater opportunities to retire from the fishery by enhancing the sale value of their businesses. The category 1 right increases the divisibility of the access right, which facilitates trading of access rights. However, the right could be developed further if the shares were linked to effort, or catch as in the Abalone and Rock lobster fisheries.

The draft FMS gives a commitment to cap effort at currently active levels. This is likely to reduce the level of overall effort (both active and latent) in the fishery, and is an important first step in restructuring the fishery. However, the draft FMS does not specify how 'currently active effort' is going to be defined. In addition, the timetable and the methods through which effort containment will be achieved are not specified. The extent to which latent effort is removed from the fishery will depend on the definition of 'currently active effort' and the method through which endorsements are capped at this level. Hence, whilst the risk to economic viability from potential activation of latent effort is likely to be reduced as a result of this response, it is not clear if it will be completely removed.

In order to increase economic viability in the fishery, excess effort (both latent and active) should be reduced. The draft FMS aims to address this issue by proposing to establish maximum effort levels within 10 years, however the methods through which this will be achieved and the extent of adjustment required is not specified. It is appropriate to undertake further investigation to determine the total level of effort and the best way to achieve it. Setting a total level of effort warrants careful examination and consultation with industry in order to ensure an effective outcome.

Under the draft FMS, fishing effort will be managed by input controls alone, with the possible exception of spanner crabs. However, to date, this has proven to be insufficiently effective in containing total effort in the fishery. In addition, input controls have been shown to have a negative effect on the efficiency, and, hence, profitability of fishers. Output controls may be better from an efficiency point of view than input controls as they allow fishers to choose how to best use inputs to achieve a given level of output. Many OTL species are considered to be suitable for management under an individual transferable quota (ITQ) system. There is a need to investigate the feasibility, including cost effectiveness, of introducing an output based management system in the fishery such as has been considered for spanner crabs.

Under the draft FMS strategies for harvesting fish at a size that provides optimum biological yield and economic return are to be determined and implemented for the primary and key secondary species**.** Optimising biological yield and economic return will have significant long-term positive benefits for resource productivity, stock rebuilding and hence the viability of the industry. The economic benefits of optimising biological yield for each target species can be modelled by age and price structured bio-economic analysis.

Improving post-harvest practices, as proposed under the draft FMS, is an important step towards increasing economic returns in the fishery. For example, minimizing waste, adding value through quality assurance, and providing consumers with increased confidence that the product was harvested in a sustainable manner and is safe to eat.

Costs to fishers in the form of new management charges could be significant as the fishery moves towards full cost recovery. Management costs to fishers for existing services are fixed until 2005/06. The full costs of managing the fishery will be recovered progressively over several years. Costs from new initiatives under the draft FMS are attributable to industry as they are implemented. A timetable for implementation of initiatives in the draft FMS is provided in FMS Appendix 1 of this EIS. Fishers will have to adjust to full cost recovery in the 2005 – 2008 period. However, the advanced notice given to them about the introduction and phasing in of full cost recovery gives them time to plan and adjust their operations. Despite this, the majority of OTL fishers have below normal returns, and, hence, are expected to have difficulty paying these charges unless profitability increases substantially. It is expected that some businesses will exit the fishery, thereby assisting the process of structural adjustment in the fishery.

E3.2 Potential Change in Overall Risks to Economic Viability

The risk of lack of secure fishing access rights is addressed through allocating shares in perpetuity under the category 1 share management system. The draft FMS should improve the rights of fishers, enabling fishers to have a longer term commitment to the fishery and its stewardship, or to sell their rights and exit the fishery. This should also improve the capacity for businesses to plan for the future and, hence, it reduces the risks from the lack of economic incentives to fishers. However, until structural adjustment has been fully implemented, and shares are transferable, the risk to economic viability from lack of economic incentives to fishers will not be removed from the fishery.

The draft FMS aims to contain effort levels, through capping each endorsement type at currently active levels. This will not necessarily improve economic performance in the fishery, but it is likely to reduce the level of overall effort, and may also reduce the risk of the potential for activation of latent effort if latent effort holders exit the fishery through the sale of shares.

Establishing a maximum level of effort for each sector of the fishery should go part of the way towards reducing effort levels to the profit maximizing level, but this depends on the level of total effort recommended. If the total effort level is set correctly, it will minimise the risk of reduced economic rent. If it is not set correctly, economic rent will be dampened to some extent by the possibility that total effort may increase due to the activation of latent effort.

Input based controls to manage effort in the fishery will not necessarily contain total effort at the profit maximizing level due to the potential for effort to increase across the fishery. Vessels may fish longer and use more advanced technology, thereby making them more efficient. Hence, the risk to economic viability from excess effort remains, if increases in technology are not managed.

The risk that input controls may be ineffective in containing total effort levels, particularly for spanner crabs, makes an examination of the potential use of output controls necessary as proposed by the draft FMS. In this fishery, the diversity of species suggests that output controls may be appropriate for some species, however a feasibility exercise is required to better understand the implications.

The risk from the overfishing of primary and key secondary species is likely to be reduced as a result of measures proposed in the draft FMS. The draft FMS includes the development of a resource assessment system covering primary and key secondary species, with the initial priority and greater detail to be focussed on primary species, although some key secondary species were considered to be at higher risk in the risk assessment. Key secondary species will be assessed, many for the first time, albeit at a more rudimentary level. This approach may be appropriate from a cost effectiveness perspective, but may not necessarily address all concerns raised in the risk assessment and the information obtained will nevertheless be essential to underpin the management of the primary species of the fishery in the longer term.

Several management responses promote the recovery of overfished species and others aim to conserve fish stocks by managing levels of active fishing effort in the fishery. The draft FMS promotes harvesting of fish at a size that provides optimum biological yield and increasing economic yield by capturing species at sizes which ensure higher market prices than from premature harvesting. Several management responses in the draft FMS promote the recovery of overfished species and others aim to conserve fish stocks by managing levels of active fishing effort in the fishery. The risk from having inadequate information on stocks of fish and their size class structure is also addressed, but this will continue to be an issue, given the large number of secondary species in the fishery.

The economic performance of fishers is likely to increase as a result of the draft FMS. This may, in turn, increase resource rent in the fishery. In addition, there may be increased information available to estimate the level of economic rent that would accrue in the fishery under different effort levels, and the maximum economic rent that could be obtained in the fishery. Obtaining such information is dependent on the outcome of a feasibility study recommended in the draft FMS, but will reduce the risks from not monitoring economic performance.

The costs of management will increase as the draft FMS recommends charging industry for the full costs of management. This should put the fishery on more sustainable footing as users pay for services. However, part of this step is adjustment among industry as some fishers choose to exit the fishery. Cost recovery is likely bring about greater transparency and accountability in management services, and hence, greater efficiency. The costs and benefits from management will be more closely assessed by fishers after full cost recovery is in place.

The need for economic research has been recognised by proposing to develop and implement a Research Strategic Plan. The draft FMS has also identified key areas for further research e.g. the economic performance indicators, the economic multiplier effects and strategies to improve the quality and usefulness of such data. As a result of implementing these management responses, the risk of inadequate information available to monitor economic viability in the fishery, will be reduced.

E3.3 Conclusions

The OTLF is an economically important fishery in NSW. Under the existing management arrangements the fishery is economically under performing with only 28% businesses having an economic surplus. Current fishing practices may also threaten the sustainability of the fishery.

Under the draft FMS, the key risks identified are addressed and in most cases these risks are reduced. However, the extent of actual risk reduction is contingent on the effective interpretation and implementation of the specified management responses to achieve the goals and objectives in the draft FMS.

The draft FMS provides secure access rights and takes steps to improve stocks of overfished species. The draft FMS also seeks to improve economic viability by removing latent effort and establishing a maximum level of effort, thereby encouraging restructuring in the fishery. Restructuring in the fishery is expected to be assisted by the exiting of businesses unable to meet higher costs as a result of full cost recovery. The draft FMS is a significant step on the longer path towards achieving ESD objectives.

The draft FMS has the capacity to address all the key risks, but is insufficiently clear on how some key objectives such as capping effort at currently active levels, will be achieved. The fishery requires substantial adjustment to increase the long term economic performance of the fishery. This will require concerted action on key management responses, such as the management of effort, over the lifetime of the FMS.

E4 Social Implications of the Draft FMS

E4.1 Fishers Social Capital

This section was prepared by Dominion Consulting Pty Ltd, and is a summary of the relevant sections of their report, which can be found in its entirety in Appendix B3.

The draft Fishery Management Strategy proposes a number of management responses to address the key social issues in the fishery. The potential social impacts of implementing these management responses are assessed against the following criteria:

- likely changes in social impacts on fishers, their families or any local communities;
- whether the level of job satisfaction among commercial fishers is likely to change;
- likely employment fate of any fishers exiting the industry; and
- whether the risk of social impacts are changed.

E4.1.1 Potential change in social impacts on ocean trap and line operators

The major social changes resulting from the draft FMS involve the potential displacement of fishers through restructuring. Restructuring is necessary to achieve a level of effort that is consistent with the generation of positive economic returns. Those impacted will most likely be part time, older fishers and fishing businesses grossing less than $10,000 per year. The impact of removing latent effort is unknown as FB involved in the OTLF may hold endorsements in other fisheries, and hence, may be able to continue to fish.

The draft FMS will have different regional community impacts as indicated by the SEIFA index of disadvantage for fishing communities. On implementation of the draft FMS, the OTL fishing communities in Montague and Clarence regions are most vulnerable to changes from the socio-economic impacts under the draft FMS, followed by Wallis Lake and Coffs Harbour.

E4.1.2 Potential change in the risk of social impacts

The change in the risk of social impacts as a result of implementing the draft FMS were assessed. Under category 1 share management, fishers will have more secure fishing rights and will be able sell their businesses and exit the fishery if they wish to do so. This is an improvement in the social situation of fishers, as currently the lack of any economic recompense on exiting, is a social barrier to leaving the industry. Hence, as a result of implementing the draft FMS risks such as insecurity of access rights, lack of compensation for outgoing fishers and lack of opportunities for business trade or transfer are reduced.

The risk of reduced employment levels in the fishery and associated impacts on dependents, may be increased by the draft FMS. This is an unfortunate part of the social cost of adjusting towards a more sustainable fishery. The draft FMS will impact “lifestyle” also, but is likely able to provide a more dependable livelihood for fishers than in more recent times.

Unemployment is a risk in regional areas of NSW and the adjustment in the fishery under the draft FMS may lead to fishers exiting the fishery. The risk of fishers not having sufficient skills for work outside the fishing industry is not reduced by the draft FMS, though those that have alternative skills to fishing may be able to exit the industry more easily after the FMS is implemented. The OTL fishing communities in the Montague and Clarence areas are most vulnerable to changes from the socio-economic impacts under the draft FMS given their higher dependence on OTL fishing, followed by the Wallis Lake and Coffs Harbour areas. However reducing fishing effort through adjustment will have future benefits for all remaining fishers.

Responses involving awareness, communication, compliance, and the code of practice are likely to have some positive impact in reducing conflicts and increasing compliance in the fishery. But further reduction of the risk of conflict among OTL fishers and with other fishers, requires cooperation between management and industry. The draft FMS continues to promote stakeholder involvement in management advisory committees.

The importance of an increased emphasis on socio-economic monitoring has been recognized in the draft FMS. Research should prioritise gaining data on fishing communities, so as to reduce the cumulative impacts from successive management strategies. Research is also required into factors influencing the collective attitudes of fishers and increasing cooperation in co-management.

E4.1.3 Conclusions

The ocean trap and line fishing communities are based all along the NSW coast and they and their employees are highly dependent on fishing for their income, employment and lifestyle. Underperformance of the OTLF is a threat to economic viability and poses social risks also. Adjustment is required to secure a healthy future for the fishery and for the communities that depend on the OTLF.

These adjustments will impact fishers, employees, their families and communities, through reduced employment and impacts on lifestyle factors associated with fishing. Some fishers will retire, while others may seek alternative employment. Fishers may have difficulty in finding alternative employment opportunities, particularly in regional areas of NSW. The long term viability of the fishery requires tough adjustment steps to be taken in order to secure a sustainable income and livelihood for fishers in the future.

The positive social impacts of the draft FMS are secure fishing access rights, opportunities to transfer/trade shares or fishing businesses, the potential to build greater incentives for investing in long term businesses and family involvement in the fishery. Under category 1 share management, fishers have increased access security. Fishing activities will be efficiently monitored and user conflicts are likely to be reduced through a series of communication initiatives. The socio-economic monitoring of the fishery will be increased as a result of implementing the draft FMS, which is a significant improvement over the current situation.

E4.2 Health and Safety Issues

The draft FMS will not result in any change to the health and safety risks of the fishery. The only potential area of concern is banning the use of spikes. Fishers sometimes use these on a variety of species that are more dangerous to handle, such as rays and fish with venomous spines. The draft FMS aims to develop improved handling practices and along with the code of practice, should mitigate any problems associated with safety in handling dangerous or awkward animals on deck.

E4.3 Implications of the Draft FMS for Aboriginal Culture

This section is a summary of the relevant sections of the report that was prepared by Umwelt (Australia) Pty Ltd, which can be found in its entirety in Appendix B4.

Table E4.1 presents a simple qualitative assessment and ranking of risks to Aboriginal values that are associated with the operation of the OTLF under the proposed draft FMS. As discussed in Chapter B, the risks to Aboriginal sites and cultural practices were low due to the existing fishery, so there was little change required via the draft FMS. Any potential changes to those risks are presented in Table E4.1.

Table E4.1 Summary of risks to Indigenous values under the draft FMS.

Broad issue/value	**Risk – existing management**	**Risk – if the draft FMS is implemented as proposed**
Aboriginal sites – the physical evidence of past Aboriginal land use	Low (low probability and low consequence)	Very low/minimal (very low probability and low consequence). It is most unlikely that the OTLF will impact on Aboriginal sites on the deep sea floor.
Aboriginal places – the locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world	Low	Low. Whilst some headlands and islands are known to be places of cultural value, often associated with stories, there is limited potential for Ocean Trap and Line activities to impact on these places. Further involvement of Aboriginal people in the fishery MAC will minimise this risk.
Aboriginal marine totem species	Moderate	There is limited detailed documentation about Indigenous totem species in the NSW marine environment and the significance of impacts on/risks to these values is therefore difficult to determine. Whilst there can be no doubt that some totem species are target species in the commercial fishery, the extent of concern to Aboriginal people needs further clarification. Initial steps to reduce risk involve further consultation with Aboriginal people, particularly Elders.
Aboriginal cultural landscapes - the places and species in the landscape that are important to Aboriginal people. As a separate issue from Aboriginal places, this refers to the presence and distribution of Aboriginal foods and medicines in the marine landscape	Low to moderate	Low – risk will be reduced as better information about species of concern to communities along the whole coast become better documented and Indigenous participation in fishery management is enhanced.
Aboriginal socioeconomic participation in the commercial fishing sector	Moderate – currently very low participation	Low to moderate – the strategy may facilitate enhanced opportunities for economic participation and skill development, in association with the actions that are priorities in the Indigenous Fisheries Strategy and are further explored in the Indigenous Commercial Fishing Opportunities Action plan. Adoption of key recommendations of the Indigenous Fisheries Advisory Committee will help to open up opportunities and reduce the risk that commercial fishing strategies present to Indigenous rights.

E4.4 Implications of the Draft FMS for Sites of Historic or Heritage Significance

This section is a summary of the relevant sections of the report that was prepared by Umwelt (Australia) Pty Ltd, which can be found in its entirety in Appendix B4.

As discussed in Chapter B, the risks to European heritage sites were generally low due to the existing fishery, so there was little change required via the draft FMS. In this context, the risk assessment considered it necessary for the draft FMS to implement procedures for monitoring (for instance locations, frequency and consequence) and reporting incidents.

The draft Fishery Management Strategy requires that fishers respond to new information about heritage resources. Ocean Trap and Line fishers may from time to time encounter shipwreck remains on the sea floor. Although the risk that ocean trap and line activities will detrimentally impact on historic heritage resources is very low, the operation of the Ocean Trap and Line Fishery does present an opportunity to further reduce risks in the long term by contributing to improved spatial data about the locations of shipwrecks.

Fishers will report location (GPS co-ordinates, water depth) and any other information they detect about the structure to the NSW Heritage Office and NSW DPI. This information will add to the database, so that fishers can be alerted about potential obstacles on the sea floor (with heritage and safety implications), and the Heritage Office will have more accurate information about the location of shipwrecks.

A second appropriate management response is to provide licence holders with basic information about their responsibilities under the Heritage Act, including the provisions relating to damage to structures, exclusion zones and collection of any historic artefacts that may be observed.

The Heritage Act requires that relics not be disturbed without obtaining a permit. In rare cases, this would mean that fishing in the vicinity of a structure that has been reported to the Heritage Office should cease until the nature and significance of a relic has been investigated and confirmed.

E5 Assessment of Performance Monitoring, Reporting and Research

E5.1 Assessment of Performance Monitoring and Reporting

The performance monitoring and reporting in the draft FMS is intended to serve two functions. First, they are to monitor the performance of the draft FMS in achieving its seven broad goals (DP guidelines D4 - Appendix A2). Thus the performance indicators and trigger points were set at the goal level not individual management responses. Second, the performance monitoring and reporting are to monitor the impacts, as identified in the risk assessment stage, of the fishery on the environment (DP guidelines E5(a) - Appendix A2). Therefore, the assessment of the performance monitoring will be based on these two aspects – management and environmental.

Two basic questions were used to assess the performance monitoring and reporting:

a) Does it adequately measure and report the performance of the draft FMS against its goals?

b) Does it adequately monitor the potential impacts of the fishery that were identified in the risk assessment as posing the greatest threat to an environmentally sustainable fishery?

E5.1.1 Performance monitoring and reporting

The performance monitoring and review in the draft FMS consists of the following components, which were assessed using the series of questions illustrated in Figure E5.1:

i) Performance indicators and trigger points

ii) Monitoring and information collection

iii) Reporting and review

E5.1.1.1 Performance indicators and trigger points

The following criteria were used to assess the adequacy of the performance indicators (PI) and trigger points (TP) for monitoring the draft FMS against its goals. They were adapted from those developed by Rochet and Trenkel (2003):

a) Relevance – is the PI connected either directly or indirectly with the expected outcome of the goal? (Poor – little or no direct or indirect connection to goal outcomes; Moderate – mainly indirect connection to goal outcomes; Good – directly connected to goal outcomes)

b) Expected effect of management – How does the PI change under the application of the management controls? There are three possible categories of change:

   i) unpredictable

   ii) change in direction, either up or down with respect to a reference direction

   iii) change in value with respect to a reference point such as a known value defined as a limit.

c) Measurable – are TP measurable and detectable?

d) Interpretable – can the changes in the TP be interpreted unambiguously as a result of management action and not other influences? Is there a clear reference point or baseline on which to make an interpretation?

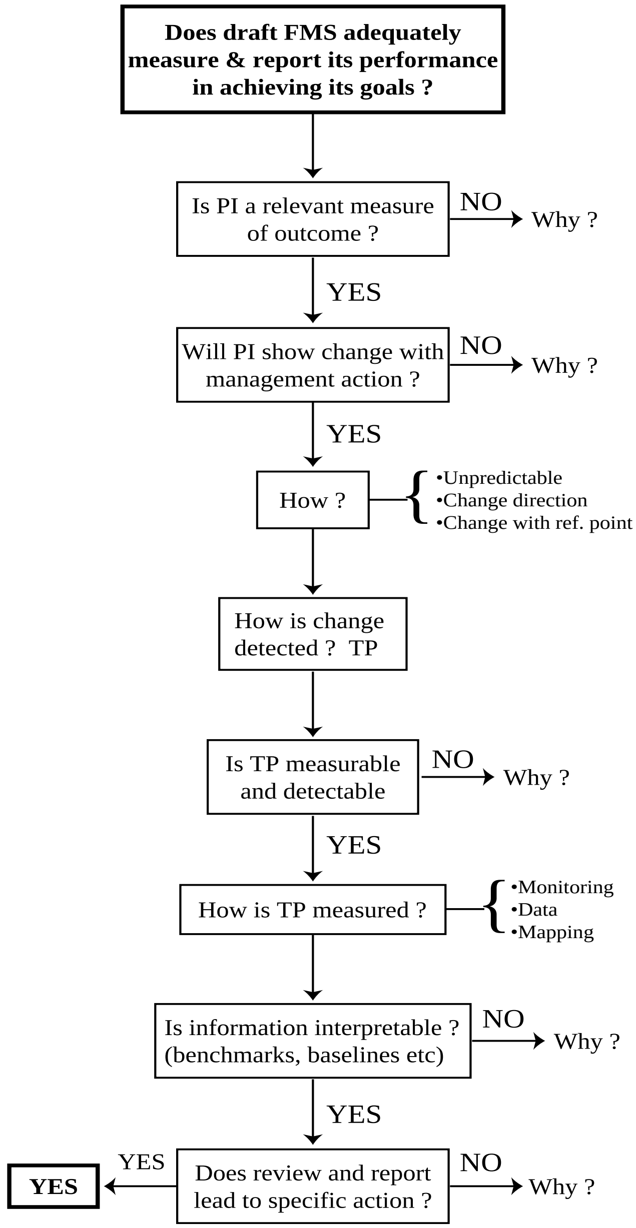


Figure E5.1 Diagram showing logical steps used to assess the adequacy of the performance monitoring and reporting in the draft FMS of the OTLF.

Note: PI = performance indicator; TP = trigger point

Tables E5.1 and E5.2 summarise how each of the 20 PI and TP meet these criteria. In terms of relevance, 50% of the PI were assessed as directly connected to the goal outcomes and these were mainly in goals 1, 3 and 7. That is, the performance of the draft FMS against these goals is being measured relatively well. Those PI that were moderately relevant (40%) were for areas where there are currently no standard types of indicators and further work is necessary to improve them. For example, the three PI in Goal 4 consider resource ‘sharing'. To be more relevant, it will be necessary to define an “appropriate share”, which will also be complicated by the need to provide a “share” for the resource, so that the fishing sectors are not fishing 100% of the available resource. Such estimates are likely to require good estimates of biomass or abundance for each species and such data is likely to be both expensive and require considerable time to collate.

Two PI had a poor rating for relevance to the goals because they did not measure the outcome of the goal (Table E5.2). Goal 2 (sustainable levels of target species) PI 2 measures changes in targeting between sectors of the OTLF rather than changes in sustainability in the stocks. However, tracking changes in targeting is related as it may signal secondary species becoming primary species. The TP for this indicator is also set in excess of the current ratio, estimated at just under 11% in 2001/02 (see Table B2.20). These estimates can vary widely depending on different data extraction dates, but to seriously address potential shifts in targeting and to limit the impacts of the fishery on species other than the primary or key secondary species, the limit should initially be set at lower than current estimates, e.g. 5%, and reviewed annually, not biennially as proposed. The annual performance reviews and biennial performance reports for the fishery present an opportunity to review the limit if necessary. Goal 2 also requires a third PI similar to the first, in that it needs to account for the number of species whose exploitation status is undefined. That is currently the majority of species in this fishery, and such a PI would meet all four criteria - it is relevant, the expected outcome is a decrease in the number due to resource assessments, it is measurable and interpretable, and is abetter indicator of the progress of the resource assessment program than PI 1.

In Goal 6 PI 2, the number of meetings of the Management Advisory Committee (MAC) for the OTLF, whilst a statutory requirement does not track the outcome of the goal, i.e. effective and efficient management. It may be very easy to measure, but does not provide any indication of whether those 2 meetings were either effective or an efficient use of resources. A more appropriate PI would be directed at whether relevant issues are discussed, the costs and associated benefits to fishers and the proportion of relevant MAC recommendations that are acted on by management.

The majority of PI (65%) had the ability to detect change under the effect of the management controls. However, there was uncertainty associated with 35% of them, which was primarily because there was only moderate relevance to the goal and/or where it was not clear that management would directly affect the PI. For example, there is considerable uncertainty associated with Goal 4 for the reasons outlined above, as well as the fact that it is difficult to ascertain how the FMS for a fishery can dictate resource allocation of a highly variable resource and one that is prone to marked fluctuations in actual and perceived value. This is further borne out in Goal 5 PI 1, in that the median fishery-wide gross return of OTL fishers may vary for many reasons other than due to the draft FMS (Table E5.2). Goal 5 also lacks a PI and TP related to changing effort levels as a result of moving to a share managed fishery. There are numerous management responses that discuss capping effort levels and reducing them over time, and given the importance of such measures for reducing pressure on fish stocks and the viability of the fishery, this aspect needs to be monitored via PI and TP.

The majority of the TP were both measurable (95%) and interpretable (70%). This gives the performance monitoring program substantial rigour in monitoring the performance of the FMS. However, there is considerable uncertainty associated with the interpretation for 20% of the TP (Table E5.1). The uncertainty is primarily associated with the lack of established reference points with which the TP can be compared, and in most cases it would be ideal to have collected at least a years data before the FMS is implemented so that any improvements due to the FMS would have been clearer. For example, for Goal 1 reference levels of species diversity/richness have not yet been established for the habitats and fishing grounds of the fishery. Nor do we have any estimate about the level of natural variability in species richness in the oceanic environment off the NSW coast. Consequently, TP 1 and 2 for Goal 1 will not be clearly interpretable until some species richness references can be established. This will need to form part of the monitoring process itself as well as the specific research project on developing a biodiversity index relevant to the fishery.

Table E5.1 Percentage of performance indicators (PI - 20 in total) and trigger points (TP - 20) that meet the criteria for adequacy in tracking the goals.

NA – not applicable; Good – directly connected to goal outcomes; Moderate – mainly indirect connection to goal outcomes; Poor – little or no direct or indirect connection to goal outcomes

Performance Indicators

Criteria	Categories		
Relevance	Good	Moderate	Poor
	50%	40%	10%
Expected effect	Yes	No	Uncertain
	65%		35%

Trigger Points

Criteria	Categories			
	Yes	No	Uncertain	N/A
Measurable	95%			5%
Interpretable	70%	5%	20%	5%

Table E5.2 Summary of the assessment of the proposed Performance Indicators and Trigger Points against the criteria for adequacy.

R - relevance, E - expected effect under management control, M - measurable, I - interpretable, N/A - not applicable

Goal No. (& summary)	PI No.	Performance Indicator		Trigger Point		Comments
		Brief Description	**Assessment**	**Brief Description**	**Assessment**	
1 (conservation of biological diversity)	1	Species composition (for all retained and bycatch species) in the fishery	*R:* Good *E:* Yes, unpredictable	Significant shift in species composition as determined by the "Large Area Species Richness" index (Gray, 1997)	*M:* Yes *I:* Uncertain	Significant shift will need to be defined; effectiveness of TP dependent on establishing a baseline BEFORE relevant measures in the FMS are implemented
	2	Proportion and species composition of discards	*R:* Good *E:* Yes, unpredictable	Species richness & quantity doesn't decrease	*M:* Yes *I:* Uncertain	The type of species richness index used for this TP should be established before sampling takes place; as above a baseline against which to compare change will be essential
	3	Response of the fishery to marine pest and disease incursions	*R:* Moderate *E:* Yes	Guidelines specified in any Marine Pest and Disease Management Program are not adhered to by the Ocean Trap and Line Fishery	*M:* Yes *I:* Yes	Communication links between Marine Pest and Disease Management program, relevant fishery managers and industry will need to be established and/or maintained
	4	Area closed to the fishery & habitat types included	*R:* Good *E:* Yes, increase	The area open to the fishery increases or the percentage with adequate descriptions of habitat types is unknown or does not increase within 5 years	*M:* Yes *I:* Yes	Ongoing measurement of changes in large area species richness should also be done inside & outside closures to determine whether biodiversity is changing as a result of the management action

Table E5.2 cont.

Goal No. (& summary)	PI No.	Performance Indicator		Trigger Point		Comments
		Brief Description	**Assessment**	**Brief Description**	**Assessment**	
2 (maintain stocks of Primary and Key Secondary species at sustainable levels)	1	Exploitation status of Primary & Key Secondary species	*R:* Good *E:* Yes	The number of Primary or Key Secondary species determined as 'overfished' (other than those already identified in the FMS) is more than one in any year	*M:* Yes *I:* Yes	This will require resource assessments to be done of all species in these two groups and will take time, but are important for the achievement of the goal, as 4 of the 25 are already recognised as overfished
	2	Total annual landings of Secondary species as a percentage of total OTL landings	*R:* Poor *E:* Uncertain	Contribution of Secondary species exceeds 15% in two successive years	*M:* Yes *I:* Yes	Doesn't measure sustainability levels; change in targeting may result in Secondary species becoming Key Secondary & therefore requires revision of Primary & Key Secondary list; 15% is 1.5 times the ratio for 0102 of 10%, and should be set below that mark ~5%.
3 (conservation of threatened and protected species)	1	Interactions which may threaten the survival of threatened species, population or community	***R:*** Good ***E:*** Yes, decrease	Any interaction which may threaten the survival of a threatened species, population or ecological community	***M:*** Yes ***I:*** Yes	Reliance on self-reporting of interactions severely undermines this trigger, which should be defined following at least the first year of an observer program
	2	Interactions which may threaten the survival of a protected species	***R:*** Good ***E:*** Uncertain	An annual review of interactions determines that the level of interaction may threaten the survival of a protected species	***M:*** Yes ***I:*** Uncertain	As above, but also there is no baseline against which to measure whether or not the FMS has had an effect, the level of interactions at which there is a problem or which interactions are a threat to the survival of protected species
	3	Number of grey nurse sharks caught by the OTLF	***R:*** Good ***E:*** Yes, decrease	Trigger point to be determined once baseline data collected through observer program and catch reporting system	***M:*** Yes ***I:*** Yes	Observer program should be used to identify areas other than Critical Habitat where the sharks are captured and to consider need for closures to line fishing
4 (resource sharing)	1	Proportion of Primary, Key Secondary & Secondary species taken by each sector (including commercial, recreational & Indigenous)	***R:*** Moderate ***E:*** Uncertain	Relative catch between sectors shifts by 25% between year 1 and year 5 values following the commencement of the FMS and then every five year period thereafter	***M:*** Yes ***I:*** Yes	No definition of "appropriate share" so percentage of change is arbitrary & must be reviewed with more information; current share levels can't be used as a baseline; data from recreational & Indigenous sectors may not be comparable; no indication of potential measures should there be a shift
	2	Proportion of each Primary and Key Secondary species between the OTLF and other NSW commercial fisheries	***R:*** Moderate ***E:*** Uncertain	Proportion across commercial fisheries shifts by 25% between year 1 and year 5 values	***M:*** Yes ***I:*** Yes	As above
	3	Proportion of each P & K2 species between endorsement types within the OTLF	***R:*** Moderate ***E:*** Uncertain	Proportion between endorsement types shifts by 25% between year 1 and year 5	***M:*** Yes ***I:*** Yes	As above

Table E5.2 cont.

Goal No. (& summary)	PI No.	Performance Indicator		Trigger Point		Comments
		Brief Description	Assessment	Brief Description	Assessment	
5 (viable fishery that meets ESD)	1	Median gross return of fishing businesses with ocean trap and line endorsements	***R:*** Moderate ***E:*** Uncertain	Median fishery-wide gross return has not increased by at least 20% four years after the commencement of the FMS	***M:*** Yes ***I:*** Uncertain	No definition of what "viable commercial fishery" therefore percentage of change is arbitrary & must be reviewed to determine a more accurate measure and trigger level
	2	Average market value of ocean trap and line shares when traded	***R:*** Moderate ***E:*** Uncertain	To be determined	***M:*** N/A ***I:*** N/A	PI should be revised after the share management plan for the fishery has been established
6 (compliance, research and management)	1	Percentage of inspections resulting in minor & major offences	***R:*** Moderate ***E:*** Yes	Percentage of detections: < 20% minor < 10% major	***M:*** Yes ***I:*** Yes	TP should be reviewed after the first year, may need to be smaller. Reasons for rate of non-compliance, especially major, will need to be investigated to improve efficiency & effectiveness (e.g. see Honneland, 2000).
	2	Number of Ocean Trap & Line MAC meetings held each year	***R:*** Poor ***E:*** Yes	< 2 meetings per year	***M:*** Yes ***I:*** No	May be a regulatory requirement, but does not measure outcome of goal; number of meetings is irrelevant; effective & efficient management indicated by whether all relevant and important issues are adequately discussed within the minimum number of meetings; also indicated by degree to which management acts on recommendations and outcomes from MAC meetings
	3	Reviews & outcomes of strategic plans for research & compliance	***R:*** Moderate ***E:*** Yes	Plans expire without being reviewed or outcomes of reviews are not acted on	***M:*** Yes ***I:*** Yes	Criteria for reviews must be specified and an accountability mechanism for implementing the review outcomes established or clarified
7 (improve knowledge of fishery and resources)	1	Scientific observer program operated in accordance with specifications	***R:*** Good ***E:*** Yes	Observer program does not meet specifications	***M:*** Yes ***I:*** Yes	Effectiveness of PI depends on the rigor of the specifications; different specifications may be needed for different types of observer programs
	2	Number of active research projects with flow-on benefits to OTLF & fill information gaps from EIS	***R:*** Good ***E:*** Yes	Number of research projects relevant to information gaps < 2 in any one year.	***M:*** Yes ***I:*** Yes	List of information gaps should be held by internal fisheries approval process to ensure proposed projects are relevant and discussed with MAC
	3	Accuracy of catch return (or daily logbook) data	***R:*** Good ***E:*** Yes	The percentage of species records with poor reporting does not decline after 1 year of operation of new reporting procedures	***M:*** Yes ***I:*** Yes, if % defined	"Accuracy" & percentage needs to be defined

E5.1.1.2 Monitoring and information collection

Table E5.3 shows that data and other information required for the PI and TP will be obtained using a range of fishery programs and other sources, but primarily from improved catch and effort reporting systems for the fishery. Reliance upon self-reporting and other existing programs partly explains why some of the PI are either of limited relevance to the outcomes of the goal, or where there is uncertainty in the ability to detect change due to the draft FMS. The poor quality of the fishery data was recognised in the risk assessment as requiring serious improvement and although improvements have been proposed in the draft FMS, they need to go further by including independent validation.

Table E5.3 Sources of information used to monitor Performance Indicators.

Note: * denotes that 5 are external reports

Information source	**Number of PI using source**
Mapping	1
Resource assessments	1
Compliance	2
Observer study	7
Catch data/returns	9
Other reports	9*

There are 9 PI and TP that require information from reports produced either by other sections within NSW DPI or external agencies. A vast amount of data and information will be needed to adequately monitor the performance of the OTLF against its goals. Furthermore, given the implementation of FMS is a relatively new process, careful attention will be required as the FMS is implemented as to how the results of reports will be coordinated to ensure the appropriate information is passed on to the right group of people for appropriate analysis, interpretation and action. The NSW DPI is currently revising the Resource Assessment Framework (Scandol, 2004) and it includes consideration of these issues. The framework proposes some technical and procedural responses to address those concerns discussed above, as well as other cross-fishery issues.

E5.1.1.3 Reporting and review

Reporting and reviewing is a crucial step in monitoring the performance of the fishery because it provides a path for feedback into the process and opportunities for learning how to improve the management and science of the OTLF. Two types of reporting are proposed in the draft FMS – performance assessment and trigger point review. In the former both the performance indicators and implementation of each management response will be included and reviewed annually and reported biennially. The latter reports on any performance indicator that has been triggered encompassing the likely causes for the trigger going off and recommendations for remedial action required, within a specified timeframe. It will be important that there is some mechanism to ensure the recommendations for remedial action from both these types of report are acted on in an appropriate and timely manner. The response taken on any recommended remedial action in the previous year should be included as part of the annual review.

The review and reporting process of the draft FMS will be complex and therefore it will be essential there are clear paths of information transfer and analysis. Apart from reports being submitted to the Minister for Primary Industries and the relevant MAC and advisory councils, it is not clear in the draft FMS how information will be disseminated to the relevant professionals within or outside of

NSW DPI, including scientists and managers, for their input, nor how any remedial actions will be formulated and by whom. The reporting and review process would be substantially strengthened if these mechanisms were specified.

Many performance monitoring programs in other parts of the world have specific remedial actions already set if a trigger point is tripped (e.g. Gray and Jensen, 1993; Caddy and Mahon, 1995; Caddy, 2002) so that management can take action immediately when there is a signal something is wrong. These types of programs usually occur in fisheries with well developed resource assessment data and analysis where specific management responses can be identified and are specifically linked to the PI, which is not the case in this and other commercial fisheries of NSW. However, the performance indicators and trigger points in the draft FMS of the OTLF are all at a very preliminary level and until these are refined (via research, monitoring, review, and feedback) remedial actions cannot be specified in advance. But it would be highly desirable that as the performance indicators and trigger points are improved that the review process be adjusted to incorporate pre-determined management action (in consultation with stakeholders, scientists and management) if an indicator is triggered (where a limited number of factors could have triggered it). This would have the advantage of allowing management to respond immediately to a problem rather than waiting for a lengthy and costly consultative process. Of course it would be essential that the outcomes of such management actions be monitored and reported.

E5.1.1.4 Conclusion

The answer to the question posed at the beginning – "Does the performance monitoring and reporting process in the draft FMS adequately measure its performance in attaining the goals?" - is mostly yes. However, many of the PI and TP are preliminary until further work is done to develop them or determine new ones that are more appropriate. It is essential that this further work and development is done.

E5.1.2 Environmental impact monitoring

As discussed in Chapter B2, there are limited ecological impacts that the OTLF is likely to have on the marine environment, but as yet we don't know the extent or magnitude of these impacts, not even for the majority of the primary species of the fishery. Monitoring impacts in the sea is very complex. One of the major difficulties is knowing what to monitor, at what spatial and temporal scales and how to measure them (Fairweather, 1991; Underwood, 1995). For some primary species we have a reasonable understanding of what to measure in order to monitor the impact of growth and recruitment overfishing, such as length and sex composition in catches of a species. But for many other impacts it is not clear what to measure, nor how, because the ecological processes that may be affected by the OTLF are complex, have multiple interactions and can involve populations and assemblages of species across a large range of spatial and temporal scales. Furthermore, natural variability in marine systems is often large. Therefore, detecting that an impact has occurred requires the ability to distinguish changes in whatever is being measured (e.g. length of adult fish) from this natural background variability (Fairweather, 1991; Underwood, 1995). There is a substantial body of ecological research that provides many insights into how to detect impacts (e.g. Fairweather, 1989; Schmitt and Osenberg, 1996; Underwood, 1996). Clearly, the OTLF should make use of this research in applying it to understanding the ecological impacts that could be attributable to the OTLF in the oceanic environment off NSW, even though they are currently thought to be somewhat limited.

Therefore, monitoring for the impacts of the OTLF on the marine environment is not a simple case of regularly measuring a set number of entities and watching for when they exceed certain critical levels. Rather, it will require a more diverse approach via research programs designed to increase our understanding of the oceanic environment and how fishing impacts may be occurring in them, that help determine what aspects could be monitored for detecting impacts from fishing. How much of this increased understanding can be done through the FMS itself will be limited by its scope and will therefore require collaboration with other research projects within and outside NSW DPI.

The DP guidelines (Appendix A2) for this EIS requires that performance reporting and monitoring be assessed in terms of their effectiveness in providing information for monitoring impacts of the proposed FMS for the OTLF on the environment. The effectiveness of the information to monitor impacts was assessed using the following questions:

a) For the impacts of overfishing, changes in biodiversity and threatened species what entities should be measured to monitor them?

b) Is the information provided by the performance indicators and relevant management responses adequate to monitor the impacts?

c) For other ecological impacts what information is needed to investigate how these impacts manifest themselves on the oceanic environment of NSW and the adequacy of the research programs to provide this information?

d) How is the information reported and acted upon?

E5.1.2.1 Measures of impacts in the OTLF

There were four major ecological impacts of the OTLF identified in the risk assessment of Chapter B2. These were:

i) overfishing: recruitment (gemfish) and growth (snapper, silver trevally and yellowtail kingfish)

ii) changes to biodiversity

iii) impeding recovery of threatened species or populations

iv) disruption of ecological processes (which encompasses several processes such as recruitment, dispersal, predator-prey interactions etc.)

There were no direct measures for ecological processes. Given the lack of knowledge about the ecological processes in the oceanic environment it is difficult to measure disruption to ecological processes directly. However, these types of impacts can have profound long-term effects of the sustainability of a fishery (e.g. Fogarty and Murawski, 1998) and should not be ignored. In reality, disruptions to ecological processes are the results of the cumulative effects of the other major impacts that have been identified. Therefore, until our knowledge base about the ecology of the oceanic environment improves, emphasis must be placed on ensuring that the measures of the other impacts are adequate and analysed singularly, as a whole and cumulatively.

Table E5.4 lists the main entities to be measured for the first three impacts and is an indicative list rather than an exhaustive one. It also summarises the information provided by the Performance Indicators (PI) and Management Responses (MR) that relate to these entities, and details the adequacy of those measures.

Table E5.4 List of ecological impacts of the OTLF, the entities measured to monitor them and adequacy of the information provided by the PI and MR.

Y – yes, N- no, A – adequate, P – primary species, K2 – key secondary species, S – secondary species, PI – performance indicator, MR – management response

Potential ecological impacts	What needs to be measured to monitor impacts?	Goal #	PI #	Information provided by PI	A	MR #	Information provided by MR	A
Growth & recruitment overfishing	Size structure of P, K2, S; Landings, temporal variability, exploitation status	2	1	Determining exploitation status will require knowing landings & temporal variability	Y	2.1a	Quantity, length, age, sex composition of landings of P & K2 spp; Indicates whether there are significant changes in reported landings over time	Y
						2.1b	Develop and conduct resource assessment for the P & K2 spp; basis for determining overfished species and assessing many species for the first time	Y
						2.1c	Annual landings of P & K2 spp against reference levels; contributes to determining exploitation status; weakened by use of 'species group level' for status	Y, when done by species, not groups
						2.1d	Monitor S spp against historical highs and lows	Y
						2.1e	Cost effectiveness of fishery-independent surveys	N
						2.1f	Review and where appropriate implement minimum legal lengths for P & K2 spp	Part
						2.1g	Minimum legal length (MLL) of 130 cm for wobbegong sharks	N
						2.1h	Economic assessment of increasing snapper MLL to 32 cm	N
						2.1i	Cap the catch of school and gummy sharks whilst developing a quota scheme with AFMA	Y
						2.1j	Input controls for spanner crab whilst the feasibility of output controls are considered	Part
						2.1k	Onboard observers to collect biological information for elasmobranchs	N
						2.2a	Recovery program for gemfish Recovery program for snapper	Y N
						2.2b	Implement provisions of silver trevally recovery program	Y
	Bycatch/discards	1	1	Species composition of retained and non-retained parts of the fishery	N	1.2a	Observer program to monitor rates and other aspects of discards	N
						1.2b	Fish escape panels (50 x 75 mm mesh) in fish traps	Part
						1.2c	Prohibit use of fish spikes or clubs	Y
						1.2f	Exclusive use of circle hooks for unattended line methods	Part
			2	Measures changes in proportion discarded	N	1.2a	Observer program to monitor rates and other aspects of discards	N

Summary: *Overall, it would appear that the most important entities for determining overfishing (i.e. resource assessments) are being measured by the PI or MR. Some shortcomings are the use of groups of species, the cross-fishery observer program that may not be able to adequately address discard issues and awaiting the results of potentially lengthy economic surveys (re escape panels and size limit changes) when biological information suggests that the time to act is now.*

Table E5.4 cont.

Y – yes, N- no, A – adequate, P – primary species, K2 – key secondary species, S – secondary species, PI – performance indicator, MR – management response

Potential ecological impacts	What needs to be measured to monitor impacts?	Goal #	PI #	Information provided by PI	A	MR #	Information provided by MR	A
Decrease or change in biodiversity	Proportion of habitat types (surrogate) utilised by the fishery	1	4	Closed areas and their habitat types	Part	1.1a	Map fishing grounds and associated geological features	Part
	Number of species in habitats	Not provided				Not provided		
	Number of species caught by or interact with fishery	1	1 & 2	Species composition and proportions of retained and non-retained parts of the fishery	N	1.2a	Observer program to monitor rates and other aspects of discards	N
						1.1b	Catch returns to determine number of lost traps, i.e. potential for ghost fishing	N
		7	3	Accuracy of catch return data	Part	7.3a	Periodic review of returns	Part
Summary: *Overall, it would appear that the FMS is deficient in addressing this impact as only two of the three entities is proposed to be partially measured by both PI & MR, and does not include the most directly related entity of species composition of affected species. Collectively, there is either insufficient or inadequate information provided to monitor & interpret changes to species richness*								
Impede recovery and conservation of threatened species	Rate & outcomes of interactions with threatened species, populations & communities & protected species	3	1	Catch returns and observer program to report interactions with threatened spp to Threatened Species Unit	Part	1.2a	Observer program to monitor rates and other aspects of discards and interactions	N
			2	Annual review by Threatened Species Unit of catch returns and observer program to assess interactions with protected spp	Part	3.1a	Modify catch return forms	N
			3	Number of grey nurse sharks caught by the fishery	Y	3.1b	Implement provisions of relevant recovery plans	Part
						3.1c	Circle hooks for unattended line and investigate for attended lines; prohibit wire trace	Part
Summary: *Overall, it would appear that the FMS will aid the recovery and conservation of the majority of threatened species, largely because most are already at moderately low risk. It will not, however, reduce the risk to grey nurse sharks or black cod, at high and moderately-high risk, respectively*								

E5.1.2.2 Adequacy of information provided to monitor impacts

Assessment of the adequacy of the information was based on how well the PI corresponded to the entities to be measured for each of the first three impacts (Table E5.4). Some of the most important entities for determining overfishing impacts (resource assessments) are monitored via appropriate PI and MR and will primarily consist of monitoring the landed catch. From a fishery and species perspective, this is important information that is also relatively cost-effective and easy to collect. The other important information related to overfishing, that of bycatch and discard data, is not as cheap or as easy to collect and as such will be monitored through a cross-fishery observer program and possibly a pilot survey of discard mortality in the trap component of the fishery. Impacts on threatened species will also be primarily monitored through the cross-fishery observer program, and although it could provide independent validation of self-reported data, as it is not fishery-specific there is concern that it may not be able to provide sufficient spatial and temporal coverage of the fishery to collect the necessary information upon which to base future management decisions. The need for independent validation of self-reported data via a fishery-specific observer program was recognised in the risk assessment and in the previous section on PI, and is worth highlighting again here. The remaining potential impact, changes to biodiversity, is only partially monitored by some of the PI and MR, but this is not surprising given the extent and expense of such an undertaking.

The level of detail provided by the PI and MR varies greatly among impacts. Management responses 2.1a, b, c, g, i and j provide substantial detail to monitor the impact of overfishing on primary, key secondary and secondary species. They do not, however, directly address the ongoing overfishing of snapper and kingfish. The combination of the information from these MR means that detecting this impact should be relatively well monitored for most species of the fishery provided that suitable reference points for what constitutes overfishing for each species can be specified, and that the assessments are done in a timely manner. Whether detection of this impact is possible within a reasonable timeframe is unknown. Information from these MR will contribute to determining the exploitation status of primary and key secondary species, which is one of the PI for Goal 1.

Some of the other management responses under Objective 2.1 were less detailed or were considered unlikely to contribute to preventing overfishing. Some focussed on Cost-Benefit Analysis (CBA), and in their proposed format, generally oppose ESD as they do not consider the broader environmental or social aspects. For example, the snapper CBA fails to recognise research (i.e. Ferrell and Sumpton, 1997) that has already been done and shown that for the long-term sustainability of the species (and thus environmental and social wellbeing), further size increases beyond the current 30 cm are required. Ferrell and Sumpton (1997) also reported that financial gains could be realised within a short timeframe of increasing the size limit up to 36 cm, although substantial losses are likely beyond that size. The species, fishery and fishers, commercial and recreational alike, will all bear the cost in the long-term of not implementing the size increase for snapper in the short term while an economist ponders what is already fairly obvious – that a fishery that derives a large proportion of its income from a species will no longer be viable if the species collapses or continues to be caught at a size that is unsustainable.

Related to the snapper issue is that of mesh selectivity, which is addressed by management response 1.2. Whilst it is reasonable to provide a one-year phase in period for the appropriately sized mesh escape panels and to be further examined via a specific observer program, the subsequent size increase to 30 cm has meant that the 50 mm x 75 mm mesh escape panels will have little effect in terms of reducing the number of undersized snapper retained in fish traps. Other mesh sizes were considered likely to be more appropriate by Stewart and Ferrell (2002, 2003) in the event of size increases beyond 28 cm, which was the MLL during their study. The draft FMS should be implementing larger mesh sizes, such as the 80 x 100 mm gabion wire, and/or considering alternate ways of managing the discard issue in the trap component of the fishery. Further, MR 1.2 indicates there will be no review of mesh size until 5 years after the implementation of the first share management plan. This may provide some short-term certainty to fishers, but it does nothing positive for the species of the fishery and any bycatch species. The proposed pilot survey to investigate the mortality of snapper discarded from fish traps could provide important information with which to make more informed management decisions and/or initiate more comprehensive studies about this poorly understood component of the fishery. Further, the results of the mesh selectivity component of the observer program should be reviewed and reported on annually to ensure that appropriate gear is being used in the fishery. This will become more important as many species of the fishery that do not currently have size limits (e.g. trevally) are likely to have them in future.

There is only likely to be partial measurement of two of the three entities to determine changes to biodiversity, and they will be measured indirectly. The third, that of number of species in habitats, is not measured at all but that is not overly surprising given the size and complexity of the issue and its importance relative to other issues of the fishery. The entity of most relevance to the fishery, that of the number of species that interact with the fishery, will be measured through the cross-fishery observer program, for which the problems have been previously discussed. A fishery-specific observer program is required to record the species and proportions of both the retained and discarded (thus total) components of this multi-method, multi-species fishery. Such a program could, for the first time, provide a detailed list of all species that are directly affected by the fishery, and would provide important information for future decisions about the need or otherwise for BRD or closures (spatial or temporal). Understanding the species that are directly affected could also have provided a better basis for determining those species that could be indirectly affected by the fishery, an aspect that like discarding in general, the risk assessment highlighted as poorly understood in the existing fishery and likely to remain as such in the fishery proposed in the draft FMS.

The other monitoring proposed to determine changes to biodiversity will not provide the necessary information for monitoring or interpreting changes to species richness (this is not the sole indicator of biodiversity, but is a readily obtainable measure for the fishery). Whilst the number of areas closed to the fishery (Goal 1 PI 4) may minimise the potential impact of this fishery on biodiversity in principle, unless they (a) contain habitats and species that exist in fished areas, (b) are of significant spatial and or temporal extent, and (c) are compared to fished areas then they are likely to be of little or no value. There is little point in closing multiple areas that for whatever reason could not or would not be used by the fishery in the first place - that may afford protection to the species that inhabit those areas, but does nothing for the species and assemblages that are targeted by the fishery. Having adequate descriptions of habitat types (PI 4) for closed areas will only be effective if it is the basis for ensuring that otherwise fishable areas are closed to the fishery. This may well already be the case for this fishery, given the existence of and current consideration for further Marine Parks, which are likely to have closed and could yet close extensive areas to the fishery. Any closures will be of limited use, however, unless they are readily enforceable, and the simplest way to do that is through the use of Vessel Monitoring Systems (VMS), which can also be used to record catches and many other aspects. The draft FMS only proposes to “investigate the feasibility” of such systems, however, mindful of fishers’ ability to pay for such systems and relative to the current cost of compliance. For the smaller fishing businesses, this may represent a significant cost (which need not be an initial lump sum), but at the fishery level and for management it would appear to be a significant benefit.

E5.1.2.3 Investigation of other ecological impacts and adequacy of research to provide information

As discussed in the previous section, from a fishery-centric perspective, the most important risk to the fishery, that of overfishing, should be addressed by the draft FMS for the primary and key secondary species, except for snapper and kingfish. It is generally the broader environmental impacts, such as changes to biodiversity and ecological processes that have not been addressed as adequately. To ensure that the fishery is conducted in a sustainable manner, these aspects need to be addressed by collating the relevant information, which will both assist in the determination of the effectiveness of the FMS and of the need or otherwise for other measures.

The most fundamental information needed to monitor those other ecological impacts is the description and analysis of patterns of abundance and distribution of various ecological entities, such as non-commercial species of fish, invertebrates and habitat associations, at a variety of spatial and temporal scales (Fairweather, 1989; Underwood, 2000). Unless we understand these ecological entities, some information for which will come from some of the proposed measures, monitoring the impacts of fishing on these aspects will not be possible. Table E5.5 lists some of these entities and summarises the proposed research programs that may address them.

The greatest opportunity presented by the draft FMS to investigate these impacts of fishing is through research on the effectiveness of closures, as discussed in the previous section. The research program of the draft FMS has been assessed in detail in Section E5.2, and generally speaking, "promoting initiatives" will do little to elucidate these impacts. In particular, there is no proposed research on the effectiveness of closures, be they existing closed areas or any that may become closed to the fishery in future. Whilst this assessment acknowledges the use of closing areas of fishable habitat as a surrogate for protecting biodiversity, it cannot be accepted at face value and requires some degree of investigation. This will provide assurance to fishers that in 'losing' an area they are providing a fishery, environmental and social benefit, instead of appearing as the loss of more grounds for no tangible benefits. Relevant information about these impacts will be best obtained via properly designed large scale experiments using the closures to describe, analyse and interpret patterns in aspects of habitat associations, biodiversity changes and some specific ecological processes. These research projects need to be given higher priority if information to assist in understanding these ecological impacts of fishing is to be obtained.

Table E5.5 Ecological impacts of the OTLF and their aspects requiring further investigation.

Ecological Impact	Proposed research in draft FMS	Aspects requiring investigation
Changes to biodiversity	Impacts of trap and line fishing on ocean ecosystems (including habitat and trophic interactions)	Patterns of distribution and abundance of species over a broad range of habitats and spatial and temporal scales, in particular in areas closed to the fishery
Disruption of ecological processes	Impacts of trap and line fishing on ocean ecosystems (including habitat and trophic interactions)	Key process, such as recruitment, dispersal and settlement of species, in particular in areas closed to the fishery

E5.1.2.4 Reporting on impact monitoring

Measuring and monitoring the appropriate entities is only part of the process of providing effective information for monitoring impacts. What is monitored must also be reported in a coherent and ongoing manner. Much of the reporting of the impact monitoring for the fishery will be done via biennial reports on the progress of implementing the management responses and performance monitoring, particularly for the primary, key secondary and secondary species. Importantly, resource assessment reports will also be externally reviewed every four years. However, there are some impacts which are not adequately covered in the reporting framework of the draft FMS. For example, the draft FMS proposes to map the major fishing grounds of the fishery, including available information on associated geological features, but there is no clear process for how the condition of these habitats might be reported on in an ongoing manner, nor any indication that it will provide an overall proportional assessment of the area of a particular habitat type not fished by or closed to the fishery. Much of this type of information is likely to already be available, both through mapping conducted by CSIRO and various State government departments responsible for the management of the coastline. The other aspect of habitat condition and or assemblages associated with those habitats in fished and unfished areas is likely to be both expensive and time consuming to collect, but is the sort of information that is required to adequately achieve the goal and objective. Without some indication of the differences in assemblages between fished and unfished areas, it is not reasonable to accept the availability of a particular habitat type as a surrogate for ‘promoting the conservation of biological diversity in the marine environment’. As previously stated, ongoing reporting would be particularly important where areas have been closed to the fishery, for both the fishing industry and the community. In the absence of such information, the management response does little to achieve its goal, and appears more suited under the goal of resource sharing and minimising social and within fisheries conflict.

Because the information to monitor the various major impacts of the fishery is dispersed throughout the MR of the draft FMS and distributed according to goals rather than impacts, it would be easy for this information to become disjunct. This is especially the case for impacts other than overfishing. Therefore, it is recommended that a specific list be kept of the entities being measured for each impact and that the results of the impact monitoring be provided in the report on implementing the MR. This will enable a clearer picture of how impacts are being managed.

E5.1.2.5 Conclusion

The information provided by the draft FMS is reasonably adequate for monitoring most of the fishery-centric impacts of the fishery, due largely to the fact that there is limited potential for such impacts in the existing trap and line fishery. In particular, the relatively habitat-friendly nature of the methods of the fishery restricts the potential for direct damage and the associated flow-on effect to species that occupy those habitats, both fishery and non-fishery species. The primary fishery-centric impact, that of overfishing of the primary or key secondary species, is monitored in several ways and in general is likely to address the issue, but needs strengthening in the area of data quality and reporting periods. In particular, independent validation, which is currently possible by cross-checking reported landings of fishers against those of the registered fish receivers, needs to be done on a systematic and not an ad hoc basis as currently appears to be the case. This, coupled with improving species identifications and preventing the reporting of groups of like fishes, will drastically improve the data that is so pivotal for better understanding the potential impacts of the fishery.

Monitoring of another important facet of the fishery, that of bycatch and discarding, is not likely to be adequately addressed through a cross-fishery observer program or the proposed escape panels for fish traps, given the multi-method, multi-species nature of this fishery. To more appropriately monitor these issues, a fishery-specific observer program would need to be implemented, which is also likely to require considerably more funding than is currently available in the industry-funded program. In addition, there are a number of areas where a greater commitment to gathering relevant information about the patterns and nature of ecological impacts is required. That said, it also needs to be acknowledged that monitoring impacts in the oceanic environment is very complex and requires a more comprehensive approach than simply monitoring a few entities.

E5.2 Assessment of Research Plan

E5.2.1 Method of assessment

The DP guidelines (Appendix A2) for this EIS requires that proposed research be assessed in terms of its effectiveness in identifying and prioritising research that fills information gaps for sustainable management of the fishery. The key element in the assessment is “effectiveness”. Two criteria were used in assessing whether the proposed research will be effective.

a) Does it address information gaps identified in the risk assessment or arising from the draft FMS itself?

b) Is the research sufficiently targeted to answer the questions raised by the knowledge gap?

Importantly, most of the major information gaps that were identified in the risk assessment have been addressed by the draft FMS, but the degree to which they have been addressed varies considerably and will be discussed under each of the four ecological research areas. The fifth area of research, that of economics, is discussed in E3.

E5.2.2 Assessment of proposed research

E5.2.2.1 Resource assessments of primary and key secondary species

Resource assessments and basic biological and ecological information were identified as significant information gaps in the risk assessment and represent important research to allow for sustainable harvesting. For the majority of primary species, Class 2 Assessments (1 being the best and 5 the most basic) are proposed and represent new programs or more formal and standardised analysis of existing data for some species.

In addition, two of the three key secondary species considered to be at high risk in the risk assessment (Chapter B2), namely black-spot pigfish and wobbegong sharks, could also have Class 2 Assessments. This indicates that the assessment levels are commensurate with the risk as determined in Chapter B2, and should be an ongoing program, not re-considered every two years as proposed in the draft FMS. All other key secondary species, including those at high risk, namely gummy sharks and the multi-species complex referred to as ‘mixed sharks’ will receive Class 3 Assessments, which seems appropriate given the identification issues that need to be resolved first, followed by a data collection program. Half of these assessments represent new programs, most of which have no existing length data, so should significantly improve both the quality and quantity of information about these species upon which management decisions can be made that are less precautionary and more robust. On the basis of the proposed assessment levels alone, it is apparent that the draft FMS has addressed the information gaps related to biological information for primary and key secondary species, and/or species at high risk as identified by the risk assessment. That is assuming that the assessments as listed in Table D4.6 commence upon implementation of the FMS and remain ongoing programs, as opposed to potentially being cut after a two year review.

It does not, however, address broader ecological aspects of importance to those species. Whilst resource assessments are a very important and significant step, they will not fill information gaps on their ecology or ecological processes relevant to oceanic ecosystems in which the fishery operates. The probable reason for not addressing ecological processes in the research plan is the great difficultly in doing such research both from a logistical and resource perspective and because resource assessment research seems to be more directly relevant to managing the fishery sustainably. However, there is increasing recognition in fisheries research that understanding the ecological processes that shape fish communities is as equally important in making predictions about future trends as traditional stock assessment information (Pitcher, 2001; Pauly and Christensen, 2002; Reynolds *et al*, 2002; Holland, 2003). Furthermore, for some commercial species it may in fact be more beneficial to understand some key aspects of their ecology rather than their stock size and dynamics alone.

It is acknowledged that resources are very limited and NSW DPI needs to be prudent in where these resources are channelled to lower uncertainty and enable more fishery management to be ecologically sustainable. Therefore, it is strongly recommended that serious consideration be given to whether research into some aspects of the ecology of the fish communities of the OTLF would be more cost efficient for, or at least add significantly to, its ability to manage the fishery than relying solely on traditional stock assessment approaches.

E5.2.2.2 Quantification and reduction of bycatch

The principal research program proposed in the draft FMS is the cross-fishery observer program, and will be used to quantify the spatial and temporal distribution of bycatch, and gauge the effectiveness of bycatch reduction devices (BRD) such as escape panels and circle hooks. If the program was fishery-specific, it would represent an important step forward in determining the need for any further measures of reducing bycatch in the fishery, however, as proposed it is unlikely that it will be able to provide sufficient spatial and temporal coverage of the fishery to adequately understand bycatch in this fishery. Further, an observer program is not the appropriate tool with which to investigate the mortality rate of discards, and this information should be collected by a separate, issue-specific research program. A pilot study is proposed to investigate the mortality of snapper that are discarded from fish traps, with the aim of providing information around which to design a more comprehensive study. This information is important to achieve ecological sustainability, reduce risks and fill existing information gaps.

The high discard mortality of undersize female spanner crabs has been previously addressed by fisheries managers through a closure on the taking of spanner crabs during the spawning season, yet little is known about the other methods of the fishery, i.e. trap and line. The risk assessment considered discard mortality issues in the demersal trap fishery and in the line fishery to be major information gaps that need to be addressed by the draft FMS. As previously discussed, the proposed change to 50 x 75 mm mesh escape panels in fish traps is likely to increase the number of undersized snapper discarded due to the size increase to 30 cm TL (and may yet increase further) since the report investigating that mesh was written (see Stewart and Ferrell, 2001 and 2002). Larger mesh sizes in escape panels, such as the 50 x 87 mm weldmesh or 80 x 100 mm gabion wire investigated by Stewart and Ferrell (2002), are more appropriate given the increase in snapper MLL to 30 cm and a further potential increase to 32 cm. The associated loss of other important species highlights the need as discussed in Chapter B2 for the draft FMS to consider the use of multiple mesh configurations that are better able to target the multiple species of this fishery. Although such an approach or process is not considered in the draft FMS, it is likely to be a result of determining MLL for the primary and key secondary species of the fishery, as is proposed in the draft FMS. Silver trevally is already proposed to increase to 30 cm under the Ocean Trawl FMS, and other species are also currently being reviewed.

Another related information gap that was identified in the risk assessment was ghost-fishing, in particular the quantity of lost gear and its hazard life (the length of time that the lost gear is likely to continue fishing). The draft FMS does not propose any research in this area, although it does propose to address one of the issues by having fishers report the number of lost traps on their annual catch returns, but does not include line gear. Data quality, particularly self-reported data that has not been independently validated, was also identified as a serious risk in the assessment and should not be the basis for determining the potential extent of ghost-fishing via lost traps. The data, including the number of lost lines/hooks, should be collected through the observer program and to aid in the interpretation of the results, needs to be complemented by an assessment of the hazard life of the gear. Knowing one or the other is useless, as by itself it does not tell you anything. The small-scale manipulative experiments that are discussed in the draft FMS need to be done, not discussed, if this component of 'research' is to be effective. In its current format it does not fill any information gap.

E5.2.2.3 Impacts of trap and line fishing on ocean ecosystems

There is no specific research proposed in the draft FMS to address this issue, although there are numerous management responses and an indirect area of research that will go some way towards understanding these impacts. The management responses largely relate to mapping major trapping grounds, collecting information on ghost-fishing, improving species identifications, resource assessments and examining discards in the fishery through the observer program. The merits or otherwise of these responses have been previously discussed and suffice to say that collectively they will provide some information, but do not represent research *per se*.

The draft FMS would be greatly strengthened if it included a dedicated set of research projects using rigorous scientific methods (Walters, 1986; Underwood, 1990, 1992; McAllister and Peterman, 1992) to test predefined hypotheses about the differences between areas open and closed to the fishery in terms of biodiversity and biomass of primary and key secondary species. As a minimum, the research plan should consider how the results of research from the Marine Parks Authority on the effectiveness of the marine parks could be used to evaluate and test other areas closed to the fishery. That said, it should be acknowledged that the necessary studies to rigorously assess impacts on ecosystems due to the fishery are likely to be very difficult and prohibitively expensive, especially when weighed against the various other research needs of the fishery.

The indirect area of research proposed in the research plan relates to determining indicators for biodiversity. Instead of a direct research project it is suggested that a combination of other studies by both NSW DPI and other government organisations could form the basis for such research. However, the plan is unclear how the various initiatives referred to could contribute to determining biodiversity indicators. Whilst it is acknowledged that this area of research is very difficult the research plan does not make a strong commitment to pursuing means of how biodiversity indicators could be identified. It does note that NSW DPI currently has a joint research project with the University of British Columbia (Canada) that will develop an ecosystem-based model for fishery management in NSW. Whilst it is hoped this will provide a better understanding of the ecosystems in which the fishery operates, it is not clear to what extent it may contribute to developing appropriate biodiversity indicators at the fishery level, although the project has recently been refocused to consider the development of indicators.

E5.2.2.4 Impact of fishing on threatened species

The risk assessment considered the risk to the majority of threatened species to be low, and that a limited number of finfish could be at moderate or greater risk. Those risk levels are not increased under the draft FMS and are reduced for great white sharks, although grey nurse sharks and black cod will remain at high and moderately-high risk, respectively. Irrespective of the adequacy of the management responses to address those species, appropriately the draft FMS does not propose any specific research into these species, instead proposes to be consistent with and subservient to any measures proposed in their recovery plans. The recovery plans are the appropriate avenue to guide specific research on relevant issues, and where appropriate should include measures to mitigate the impacts of this fishery. Assuming that the recovery plans are effective in reducing all risks to the species and contain research proposals to investigate those impacts, then it is considered unnecessary for the draft FMS to propose research into those species. As the recovery plan is species-specific, then it has a much greater chance of implementing appropriately scaled observer programs than even a fishery-specific observer program could achieve, not to mention the cross-fishery program as is proposed in the draft FMS.

CHAPTER F JUSTIFICATION FOR THE PROPOSED COMMERCIAL FISHING ACTIVITY

F1 The Need for the OTLF

This section examines the need for undertaking the fishing activity proposed in the draft Fishery Management Strategy (FMS) and the consequences of not undertaking the activity. The OTLF exists because it satisfies a number of significant community needs, each of which is discussed separately below.

Should the OTLF not continue, some of the resources used by the fishery would become available to other users, or would contribute to ecological processes and diversity. However, many of the primary and key secondary species taken by the OTLF can not be taken in significant quantities by other fishing methods that have a lesser or equal impact on the environment, and it is unlikely that increased catches by other resource harvesters would offset the loss of product if the OTLF ceased to operate. The employment and economic contributions of the OTLF to the coastal economy of NSW are also quite significant, and would not be easily replaced should the fishery cease to operate.

F1.1 Supply of Seafood to the Community

The OTLF provides, on average, about 1,800 t of fresh seafood annually, most of which is consumed locally within NSW, although small quantities of certain species are exported. The supply of shellfish and finfish to local markets by commercial fishers satisfies demand from consumers who do not wish to, or are unable to, venture out and catch the fish themselves. If the OTLF ceased to operate, availability of these species to NSW consumers would be significantly reduced, as other fisheries or fishing methods would be unable to land sufficient quantities (or similar quality) of product to meet market demand.

A survey undertaken by Ruello and Associates in 2000 identified the increasing importance of fresh local seafood to both consumers and businesses, and retailers continue to promote the local product (e.g. recent promotion of silver warehou, *Seriolella punctata* by Sydney Fish Market). A viable OTLF will continue to satisfy the high community demand for local, fresh seafood.

F1.2 Employment Considerations

The OTLF provides considerable employment opportunities in many coastal centres in NSW, with around 991 to 1925 people being employed either directly or indirectly by fishing businesses endorsed to operate in the fishery. In many instances these jobs are created in rural areas where unemployment rates are generally higher than in urban areas. The presence of trap and line fishers in a port also encourages the development of considerable infrastructure for the supply of fuel, ice, electronic aids and vessel maintenance, and for the unloading, handling and marketing of product. The available studies relating to employment flow-on effects for the OTLF in NSW indicate a multiplier factor of 0.4 times the direct effect (Tamblyn and Powell, 1988; Powell *et al.*, 1989). Even with the necessary effort controls proposed to be implemented by the draft FMS, the OTLF will continue to support a significant number of jobs in the broader community.

F1.3 Economic Considerations

In 2000/01, revenue at first point of sale for seafood caught from NSW waters by ocean trap and line fishers was approximately $10 million. All businesses contributed to the local economy through the purchase on inputs and factors of production. This revenue for the fishery provides an important source of employment for fishers and has multiplier effects in regional communities. Economic multipliers in the fishing industry are, however, low and total effects are generally between 1.5 and 2 times the direct effect (Tamblyn and Powell, 1988; Powell *et al.*, 1989). A significant proportion of the catch is sold in local and regional outlets, as well as the traditional markets in Sydney, Brisbane, Melbourne and Canberra, so the fishery can be considered to be a significant component of the regional fishing industry economy.

F2 Justification of Measures in Terms of ESD Principles

The OTLF is a multi-method, multi-species fishery managed by input controls, such as trap size, limits on vessel size, and for some species minimum size limits or trip limits apply. The benefits and need to maintain a viable commercial OTLF are outlined above.

The impact of the OTLF on the marine environment has been assessed in the EIS by an initial analysis of the risks associated with the existing management regime. The risks associated with the fishery are partitioned into components related to the impacts of trap and line fishing on retained species, incidental catches, threatened and protected species, habitat damage and other associated activities. These risks have been fully reviewed and discussed in Part 2 of Chapter B and Chapter E of this EIS.

The draft FMS, as outlined in Chapter D of the EIS, proposes goals, objectives and management responses for the fishery, having regard to the risks identified in the existing management regime (i.e. Part 2 of Chapter B). The preferred suite of rules (including management responses) in the draft FMS, provides for appropriate access to the resources and incorporates the tools necessary to achieve resource sustainability.

The draft FMS provides a broad framework for managing the OTLF that describes a range of programs to be implemented; some of which are immediate actions, others are longer term programs with a development stage and need to undertake further stakeholder consultation built in. For these longer term programs, while the draft FMS outlines the proposals in broad terms, it often omits fine detail and the environmental assessment has consequently concluded only a negligible or minor reduction in risk in some areas. In order to ensure that the fishery operates in an ecologically sustainable manner into the future and that the risks are meaningfully reduced, it will be important to ensure that the strategies and plans that are subsequently developed under the FMS are implemented so as to fulfil the goals and objectives for the fishery. With this qualification, it can be stated that the draft FMS address the principles of ESD in the following ways.

F2.1 Precautionary Principle

The precautionary principle is defined in the May 1992 Intergovernmental Agreement on the Environment as:

"where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation" (Deville and Harding, 1997).

The introduction of the precautionary principle has, as described by Deville and Harding (1997), shifted the 'onus of proof' regarding impacts away from regulatory bodies and more towards those whose actions may cause damage. Those undertaking the activity are required to provide a convincing argument that their actions will not have serious or irreversible impacts on the environment, which exceed the long-term benefits of the actions.

As recognised in the assessment guidelines under which this EIS was prepared, scientific research into the size and characteristics of shellfish and finfish stocks is inherently complex and costly. Shellfish and finfish populations and the aquatic environment inhabited by them are extremely dynamic. This means that the level of scientific uncertainty associated with shellfish and finfish stocks, and aquatic communities in general, is very high. This is especially so for the many species taken in the OTLF that are of low commercial value or occur only infrequently in catches. This situation is by no means unique to NSW or indeed Australian fisheries.

Historically, management of the OTLF has been issue-driven, resulting in management that could be described as somewhat fragmented and un-coordinated. Measures proposed in the draft FMS take a more precautionary approach by continuing the existing controls on fishing, and by proposing new initiatives to deal at the "whole-of-fishery" level with the uncertainty surrounding the impact of trap and line fishing on ocean habitats and the effects of trap and line fishing on incidental species. Appropriate actions within the draft FMS that are positive precautionary steps aiming to minimise the impacts (known and presumed) of trap and line fishing on the ocean environment include:

- implementing escape panels in fish traps
- encouraging further research into bycatch reduction and setting research priorities to fill the information gaps identified in this EIS
- initiating programs to set long term fishing effort targets
- implementing new limits on the amount of gear able to be used
- implementing an onboard observer program
- improving the strength of the compliance regime through a penalty points scheme, involving endorsement suspension and share forfeiture
- improving the collection of social and economic information on the fishery, and
- developing a code of practice

The performance monitoring system established by the proposed FMS also provides a necessary safeguard in case there are changes in either the operation of the fishery or stock levels, which could compromise the long-term sustainability of the fishery.

F2.2 Intragenerational Equity

Intragenerational equity relates to distributing the costs and benefits of pursuing ESD strategies as evenly as practicable within each generation (i.e. within the OTLF but also between the fishery and other parts of the community).

A large number of species caught in the OTLF are taken in other commercial fisheries and also by recreational and Indigenous fishers, sometimes as key target species. In some cases it is the juvenile or small fish that are caught by the OTLF, of species where the adults or larger fish are taken by other fisheries, however in many cases the OTLF takes the same size classes of fish taken by other fishers. In addition to the issue of allocation of the resource, there are issues relating to habitat degradation and the allocation and management of often conflicting user activities (i.e. commercial fishing, charter boat/recreational fishing, boating, swimming etc.).

The draft FMS contains proposals to assess the size of the total catch of each species by all sectors, so that the distribution of the resource is known, and performance measures are to be put in place to monitor and manage the distribution of catches of the retained species between sectors. The measures proposed in the draft FMS distribute, as far as practicable, a fair and equitable sharing of the fisheries resource amongst fishers and the community. The operation of the fishery provides fresh local seafood to satisfy an ever-increasing consumer demand for seafood. Under the FMS, resource assessments incorporating data from all significant user groups will be developed for each of the primary and key secondary species.

The cross-jurisdictional liaison, mapping of trap and line grounds, and the development of a code of practice proposed in the draft FMS all promote equity of access to the physical environment used by ocean trap and line fishers and others in the community.

F2.3 Intergenerational Equity

Intergenerational equity relates to the present generation ensuring that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Intergenerational equity in the context of the OTLF is a fundamental, if complex, concept. It consists of ensuring the fishery operates in a manner that minimises the impact of trap and line fishing on habitat, bycatch and threatened species, populations and ecological communities, as well as maintaining primary, key secondary and secondary stocks at sustainable levels.

A long-term approach is necessary to ensure the sustainability of the OTLF, and the resources on which it depends. Overfished stocks may take a long time to recover when a long-lived species is involved, and benefits of management actions might not accrue for a considerable period after the 'costs' of rehabilitation have been incurred. Conversely, impacts of fishing on newly exploited stocks generally do not become evident until the stock suffers a distinct decline, which is frequently due to the cumulative effects of fishing over a considerable period.

Fishing closures, including marine parks and aquatic reserves, are used to conserve the resources and protect areas of ecological significance. There will also be substantial benefits to future generations from the recent and continued declaration of a comprehensive, adequate and representative system of marine protected areas (such as marine parks, aquatic reserves and intertidal protected areas) that includes a full range of marine biodiversity at ecosystem, habitat and species levels (Marine Parks Authority, 2000). Future generations will benefit from the data collected through the monitoring programs and future research proposed by the draft FMS.

The draft FMS contains seven broad goals that, if realised, will provide future generations with the same or improved opportunities to benefit from the valuable natural resources which the current generation enjoys. Some management measures proposed within the draft FMS to achieve these goals, and hence intergenerational equity, include:

- improvement in the accuracy of information on activities and catches of the fishery, and development of resource assessments for all primary and key secondary species
- development of a code of practice for the OTLF to address issues such as best practice techniques, handling and returning bycatch, and use of gear etc.
- continued use of fishing closures to control fishing activities within the OTLF
- continued use and review of the compliance strategic plan including advisory and education programs to deter illegal activity and educate the broader community
- implementation of an endorsement suspension and share forfeiture scheme to ensure a consistent and complimentary approach to compliance across all fisheries
- the range of changes to gear use and effort to minimise the impact of the fishery on bycatch, threatened species and to prevent overfishing of the retained species

- the provision that requires the preparation of a recovery plan for species that are determined as being overfished
- development of a comprehensive performance monitoring and review program, the results of which will be publicly available.

F2.4 Conservation of Biodiversity and Ecological Integrity

This principle incorporates the notion that conservation of biological diversity and ecological integrity should be a fundamental consideration in resource decision making. The draft FMS strongly adopts this principle, with one of the seven major goals being "to manage the OTLF in a manner that promotes the conservation of biological diversity in the marine environment". There are four objectives beneath that goal which specifically aim to address the following issues:

- mitigating the impact of trap and line fishing in NSW ocean waters on ecosystem integrity
- mitigating the impact of ocean trap and line fishing on bycatch
- mitigating the impact of the fishery on ocean habitats and their associated biota
- preventing the introduction and translocation of marine pests and diseases by fishing activities.

In order to achieve this goal and its objectives, there are 11 management responses in the draft FMS that directly address biodiversity and ecological integrity issues, including mapping trap and line grounds and assessing the intensity of fishing on each ground, using fishing closures to protect areas of key habitat, introducing an observer program to collect information on the quantity and composition of bycatch and other key information, using best practice techniques for handling non-retained animals, introducing a code of practice for the fishery, and supporting monitoring and research on ecosystem functioning.

The draft FMS also contains proposals which attempt to monitor the impact of the fishery on biodiversity, such as recording interactions with threatened or protected species, monitoring bycatch levels, and providing mechanisms for taking action if the performance of the fishery relative to the goals of the strategy changes to a significant degree.

In conclusion, the draft FMS contains a comprehensive and appropriate package of measures for ensuring that the impacts of the OTLF on biodiversity are properly managed.

F2.5 Improved Valuation, Pricing and Incentive Mechanisms

This principle relates to the use of schemes like user pays and incentive structures to promote efficiency in achieving environmental goals. The OTLF, along with most other marine commercial fisheries in NSW, is moving towards a category 1 share management fishery regime. This management framework provides for the issue of shares in perpetuity to eligible fishers and provides for the existence of a market-based trading scheme. The share management scheme for the OTLF will provide greater incentives for stewardship and long term sustainability of the resource because the value of shares when traded is likely to be linked to investor's views about the health of the fishery and the anticipated returns on investment.

The share management scheme should also provide greater flexibility over time for shareholders in the fishery to be able to trade shares with each other. This will enable fishers to change the structure of their fishing businesses more efficiently. The fishery management strategy provides for the development and implementation of an orderly structural adjustment program to achieve a viable level of fishing effort in the longer term. Once the adjustment has occurred, this will enable fishers to sell shares in those fisheries (or parts of the fisheries) that they do not rely on, and to purchase shares in the fisheries (or parts of fisheries) that are important to their fishing businesses.

The share management scheme incorporates the notion of a user pays system as there is an annual rental charge payable by each shareholder additional to the normal licensing and management fees, and the current Government policy is to phase in full cost recovery in the fishery between the years 2005 and 2008.

CHAPTER G REFERENCES

Note: articles that have not been externally peer reviewed and published in a journal or book are denoted with an asterisk (*).

*ABARE 2004. Australian Fisheries Statistics 2003. Canberra, 59 pp. ISSN 1037-6879.

*AFFA (2003). *Importation of Pilchards* (Sardinops sagax) *for Direct Introduction into Natural Waters. Biosecurity Policy Review of Viral Haemorrhagic Septicaemia Virus (VHSV). Draft Report, June 2003.* Australian Government Department of Agriculture, Fisheries and Forestry, 111 pp.

Agardy, T., Bridgewater, P., Crosby, M.P., Day, J., Dayton, P.K., Kenchington, R., Laffoley, D., McConney, P., Murray, P.A., Parks, J.E. and Peau, L. (2003). Dangerous targets? Unresolved issues and ideological clashes around marine protected areas. *Aquatic Conservation: Marine and Freshwater Ecosystems,* **13**: 353-367.

Allen, G.R. (1997). *Marine fishes of tropical Australia and south-east Asia*. West Australian Museum, Perth, Australia. 292 pp.

Allison, G.W., Lubchenco, J. and Carr, M.H. (1998). Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications* **8 (Supplement)**, S79-S92.

Alverson, D.L., Freeberg, M.H., Murawski, S.A. and Pope, J.G. (1994). *A global assessment of fisheries bycatch and discards.* FAO Fisheries Technical Paper No. 339. FAO, ROME (ITALY), 1994, 233 pp.

Anderson, M.J. and Millar, R.B. (2004). Spatial variation and effects of habitat on temperate reef fish assemblages in northeastern New Zealand. *Journal of Experimental Marine Biology and Ecology* **305**: 191-221.

*Andrew, N.L., Graham, K.J., Hodgson, K.E. and Gordon, G.N. (1997). *Changes after twenty years in relative abundance and size composition of commercial fishes caught during fishery independent surveys on SEF trawl grounds.* FRDC Project 96/139 NSW Fisheries Final Report Series No. 1. December 1997. NSW Fisheries, Cronulla.

Anon. (2003). The catching capacity of lost static fishing gears: introduction. *Fisheries Research*, **64**: 101-105.

*Anon. (2004). *Fisheries Victoria Commercial Fish Production Information Bulletin 2004.* 33 pp (Primary Industries Research Victoria (PIRVic): Queenscliff, Victoria, Australia)

Arnould, J.P.Y., Littnan, C.L. and Lento, G.M. (2000). First contemporary record of New Zealand fur seals *Arctocephalus forsteri* breeding in Bass Strait. *Australian Mammalogy* **22**: 57-62.

Ault, J.S., Diaz, G.A., Smith, S.G., Luo, J. and Serafy, J.E. (1999). An efficient sampling survey design to estimate pink shrimp population abundance in Biscayne Bay, Florida. *North American Journal of Fisheries Management* **3**: 696-712.

Auster, P.J. (2001). Defining thresholds for precautionary habitat management actions in a fisheries context. *North American Journal of Fisheries Management* **21**: 1-9.

*Australian Greenhouse Office, 2004. National Greenhouse Gas Inventory, Fact Sheet 2. 6 pp.

*Australian State of the Environment Committee, (2001). *Coasts and Oceans*, Australia State of the Environment Report 2001 (Theme Report), CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra

Ayling, T. and Cox, G.C. (1982). *Collins Guide to the Sea Fishes of New Zealand*. Collins, Auckland, New Zealand. 343 pp.

Baelde, P. (1996). Biology and dynamics of the reproduction of blue-eye trevalla, *Hyperoglyphe antarctica* (Centrolophidae), off Tasmania, southern Australia. *Fishery Bulletin* **94**: 199-211.

Ball, A.O., Sedberry, G.R., Zatcoff, M.S., Chapman, R.W. and Carlin, J.L. (2000). Population structure of the wreckfish *Polyprion americanus* with microsatellite genetic markers. *Marine Biology*, **137**: 1077-1090.

*Bannister, J.L., Kemper, C.M. and Warneke, R.M. (1996). *The action plan for Australian cetaceans.* Australian Nature Conservation Agency, Canberra, Australia.

Barnes, K.N., Ryal, P.G. and Biox-Hinzen, C. (1997). The impact of the hake *Merluccius* spp. longline fishery off South Africa on Procellariiforn seabirds. *Biological Conservation*, **82**: 227-234.

Barrett, R.T. and Krasnov, Y.V. (1996). Recent responses to changes in stocks of prey species by seabirds breeding in the southern Barents Sea. *ICES Journal of Marine Science*, **53**: 713-722.

Batley, G.E. Scammell M.S. and Brockbank C.I. (1992). The impact of the banning of tributyltin-based antifouling paints on the Sydney rock oyster, *Saccostrea commercialis*. *Science of the Total Environment*, **122**: 301-314.EPA, 2000

Battaglene, S.C. and Talbot, R.B. (1994). Hormone induction and larval rearing of mulloway, *Argyrosomus hololepidotus* (Pisces: Sciaenidae). *Aquaculture* **126**(1-2), pp. 73-81.

*Bax, N.J. and Williams, A. (2000). Habitat and Fisheries Productivity in the South East Fishery Ecosystem, Hobart, Project No. 94/040.

Bax, N.J. and Williams, A. (2001). Seabed habitat on the south-eastern Australian continental shelf: context, vulnerability and monitoring. *Marine and Freshwater Research*, **52**: 491-512.

Beardsley, G.L. (1967). Age, growth and reproduction of the dolphin, *Coryphaena hippurus*, in the Straits of Florida. *Copeia* 441-451.

Begg, G.A. (1998). Reproductive biology of school mackerel (*Scomberomorus queenslandicus*) and spotted mackerel (*S. munroi*) in Queensland east-coast waters. *Marine and Freshwater Research* **49**: 261-270.

Begg, G.A. and Hopper, G.A. (1997). Feeding patterns of school mackerel (*Scomberomorus queenslandicus*) and spotted mackerel (*S. munroi*) in Queensland east-coast waters. *Marine and Freshwater Research* **48**: 565-571.

Begg, G.A. and Sellin, M.J. (1998). Age and growth of school mackerel (*Scomberomorus queenslandicus*) and spotted mackerel (*S. munroi*) in Queensland east-coast waters with implications for stock structure. *Marine and Freshwater Research* **49**: 109-120.

Begg, G.A., Cameron, D.S. and Sawynok, W. (1997). Movements and stock structure of school mackerel (*Scomberomorus queenslandicus*) and spotted mackerel (*S. munroi*) in Australian east-coast waters. *Marine and Freshwater Research* **48**, pp 295-301.

Begg, G.A., Cappo, M., Cameron, D.S., Boyle, S. and Sellin, M.J. (1998). Stock discrimination of school mackerel, *Scomberomorus queenslandicus,* and spotted mackerel, *Scomberomorus munroi,* in coastal waters of eastern Australia by analysis of minor and trace elements in whole otoliths. *Fishery Bulletin* **96**, pp 653-666.

*Bennett, J. and Lawrence, P. (2002). Adaptive Management Framework for Catchment and Coastal Management and Decision Making. **In**: *Conference proceedings from Australia's National Coastal Conference ('Coast to Coast 2002'*), 4-8 November 2002, Twin Towns Service Club, Tweed Heads, NSW, Australia. Pages 24-27.

Best P.B. (1990). Trends in the inshore right whale population off South Africa, 1969-1987. *Marine Mammal Science*, **6(2)**: 93-108.

Bjordal, A. (2002). The use of technical measures in responsible fisheries: regulation of fishing gear. **In:** *A Fishery Manager's Guidebook. Management Measures and Their Application.* FAO Fisheries Technical Paper **424**: 21-47.

Blaber, S.J.M., Milton, D.A., Smith, G.C. and Farmer, M.J. (1995). Trawl discards in the diets of tropical seabirds of the northern Great Barrier Reef, Australia. *Marine Ecology Progress Series*, **127**: 1-13.

*Black, M. and Dixon, P.I. (1992). Stock identification and discrimination of mulloway in Australian waters. FIRTA 86/16. Centre for Marine Sciences. The University of New South Wales, Australia.

Brodziak, J. and Link, J. (2002). Ecosystem-based fishery management: what is it and how can we do it? *Bulletin of Marine Science* **70**: 589-611.

Brothers, N.P. (1991). Approaches to reducing the albatross mortality and associated bait loss in the Japanese longline fishery. *Biological Conservation*, **55**: 255-268.

*Brown, I.W. (1986). *Population Biology of the Spanner Crab in South-East Queensland*. Final Project Report (81/71) to the Fishing Industry Research Committee. 106 pp plus appendices.

*Brown, I., Kirkwood, J., Gaddes, S., Dichmont, C. and Ovenden, J. (1999). *Population Dynamics and Management of Spanner Crabs* (Ranina ranina) *in Southern Queensland*. FRDC Project 95/022. Queensland DPI Project Report QO99010. 145 pp plus appendices. QDPI, Deception Bay, Queensland.

*Brown, I.W., Dunning, M.C., Hansford, S. and Gwynne, L. (2001). *Ecological Assessment - Queensland Spanner Crab Fishery*. Department of Primary Industries, Queensland, 50 pp.

Bruce, B.D., Evans, K., Sutton, C.A., Young, J.W. and Furlani, D.M. (2001). Influence of mesoscale oceanographic processes on larval distribution and stock structure in jackass morwong, *Nemadactylus macropterus*: Cheilodactylidae). *ICES Journal of Marine Science* **58**: 1072-1080.

*Bruce, B.D. Stevens, J.D. and Otway, N.M. (2004). Movements and residence times of grey nurse sharks (*Carcharius taurus*) within nominated protected areas. Poster prepared for the Australian Society for Fish Biology 2004 Annual Conference.

Bryden, M.M. (1985). Studies of humpback whales (*Megaptera novaeangliae*), Area V. **In**: *Studies of Sea Mammals in South Latitudes*. Ling, J.K. and Bryden, M.M. (eds). South Australian Museum, pp. 115-123.

Bullimore, B.A., Newman, P.B., Kaiser, M.J., Gilbert, S.E. and Lock, K.M. (2001). A study of catches in a fleet of "ghost-fishing" pots. *Fishery Bulletin* **99**, no. 2, pp. 247-253.

Bulman, C., Althaus, F., He, X., Bax, N.J. and Williams, A. (2001). Diets and trophic guilds of demersal fishes of the south-eastern Australian shelf. *Marine and Freshwater Research* **52**: 537-548.

*Bureau of Rural Sciences (2003). *Fishery Status Reports 2002-03*. Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry, Canberra

Burger, J. (1981). The effect of human activity on birds at a coastal bay. *Biological Conservation*, **21**: 231-241.

*Burnell, S.R. and McCulloch, R.E. (2001). *Draft Recovery Plan for Southern Right Whales in Australian Waters*. Environment Australia, Canberra, Australia. 47 pp.

Burridge, C.B. and Smolenski, A.J. (2003). Lack of genetic divergence found with microsatellite DNA markers in the tarakihi *Nemadactylus macropterus*. *New Zealand Journal of Marine and Freshwater Research* **37**: 223–230.

*Butterworth, D.S., Borchers, D.L., Chalis, S. and De Decker, J.B. (1995). Estimates of abundance for southern hemisphere blue, fin, Sei, humpback, sperm, killer and pilot whales from the 1978/79 to 1990/91 IWC/IDCR sighting survey cruises, with extrapolations to the area south of 30ºS for the first five species based on Japanese scouting vessel data. *International Whaling Commission Scientific Committee*, report number SC/46/SH24, Cambridge.

Caddy, J.F. (2002). Limit reference points, traffic lights, and holistic approaches to fisheries management with minimal stock assessment input. *Fisheries Research*, **56**:133-137.

Caddy, J.F. and Mahon, R. (1995). Reference points for fisheries management. *FAO Fisheries Technical Paper* **347**, p.83.

*Callaghan and Associates Pty Ltd (2003). *Developing the Participation of Indigenous People in Commercial Fishing*. A draft discussion document and action plan prepared for NSW Indigenous Fisheries Advisory Committee. Report of a workshop in June 2003.

Cailliet, G. M. and Goldman, K. J. (2004). Age determination and validation in chondrichthyan fishes. **In:** *Biology of Sharks and their Relatives*. Carrier, J.C., Musick, J.A. and Heithaus, M.R. Eds. CRC Press, Boca Raton, FL, USA. pp. 399 - 447.

*Cameron, D. and Begg, G. (2002). *Fisheries Biology and Interaction in the Northern Australia Small Mackerel Fishery*. Final report to the Fisheries Research and Development Corporation. Projects 92/144 and 92/144.02. DPI Publications, Brisbane, Queensland.

Carey, P.W. (1992). Fish prey species of the New Zealand fur-seal (*Arctocephalus forsteri*, Lesson). *New Zealand Journal of Ecology*, **16**: 41-46.

*Casement, D. and Svane, I. (1999). *Direct effects of rock lobster pots on temperate shallow rocky reefs in South Australia.* South Australian Research & Development Institute, Adelaide. 24 pp.

*Caton, A. and McLoughlin, K (eds). (2004). Fishery Status Reports 2004: Status of fish stocks managed by the Australian Government. Bureau of Rural Sciences, Canberra.

Cavanagh, R.D., Kyne, P.M., Fowler, S.L., Musick, J.A. and Bennett, M.B. (eds) (2003). *The Conservation Status of Australasian Chondrichthyans: Report of the IUCN Shark Specialist*

Group Australia and Oceania Regional Red List Workshop, Queensland, Australia, University of Queensland, Brisbane, 170 pp.

Chan, E.H., Liew, H.C., and Mazlan, A.G. (1988). The incidental capture of sea turtles in fishing gear in Terengganu, Malaysia. *Biological Conservation*, **43**: 1-7.

Chapdelaine, G. and Rail, J. (1997). Relationships between cod fishery activities and the population of herring gulls on the North Shore of the Gulf of St Lawrence, Quèbec, Canada. *ICES Journal of Marine Science*, **54**: 708-713.

Charles, A. (1998). Living with uncertainty in fisheries: analytical methods, management priorities and the Canadian groundfishery experience. *Fisheries Research* **37**:37-50.

Charles, A. (2001). *Sustainable Fishery Systems*. Blackwell Science, Oxford; p. 370

Chen, Y. and Kennelly, S.J. (1999). Growth of spanner crabs, *Ranina ranina*, off the east coast of Australia. *Marine and Freshwater Research* **50**(4), pp. 319-325.

Cherel, Y., Wiemerskirch, H., and Duhamel, G. (1996). Interactions between longline vessels and seabirds in Kerguelen waters and a method to reduce seabird mortality. *Biological Conservation*, **75**: 63-70.

Chittleborough, R.G. (1965). Dynamics of two populations of the humpback whale, *Megaptera novaeangliae* (Borowski). *Australian Journal of Marine and Freshwater Research*, **16**: 33-128.

Chopin, F. and Arimoto, T. (1995). The condition of fish escaping from fishing gears - a review. *Fisheries Research* **21**, pp 315-327.

Chopin, F., Inoue, Y. and Arimoto, T. (1996). Short communication - Development of a catch mortality model. *Fisheries Research* **25**, pp 377-382.

*Chopin, F., Alverson, D.L., Inoue, Y., Arimoto, T., He, P., Suuronen, P. and Sangster, G.I. (1997). Sources of unaccounted mortality in fish capture technologies. **In**: *Developing and sustaining world fisheries resources: The state of science and management*. (Hancock, DA, Smith, DC, Grant, A and Beumer, JP eds). Proceedings of the World Fisheries Congress, Brisbane (Australia), 28 Jul-2 Aug 1996 pp. 149-156. CSIRO, Collingwood (Australia).

Christensen, V. (1996). Managing fisheries involving predator and prey species. *Reviews in Fish Biology and Fisheries*, **6**: 417-442.

Clapham, P.J., Young, S.B. and Brownell, R.L.J. (1999). Baleen whales: conservation issues and the status of the most endangered populations. *Mammal Review*, **29**: 35-60.

Clark, C.W. (1999). On the subject of the potential impact of human-made noise on whales. *Journal of Cetacean Research and Management* **1**: 207-209

*Cogger, H.G. (2000). *The status of marine reptiles in New South Wales*. A report prepared for the NSW National Parks and Wildlife Service. 65 pp.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences*. Hillsdale, N.J. and L. Erlbaum Associates, 567 p.

Coleman, F.C., Koenig, C.C. and Collins, L.A. (1996). Reproductive styles of shallow-water groupers (Pisces: Serranidae) in the eastern Gulf of Mexico and the consequences of fishing on spawning aggregations. *Environmental Biology of Fishes* **47** (2), pp. 129-141.

Collette, B.B. and Nauen, C.E. (1983). *FAO Species Catalogue. Vol. 2. Scombrids of the World. An Annotated and Illustrated Catalogue of Tunas, Mackerels, Bonitos and Related Species Known to Date*. FAO Fisheries Synopsis No. 125. Rome (ITALY), 137 pp.

*Commonwealth of Australia, (2003). *Seabird interactions with fisheries in the Australian fishing zone. National Plan of Action for reducing the incidental catch of seabirds in longline fisheries – Assessment report*. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra. See also http://www.daff.gov.au

Compagno, L.J.V. (1984). FAO species catalogue, Vol. 4., Sharks of the World. An annotated and illustrated catalogue of sharks known to date. Part 2 - Carcharhiniformes. *FAO Fisheries Synopsis*, *125* **4**: 251-655.

Compagno, L.J.V. (2001). Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Volume 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes. *FAO Species Catalogue for Fishery Purposes Fisheries*, **No. 1, Vol. 2**. Rome, FAO. 269 pp.

Compagno, L.J.V., Marks, M.A. and Ferguson, I.K. (1997). Threatened fishes of the world: *Carcharodon carcharias* (Linnaeus, 1758) (Lamnidae). *Environmental Biology of Fishes*, **50**: 61-62.

Connell, S.D. and Lincoln-Smith, M.P. (1999). Depth and the structures of assemblages of demersal fish: experimental trawling along a temperate coast. *Estuarine, Coastal and Shelf Science*, **48**:483-495.

Cook, R. (2001). The magnitude and impacts of by-catch mortality by fishing gear. **In:** *Responsible Fisheries in the Marine Ecosystem*, Sinclair, M. and Valdimarsson, G. (Eds), CAB International, Wallingford.

Cooke, S.J. and Suski, C.D. (2004). Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? *Aquatic Conservation: Marine and Freshwater Ecosystems* **14** (3): 299-326.

Croll, D.A., Clark, C.W., Calambokidis, J., Ellison, W.T. and Tershy, B.R. (2001). Effect of anthropogenic low-frequency noise on the foraging ecology of Balaenoptera whales. *Animal Conservation* **4**: 13-27

Croxall, J.P. and Gales, R.P. (1998). An assessment of the conservation status of albatrosses. In: *Albatross: Biology and Conservation*. Robertson, G. and Gales, R. (eds). Surrey, Beatty and Sons, Chipping Norton, Australia. pp. 46-65.

Cunningham, D.J. and Wilson, S.P. (2003). Marine debris on beaches of the greater Sydney region. *Journal of Coastal Research* 19,421-430.

David, J.H.M. (1987). Diet of the South African fur-seal (1974-1985) and an assessment of competition with fisheries in southern Africa. *South African Journal of Marine Science*, **5**: 693-713.

Davis, M.W. (2002). Key principles for understanding fish bycatch discard mortality. *Canadian Journal of Fisheries and Aquatic Sciences* **Vol. 59**(11), pp. 1834-1843.

Dayton, P.K., Thrush, S.F., Agardy, M.T., and Hofman, R.J. (1995). Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **5**: 205-532.

Dedual, M. and Pankhurst, N.W. (1992). Plasma steroid hormone concentrations in relation to the reproductive cycle of the sweep *Scorpis lineolatus* (Kyphosidae) caught from the wild. *Australian Journal of Marine and Freshwater Research* **43**(4), pp. 753-763.

Dempster, T. (2004). Biology of fish associated with moored fish aggregation devices (FADs): implications for the development of a FAD fishery in New South Wales Australia. *Fisheries Research* **68**: 189-201.

*Dempster, T., Brown, I., Jebreen, E., Smallwood, D., McGilvray, J. and Breddin, I. (2004). Fisheries Long Term Monitoring Program: Spanner Crab Report 2000–2003. Department of Primary Industries and Fisheries, Queensland.

Denny, C.M. and Babcock, R.C. (2004). Do partial marine reserves protect reef fish assemblages? *Biological Conservation* **116**: 119-124.

Deville, A. and Harding, R. (1997). *Applying the Precautionary Principle*. The Federation Press, Sydney. 79 pp.

Duarte, C.M. (2000). Marine biodiversity and ecosystem services: an elusive link. *Journal of Experimental Marine Biology and Ecology,* **250**: 117-131.

Duffus, J.H. (2001). Risk assessment terminology. *Chemistry International* **23(2)**.

Duffy, C.A.J., Stewart, A.L. and Yarrall, R. (2000). First record of pre-settlement juvenile bluenose, *Hyperoglyphe antarctica*, from New Zealand. *New Zealand Journal of Marine and Freshwater Research,* **34**: 353-358.

Eckersley, Y. (1996). Shark meshing: is the net result justifiable? *GEO Australia*, **18(5)**: 17-26.

Eno, N., Macdonald, D.S., Kinnear, J.A., Amos, S., Chapman, C.J., Clark, R.A., Bunker, F.S. and Munro, C. (2001). Effects of crustacean traps on benthic fauna. *ICES Journal of Marine Science* **Vol. 58**, No. 1, pp. 11-20.

*Environment Australia (1998a). *Threat abatement plan for the incidental catch (or by-catch) of seabirds during oceanic longline fishing operations.* Environment Australia – Biodiversity Group, Canberra, Australia.

*Environment Australia (1998b). *Draft recovery plan for marine turtles in Australia.* Environment Australia **–** Biodiversity Group, Canberra, Australia. 108 pp.

*Environment Australia (1999). *Threat abatement plan for competition and land degradation by feral rabbits*. Environment Australia – Biodiversity Group, Canberra, Australia.

*Environment Australia, (2001b). *Recovery plan for albatrosses and giant-petrels.* Environment Australia **-** Natural Heritage Division, Canberra, Australia. 156 pp.

*Environment Australia, (2001c). *Draft guidelines on the application of the Environment Protection and Biodiversity Conservation Act to interactions between offshore seismic operations and whales (large cetaceans).* Environment Australia, Canberra, Australia.

*Environment Australia (2002a). *Recovery plan for the grey nurse shark* (Carcharius taurus) *in Australia*. Environment Australia, Canberra

*Environment Australia (2002b). *White shark* (Carcharodon carcharias) *recovery plan*. Canberra, 43 pp.

*Environment Australia (2003). *Recovery plan for marine turtles in Australia.* Environment Australia – Approvals and Wildlife Division, Canberra, Australia. 43 pp.

Evans, D. and Grainger, R. (2002). Gathering data for resource monitoring and fisheries management. **In**: *Handbook of Fish Biology and Fisheries: Volume 2*. Hart P.J.B. and Reynolds, J.D. (eds). Fisheries New York Blackwell Publishing, p. 84-102.

Fairweather, P.G. (1989). Environmental Impact Assessment: Where is the science in EIA? *Search*, **20**: 141-145.

Fairweather, P.G. (1991). Statistical power and design requirements for environmental monitoring. *Australian Journal of Marine and Freshwater Research*, **42**: 555-567.

FAO (2003a). *International Plan of Action for the Conservation and Management of Sharks*. FAO International Plans of Action series, FAO, Rome.

FAO (2003b). *The ecosystem approach to fisheries.* FAO Technical Guidelines for Responsible Fisheries. No. 4, Supplement 2. Rome, FAO, 112 p.

Fergusson, I.K., Graham, K.J. and Compagno, L.J.V. (2003). Distribution, abundance and biology of the smalltooth sandtiger shark *Odontaspis ferox* (Risso, 1810) (Chondrichthyes: Lamniformes, Odontaspididae). *Environmental Biology of Fishes* **Submitted**.

*Ferrell, D. and Sumpton, W. (1997). *Assessment of the Fishery for Snapper* (Pagrus auratus) *in Queensland and New South Wales.* FRDC 93/074.

*Ferris, L. and Ferris, R. (2002). *The impact of recreational fishing on estuarine birdlife in central and north coast districts of New South Wales.* Australian Seabird Rescue Inc., Ballina.

*Fielder, D.S., Bardsley, W.J. & Allan, G.L. 1999. Enhancement of mulloway (*Argyrosomus japonicus*) in intermittently opening lagoons. FRDC Project No. 95/148. Final Report Series No. 14. NSW Fisheries, Australia.

Fielding, A. and Haley, S.R. (1976). Sex ratio, size at reproductive maturity and reproduction of the Hawaiian kona crab *Ranina ranina* (Linnaeus) (Brachyura, Gymnopleura, Raninidae). *Pacific Science* **30**: 131-145.

*Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury, K.J., Hundloe, T., Smith, A.D.M. and Whitworth, B. (2002). *National ESD reporting framework for Australian Fisheries: the 'How to' guide for wild capture fisheries.* Fisheries Research and Development Corporation Final Report, Project No. 2000/145, Canberra, Australia.

*Fletcher, W.J., Chesson, J., Sainsbury, K.J., Hundloe, T. and Fisher, M. (2003). *National ESD Reporting Framework for Australian Fisheries: the ESD Assessment Manual for Wild Capture Fisheries.* Fisheries Research and Development Corporation Final Report, Project No. 2002/086, Canberra, Australia.

*Fogarty, M.J. (1996). The lobster fishery: escape vents and bycatch issues. **In**: *Proceedings of the East Coast Bycatch Conference*, (Castro, K; Corey, T; DeAlteris, J; Gagnon, C eds) RI (USA), 7-8 Apr 1995.

Fogarty, M.J. and Murawski, S.A. (1998). Large-scale disturbance and the structure of marine systems: fishery impacts on Georges Bank. *Ecological Applications* **8 Supplement**: S6-S22.

Fowler, C.W. (1987). Marine debris and northern fur seals: a case study. *Marine Pollution Bulletin*, **18**: 326-335.

Fowler, A.J. and Jennings, P.R. (2003). Dynamics in 0+ recruitment and early life history for snapper (*Pagrus auratus*, Sparidae) in South Australia. *Marine and Freshwater Research*, **54**: 941-956.

Francis, M.P. (1993). Checklist of the coastal fishes of Lord Howe, Norfolk, and Kermadec Islands, southwest Pacific Ocean. *Pacific Science* **47** (2): 136-170.

Francis, M.P (1996). *Coastal Fishes of New Zealand. A Diver's Identification Guide*. Reed Books, Auckland. 63 pp.

Francis, M.P., Mulligan, K.P., Davies, N.M. and Beentjes, M.P. (1999). Age and growth estimates for New Zealand hapuku, *Polyprion oxygeneios*. *Fishery Bulletin* **97**, pp 227-242.

Francis, R.C. (1992). Use of risk analysis to fishery management strategies: A case study using orange roughy (*Hoplostethus atlanticus*) on the Chatham Rise, New Zealand. *Canadian Journal of Fisheries and Aquatic Sciences* **49**: 922-930.

Francis, R. C. and Shotton, R. (1997). "Risk" in fisheries management: a review. *Canadian Journal of Fisheries and Aquatic Sciences* **54**: 1699-1715.

Froese, R. and Pauly, D. (eds). (2005). FishBase. World Wide Web electronic publication. www.fishbase.org, version (11/2005).

Frost, A. and Cullen M. (1997). Marine debris on northern New South Wales beaches (Australia): sources and the role of beach usage. *Marine Pollution Bulletin*, **34**: 348-352

Fu, C., Mohn, R. and Fanning L.P. (2001). Why the Atlantic cod (*Gadus morhua)* stock off eastern Nova Scotia has not recovered. *Canadian Journal of Fisheries and Aquatic Sciences* **58**: 1613-1623.

Gales, R. (1998). Albatross populations: status and threats. In: *Albatross: Biology and Conservation*. Robertson, G. and Gales, R. (eds). Surrey, Beatty and Sons, Chipping Norton, Australia. pp. 20-45.

Gardner, M.G. and Ward, R.D. (1998). Population structure of the Australian gummy shark (*Mustelus antarcticus* Günther) inferred from allozymes, mitochondrial DNA and vertebrae counts. *Marine and Freshwater Research*, **49**: 733-745.

*Garnett, S.T. and Crowley, G.M. (2000). *The action plan for Australian birds.* Environment Australia, Canberra, Australia. 673 pp.

*Garrod, D.J. (1982). *Stock and recruitment* **--** *again.* Fisheries research technical report No. 68. Directorate of Fisheries Research (Great Britain). 22 pp

Gaughan D.J., Mitchell, R.W. and Blight, S.J. (2000). Impact of mortality, possibly due to herpesvirus, on pilchard *Sardinops sagax* stocks along the south coast of Western Australia in 1998-99. *Marine and Freshwater Research* **Vol. 51**(6), pp. 601-612.

Gerrodette, T., Dayton, P.K., Macinko, S. and Fogarty M.J. (2002). Precautionary management of marine fisheries: moving beyond burden of proof. *Bulletin of Marine Science*, **70**: 657-668.

*Gibbs, P. (1997). A review of information on NSW South Coast estuarine fisheries. NSW Fisheries Research Institute, Cronulla. 74 pp.

Gillanders, B.M. (1995a). Feeding ecology of the temperate marine fish *Achoerodus viridis* (Labridae): size, seasonal and site-specific differences. *Marine and Freshwater Research* **46**, 1009-1020.

Gillanders, B.M. (1995b). Reproductive biology of the protogynous hermaphrodite *Achoerodus viridis* (Labridae) from south-eastern Australia. *Marine and Freshwater Research* **46**, 999-1008.

Gillanders, B.M., Ferrell, D.J. and Andrew, N.L. (1999a). Size at maturity and seasonal changes in gonad activity of yellowtail kingfish (*Seriola lalandi*; Carangidae) in New South Wales, Australia. *New Zealand Journal of Marine and Freshwater Research* **33**, 457-468.

Gillanders, B.M., Ferrell, D.J. and Andrews, N.L. (1999b). Aging methods for yellowtail kingfish, *Seriola lalandi*, and results from age- and size-based growth models. *Fishery Bulletin* **97**: 812-827.

Gillanders, B.M., Ferrell, D.J. and Andrew, N.L. (2001). Estimates of movement and life-history parameters of yellowtail kingfish (*Seriola lalandi*): how useful are data from a cooperative tagging program? *Marine and Freshwater Research* **52**, 179-192.

Gislason, H. (2002). The effects of fishing on non-target species and ecosystem structure and function. **In**: *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem*. Food and Agriculture Organisation of the United Nations, Reykjavik, p.1-21

Glasby, T.M. (1998). Estimating spatial variability in developing assemblages of epibiota on subtidal hard substrata. *Marine and Freshwater Research*, **49**: 429-437.

Goldman, K. J. (2002). Aspects of age, growth, demographics and thermal biology of two lamniform sharks. PhD. Dissertation. College of William and Mary, Williamsburg, VA.

*Goulstone, A. (1996). Fisheries Management Techniques. Fishnote DF 61, March 1996. NSW Fisheries, Cronulla.

Goulstone, A. and McIlgorm, A. (2001). Initial Allocation of Harvesting Rights in the New South Wales Ocean Trap and Line Fishery, Australia. **In**: Case Studies on the Allocation of Transferable Quota Rights in Fisheries, FAO Fisheries Technical Paper No. 411 (ed. R. Shotton), pp 159-170.

Grandcourt, E.M., Al Abdessalaam, T.Z., Francis, F. and Al Shamsi, A.T. (2005). Preliminary assessment of the biology and fishery for the narrow-barred Spanish mackerel, *Scomberomorus commerson* (Lacépède, 1800), in the southern Arabian Gulf. *Fisheries Research* **76**: 277-290.

*Gray, C.A. (1995). *The influence of sewage plumes and oceanography on assemblages of larval fishes*. PhD Thesis, The University of Sydney, Sydney.

Gray, C.A. and McDonall, V.C. (1993). Distribution and growth of juvenile mulloway, *Argyrosomus hololepidotus* (Pisces: Sciaenidae), in the Hawkesbury River, South-eastern Australia. *Australian Journal of Marine and Freshwater Research*. 44: 401-409.

Gray, C.A. and Otway, N.M. (1994). Spatial and temporal differences in assemblages of demersal fishes on the inner continental shelf off Sydney, south-eastern Australia. *Australian Journal of Marine and Freshwater Research*, **45**:665-676.

*Gray, C.A., Pease, B.C., Stringfellow, S.L., Raines, L.P., Rankin, B.K. and Walford, T.R. (2000). *Sampling Estuarine Fish Species for Stock Assessment*. FRDC Project No. 94/042. NSW

Fisheries Final Report Series No. 18, ISSN 1440-3544. NSW Fisheries Research Institute, Cronulla, NSW.

Gray, J.S. (1997). Marine biodiversity: patterns, threats and conservation needs. *Biodiversity and Conservation*, **6**: 153-175.

Gray, J.S. (2000). The measurement of marine species diversity, with an application to the benthic fauna of the Norwegian continental shelf. *Journal of Experimental Marine Biology and Ecology*, **250**: 23-49.

Gray, J. S. and Jensen, K. (1993). Feedback monitoring: a new way of protecting the environment. *Trends in Ecology and Evolution*, **8**:267-268.

*Greboval, D. and Munro, G. (1999). Overcapitalisation and excess fishing capacity in world fisheries: underlying economics and methods of control. **In**: Managing Fishing Capacity: Selected Papers on Underlying Concepts and Issues (D. Greboval ed.). *FAO Fisheries Technical Paper No. 386.* FAO, Rome.

Griffiths, M.H. (1996). Life history of the dusky kob *Argyrosomus japonicus* (Sciaenidae) off the east coast of South Africa. *South African Journal of Marine Science*. 17: 135-154.

Griffiths, M.H. (1997a). Feeding ecology of the South African *Argyrosomus japonicus* (Pisces: Sciaenidae), with emphasis on the eastern cape surf zone. *South African Journal of Marine Science*. 18: 249-264.

Griffiths, M.H. (1997b). Influence of prey availability on the disturbance of dusky kob *Argyrosomus japonicus* (Sciaenidae) in the Great Fish River Estuary, with notes on the diet of early juveniles from three other estuarine systems. *South African Journal of Marine Science*. 18: 137-145.

Griffiths, M.H. and Hecht, T. (1995a). Age and growth of South African dusky kob *Argyrosomus japonicus* (Sciaenidae) based on otoliths. *South African Journal of Marine Science*. 16: 119-128.

Griffiths, M.H. and Hecht, T. (1995b). On the life-history of *Atractoscion aequidens*, a migratory sciaenid off the east coast of southern Africa. *Journal of Fish Biology* **47**(6), pp. 962-985.

Griffiths, M.H. and Heemstra, P.C. (1995). A contribution to the taxonomy of the marine fish genus *Argyrosomus* (Perciformes: Sciaenidae), with descriptions of two new species from southern Africa. *Special Publications J.L.B. Smith Institute of Ichthyology, Grahamstown* **65**, pp 1-40.

Grove-Jones, R.P. and Burnell, A.F. (1991). *Fisheries Biology of the Ocean Jacket (Monacanthidae:* Nelusetta ayraudi*) in the Eastern Waters of the Great Australian Bight, South Australia*. Final report to the Fishing Industry Research and Development Council Grant Number DFS01Z. South Australian Department of Fisheries.

Guillory, V. (1993). Ghost-fishing by blue crab traps. *North American Journal of Fisheries Management* **13**, no. 3, pp. 459-466.

Hall, D.A. (1986). *An assessment of the mulloway* (Argyrosomus hololepidotus) *fishery in South Australia with particular reference to the Coorong Lagoon*. Department of Fisheries, South Australia.

Hall, S.J. (1999). *The Effects of Fishing on Marine Ecosystems and Communities*. Blackwell Science, Oxford. 274 pp.

Hall, D.L., Hilborn, R., Stocker, M. and Walters, C.J. (1988). Alternative harvest strategies for Pacific herring (*Clupea harengus pallasi). Canadian Journal of Fisheries and Aquatic Sciences* **45**: 888-897.

Harper, P.C. (1987). Feeding behaviour and other notes on 20 species of Procellariiformes at sea. *Notornis*, **34**: 169-192.

Harris, J.H. and Rowland, S.J. (1996). Family Percichthyidae: Australian freshwater cods and basses. **In**: *Freshwater Fishes of South-Eastern Australia* (ed. R.M. McDowall). Reed Books, Sydney

*Hayes, K.R. (1997). *A review of ecological risk assessment methodologies*. Technical report No. 13, Centre for Research on Introduced marine Pests (Australia), CSIRO, Hobart, 117 pp.

Haynes, D. (1997). Marine debris on continental islands and sand cays in the far northern section of the Great Barrier Reef Marine Park, Australia. *Marine Pollution Bulletin* **34**,276-279.

*Healthy Rivers Commission (2000). *Securing Healthy Coastal Rivers: A Strategic Perspective*. Healthy Rivers Commission, Sydney.

*Heemstra, P.C. and Randall, J.E. (1993). *FAO Species Catalogue Volume 16: Groupers of the World (Family Serranidae, Subfamily Epinephelidae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date*. FAO Fisheries Synopsis No. 125, Vol. 16. Food and Agriculture Organisation of the United Nations, Rome. pp 382.

Heino, M. and Godo, O. R. (2002). Fisheries-induced selection pressures in the context of sustainable fisheries. *Bulletin of Marine Science* **70**: 639-356.

*Henry, G.W. and Lyle, J.M. (2003). *The National Recreational and Indigenous Fishing Survey*. FRDC Project No. 99/158. Final Report Series No. 48 ISSN 1440-3544. NSW Fisheries, Cronulla, 188 pp.

*Herfort, A. (1997). *Marine debris on beaches in New South Wales*. Ocean Watch Australia, Sydney.

*Hickman, L.J. (1999). Effects of fur seals on fishing operations along the New South Wales south coast. BA (honours) thesis. The University of NSW – Australian Defence Force Academy. 109 pp.

Higgins, P.J. and Davies, S.J.J.F. (1996). *Handbook of Australian, New Zealand and Antarctic Birds – Volume 3 Snipe to Pigeons*. Oxford University Press, Melbourne, Australia. 1028 pp.

Hilborn, R. and Walters, C.J. (1992). *Quantitative fisheries stock assessment – choice, dynamics and uncertainty*. Chapman and Hall, London, p. 570.

Hilborn, R., Pikitch, E.K. and Francis, R.C. (1993). Current trends in including risk and uncertainty in stock assessment and harvest decisions. *Canadian Journal of Fisheries and Aquatic Sciences*, **50**: 874-880.

Hilborn, R., Maguire, J., Parma, A.M. and Rosenberg, A.A. (2001). The precautionary approach and risk management: can they increase the probability of successes in fishery management? *Canadian Journal of Fisheries and Aquatic Sciences* **58**: 99-107.

Hofman, R.J. (1990). Cetacean entanglement in fishing gear. *Mammal Review,* **20(1)**: 53-64.

Holland, D.S. (2003). Integrating spatial management measures into traditional fishery management systems: the case of the Georges Bank multispecies groundfish fishery. *ICES Journal of Marine Science*, **60**: 915-929.

Hooper, J.N.A. Kennedy J.A. and Quinn R.J., (2002). Biodiversity 'hotspots', patterns of richness and endemism and taxonomic affinities of tropical Australian sponges (Porifera). *Biodiversity and Conservation*, **11**: 851-885.

Horn, P.L. (1988). Age and growth of bluenose, *Hyperoglyphe antarctica* (Pisces: Stromateoidei) from the lower east coast, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* **22**: 369-378.

*Humane Society International (2004). Nomination to the Commonwealth Department of Environment and Heritage to have southern bluefin tuna (*Thunnus maccoyii*) listed as an endangered species under the EPBC Act 1999. 15 pp.

Huntsman, G.R. and Schaaf, W.E. (1999). Simulation of the impact of fishing on reproduction of a protogynous grouper, the graysby. *North American Journal of Fisheries Management* **14** (1), pp. 41-52.

Huntsman, G.R., Potts, J., Mays, R.W. and Vaughan, D. (1994). Groupers (Serranidae, Epinephelidae): Endangered Apex Predators of Reef Communities. **In**: *Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals,* pp. 217-231. American Fisheries Society Symposium, Vol. 23.

Hutchings, J.A. (1999). Influence of growth and survival costs of reproduction on Atlantic cod, *Gadus morhua,* population growth rate. *Canadian Journal of Fisheries and Aquatic Sciences* **56**: 1612-1623.

Hutchings, J.A. and Myers, R.A. (1994). What can be learned from the collapse of a renewable resource? Atlantic cod, *Gadus morhua*, of Newfoundland and Labrador. *Canadian Journal of Fisheries and Aquatic Sciences* **51**: 2126-2146.

Hutchins, B. and Swainston, R. (1993). *Sea fishes of southern Australia*. Swainston Publishing, Perth, Australia. 180 pp.

Hutton, T., Griffiths, M.H, Sumaila, U.R. and Pitcher, T.J. (2001). Cooperative versus non-cooperative management of shared linefish stocks in South Africa: an assessment of alternative management strategies for geelbek (*Atractoscion aequidens*). *Fisheries Research* **51**: 53-68.

Ibsen, T. (1999). Sustainable fisheries: the linkage with trade and the environment. *Linkages Journal* **4** (2): 2-4.

*Independent Pricing and Regulatory Tribunal (IPART) (1998). *Pricing principles for Management Charges in NSW Commercial Fisheries- Final Report.* Report prepared for the Minister of Fisheries. 63 pp.

*IMCRA technical group (1998). Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environment. Version 3.3. Environment Australia, Commonwealth Department of the Environment, Canberra.

*IUCN (2002). *The threatened status of sharks and related species*. Shark Specialist Group. [http://www.flmnh.ufl.edu/fish/organizationa.ssg/threatenedsharks.pdf]. September, 2003.

James, G.D. (1984). Trevally, *Caranx georgianus* Cuvier: Age determination, population biology and fishery. New Zealand Ministry of Agriculture and Fisheries, Fisheries Research Bulletin No. 25. 51 pp

James, J.D. and Habib, G. (1979). First record of Australian bonito, *Sarda australis*, from New Zealand. *New Zealand Journal of Marine and Freshwater Research*, **13**: 425-426.

Jennings, S. and Kaiser, M.J. (1998). The effects of fishing on marine ecosystems. *Advances in Marine Biology* **34**:201-352

Jennings, S., Greenstreet S.P.R. and Reynolds J.D. (1999). Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. *Journal of Animal Ecology*, **68**: 617-627.

Jennings, S., Pinnegar J.K., Polunin N.V.C. and Warr K.J. (2001). Impacts of trawling disturbance on the trophic structure of benthic invertebrate communities. *Marine Ecology Progress Series*, **213**: 127-142.

Johnson, G.D. (1984). Percoidei: development and relationships. **In**: *Ontogeny and Systematics of Fishes* (Moser, H.G. ed.), pp. 464-498. American Society of Ichthyologists and Herpetologists Special Publication 1. Lawrence Kansas: Allen Press, Inc.

Johnson, M.S., Creagh, S. and Moran, M. (1986). Genetic subdivision of stocks of snapper, *Chrysophrys unicolor*, in Shark Bay, Western Australia. Australian Journal of *Marine and Freshwater Research*, **37**: 337-345.

Jones, M.M. (1995). Fishing debris in the Australian marine environment. *Marine Pollution Bulletin*, **30**: 25-33.

Jordan, A.R. (1999). The ecology of sand flathead and jackass morwong. PhD thesis, University of Tasmania. 191 pp.

Jordan, A.R. (2001a). Age, growth and spatial and interannual trends in age composition of jackass morwong, *Nemadactylus macropterus*, in Tasmania. *Marine and Freshwater Research* **52**: 651-660.

Jordan, A.R. (2001b). Spatial and temporal variations in abundance and distribution of juvenile and adult jackass morwong, *Nemadactylus macropterus*, in south-eastern Tasmania. *Marine and Freshwater Research* **52**: 661-670.

Joung, S., Chen, C., Clarke, C., Uchida, S. and Huang, W.Y.P. (1996). The whale shark, *Rhincodon typus*, is a live bearer: 300 embryos found in one "megamamma" supreme. *Environmental Biology of Fishes* **46**: 219-223.

Kailola, P.J., Williams, M.J., Stewart, P.C., Reichelt, R.E., McNee, A. and Grieve, C. (1993). *Australian Fisheries Resources*. Bureau of Resource Sciences and the Fisheries Research and Development Corporation. Commonwealth of Australia, 422 pp.

Kennelly, S.J. (1992). Distributions, abundances and current status of exploited populations of spanner crabs *Ranina ranina* off the east coast of Australia. *Marine Ecology Progress Series* **85**(3), pp. 227-235.

Kennelly, S.J. (1995). The issue of bycatch in Australia's demersal trawl fisheries. *Reviews in Fish Biology and Fisheries*, **5**: 213-234.

*Kennelly, S.J. and McVea, T. (Eds) (2001). *Status of Fisheries Resources, 2000/2001*. NSW Fisheries, Cronulla.

*Kennelly, S.J. and McVea, T. (Eds) (2003). *Status of Fisheries Resources, 2001/2002*. NSW Fisheries, Cronulla.

*Kennelly, S.J. and Scandol, J.P. (1999). *Relative Abundances of Spanner Crabs and the Development of a Population Model for Managing the NSW Spanner Crab Fishery*. FRDC Project No. 96/135. NSW Fisheries Final Report Series No. 21. ISSN 1440-3544. NSW Fisheries Research Institute, Cronulla NSW.

Kennelly, S.J. and Scandol, J.P. (2002). Using a fishery-independent survey to assess the status of a spanner crab (*Ranina ranina*) fishery: univariate analysis and biomass modelling. *Crustaceana* **75(1)**: 13-39.

Kennelly, S.J. and Watkins, D. (1994). Fecundity and reproductive period, and their relationship to catch rates of spanner crabs, *Ranina ranina*, off the east coast of Australia. *Journal of Crustacean Biology* **14**, 146-150.

Kennelly, S.J., Watkins, D. and Craig, J.R. (1990). Mortality of discarded spanner crabs *Ranina ranina* (Linnaeus) in a tangle-net fishery **--** laboratory and field experiments. *Journal of Experimental Marine Biology and Ecology* **140**(1-2), pp. 39-48.

Kiessling, I. (2003). *Finding Solutions: Derelict Fishing Gear and Other Marine Debris in Northern Australia*. National Oceans Office, Darwin.

Kingsford, M.J. and Defries, A. (1999). The ecology of and fishery for *Coryphaena* spp. in the waters around Australia and New Zealand. *Scientia Marina* **63**(3-4), pp 267-275.

*Kirkwood, G.P., Beddington, J.R. and Rossouw, A. (1994). Harvesting species of different life spans. **In**: *Large-scale Ecology and Conservation Biology*. Edwards, P. J., May, R. M. and Webb, N. R. (eds). Oxford, Blackwell Science.

*Kirkwood, R., Pemberton, D. and Copson, G. (1992). *The Conservation and Management of Seals in Tasmania.* Department of Parks, Wildlife and Heritage, Hobart. 48 pp.

Klaer, N.L. (2001). Steam trawl catches from south-eastern Australia from 1918 to 1957: trends in catch rates and species composition. *Marine and Freshwater Research*, **52**: 399-410.

Korsbrekke, K., Mehl, S., Nakken, O. and Pennington, M. (2001). A survey-based assessment of the Northeast Artic cod stock. *ICES Journal of Marine Science*, **58**: 763-769.

Krajangdara, T. and Watanabe, S. (2005). Growth and reproduction of the red frog crab, *Ranina ranina* (Linnaeus, 1758), in the Andaman Sea off Thailand. *Fisheries Science* **71**: 20-28.

Kuiter, R.H. (1993). *Coastal fishes of south-eastern Australia*. Crawford House, Bathurst, Australia. 437 pp.

Kuiter, R.H. (1996). *Guide to sea fishes of Australia*. New Holland, Frenchs Forest, Australia. 433 pp.

Laist, D.W. (1987). Overview of the biological effects of lost and discarded plastic debris in the marine environment. *Marine Pollution Bulletin*, **18**: 319-326.

*Laist, D.W. (1996). Marine debris entanglement and ghost-fishing: A cryptic and significant type of bycatch? **In:** *Proceedings of the Solving Bycatch Workshop; Considerations for Today and*

Tomorrow (Wray, T. ed). September 25-27, 1995, Seattle, Washington, Alaska Sea Grant College Program, Fairbanks, AK (USA), pp. 33-40

Lane, D.E. and Stephenson, R.L. (1998). A framework for risk analysis in fisheries decision-making. *ICES Journal of Marine Science* **55**:1-13.

Last, P.R. and Stevens, J.D. (1994). *Sharks and rays of Australia*. CSIRO, Melbourne, Australia. 513 pp.

Leadbitter, D. (1992). Special fauna black cod survey. **In**: Reef Biology. A Survey of Elizabeth and Middleton Reefs, South Pacific, by the Australian Museum. *Kowari* **3**: 103-106. ANPWS, Canberra.

Leatherwood, S. and Reeves, R.R. (1983). *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books, San Francisco.

Leis, J.M. and Rennis, D.S. (1983). *The Larvae of Indo-Pacific Coral Reef Fishes*. New South Wales University Press, Sydney.

Lenanton, R.C.J. and Potter, J.C. (1987). Contribution of estuaries to commercial fisheries in temperate Western Australia and the concept of estuarine dependence. *Estuaries* **10**(1): 28-35.

Lester R.J.G., Thompson, C., Moss, H., Barker, S.C. (2001). Movement and stock structure of narrow-barred Spanish mackerel as indicated by parasites. *Journal of Fish Biology* **59**: 833-842.

*Liggins, G.W. (1996). The interaction between fish trawling (in NSW) and other commercial and recreational fisheries. *Final Report to Fisheries Research and Development Corporation* Project No. 92/79.

Linder, E., Patil, G.P. and Vaughan, D.S. (1987). Application of event tree risk analysis to fisheries management. *Ecological Modelling* **36**:15-28.

Lindholm, R. (1984). Observations on the Chinaman Leatherjacket *Nelusetta ayraudi* (Quoy & Gaimard) in the Great Australian Bight. *Australian Journal of Marine and Freshwater Research*, **35**: 597-599.

Link, J.S., Brodziak, J.K.T., Edwards, S.F., Overholtz, W.J., Mountain, D., Jossi, J.W., Smith, T.D. and Fogarty, M. J. (2002). Marine ecosystem assessment in a fisheries management context. *Canadian Journal of Fisheries and Aquatic Sciences* **59**:1429-1440.

McAllister, M.K. and Peterman, R.M. (1992). Experimental design in the management of fisheries: a review. *North American Journal of Fisheries Management*, **12**: 1-18.

McKay, R.J. (1997). FAO species catalogue. Pearl perches of the world (Family Glaucosomatidae). An annotated and illustrated catalogue of the pearl perches known to date. *FAO Fisheries Synopsis*, **No. 125, Vol. 17**. Rome, FAO, 26 pp.

Mackie, M.C., Lewis, P.D., Gaughan, D.J. and Newman, S.J. (2005). Variability in spawning frequency and reproductive development of the narrow-barred Spanish mackerel (*Scomberomorus commerson)* along the west coast of Australia. *Fishery Bulletin* **103**: 344-354.

McLeay, L.J., Jones, G.K. and Ward, T.M. (2002). *National Strategy for the Survival of Released Line-Caught Fish: a Review of Research and Fishery Information*. FRDC Project 2001/101.

South Australian Research and Development Institute (SARDI), Henley Beach South Australia. ISBN 0730852830. 122 pp.

McPherson, G.R. (1992). Age and growth of the narrow-banded Spanish mackerel (*Scomberomorus commerson* Lacepede, 1800) in north-eastern Queensland waters. *Australian Journal of Marine and Freshwater Research* **43**, pp 1269-1282.

McPherson, G.R. (1993). Reproductive biology of the narrow-barred Spanish mackerel (*Scomberomorus commerson* Lacepede, 1800) in Queensland waters. *Asian Fisheries Science* **6**(2) pp. 169-182.

Mapstone, B.D. (1995). Scalable decision rules for environmental impact studies: effect size, Type I, and Type II errors. *Ecological Applications*, **5**: 401-410.

Marais, J.F.K. (1984). Feeding ecology of major carnivorous fish from four Eastern Cape estuaries. *South African Journal of Zoology* **19**(3): 210-223.

Marchant, S. and Higgins, P.J. (1990). *Handbook of Australian, New Zealand and Antarctic Birds - Volume 1 Ratites to Ducks*. Oxford University Press, Melbourne, Australia. 1400 pp.

Marchant, S. and Higgins, P.J. (1993). *Handbook of Australian, New Zealand and Antarctic Birds - Volume 2 Raptors to Lapwings*. Oxford University Press, Melbourne, Australia. 984 pp.

*Marine Parks Authority (2000). Draft Framework for Establishing a System of Marine Protected Areas in NSW. NSW Fisheries and National Parks and Wildlife Service, June 2000. 64 pp.

Marsh, H., Heinsohn, G.E. and Marsh, L.M. (1984). Life history, breeding cycle and population dynamics of the dugong, *Dugong dugon*. *Australian Journal of Zoology*, **32**: 767-788.

Martínez-Abraín, A., Maestre, R. and Oro, D. (2002). Demersal trawling waste as a food source for Western Mediterranean seabirds during the summer. *ICES Journal of Marine Science*, **59**: 529-537.

Mathews, C.P., Gouda, V.R., Riad, W.T. and Dashti, J. (1987). Pilot study for the design of a long life fish trap (gargoor) for Kuwait's fisheries. *Kuwait bulletin of marine science* **9**, pp. 221-234.

Mitson, R.B. and Knudsen, H.P. (2002). Causes and effects of underwater noise on fish abundance estimation. *Aquatic Living Resources* **16**: 255-263

Moore, B.R., Buckworth, R.C., Moss, H. and Lester, R.J.G. (2003). Stock discrimination and movements of narrow-barred Spanish mackerel across northern Australia as indicated by parasites. *Journal of Fish Biology* **63**: 765-779.

Moran M. and Jenke J. (1989). *Effects of fish trapping on the Shark Bay snapper fishery*. Fisheries Research Report, Fisheries Dept. WA, No 82, 29 pp

*Moulton, P.L., Walker, T.I. and Saddlier, S.R. (1992). Age and growth studies of gummy shark, *Mustelus antarcticus* Giinther, and school shark, *Galeorhinus galeus* (Linnaeus), from southern Australian waters. *Australian Journal of Marine and Freshwater Research*, **43**: 1241-1267.

Murawski, S.A. (2000). Definitions of overfishing from an ecosystem perspective. *ICES Journal of Marine Science* **57**: 649-658.

*Murphy, P. (1999). Licensing. Pp 53-58 in "Proceedings of the Commercial Fishing Industry Summit, 4-5 November 1999". NSW Fisheries, Cronulla.

Myers R.A. and Cadigan, N.G. (1995). Was an increase in natural mortality responsible for the collapse of northern cod? *Canadian Journal of Fisheries and Aquatic Sciences* **52**: 1274-1285.

Myers, R.A. and Mertz, G., (1998). The limits of exploitation: a precautionary approach. *Ecological Applications* **8** (Supplement): S165-S169.

Myers, R.A. and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature* **423**:280-283

Myers, R.A., Hutchings, J. A. and Barrowman, N. J. (1997). Why do fish stocks collapse? The example of Atlantic cod in Canada. *Ecological Applications* **7**: 91-106.

Naeem, S. (2002). Ecosystem consequences of biodiversity loss: the evolution of a paradigm. *Ecology*, **83**: 1537-1552.

*National Greenhouse Gas Inventory Committee, 2003. Australian methodology for the estimation of greenhouse gas emissions and sinks, 2002: Energy (Transport).

Nitta, E.T. and Henderson, J.R. (1993). A review of interactions between Hawaii's fisheries and protected species. *Marine Fisheries Review*, **55**: 83-92.

Nolan, C.P. and Liddle, G.M. (2000). Interactions between killer whales (*Orcinus orca*) and sperm whales (*Physter macrocephalus*) with a longline fishing vessel. *Marine Mammal Science*, **16**: 658-664.

*NSW EPA (2000). http://www.epa.nsw.gov.au/soe/soe2000.

*NSW Fisheries (2001a). *Status of Fisheries Resources 2000*. Internal report, Cronulla Fisheries Centre, Sydney, pp 306.

NSW Fisheries (2001b). *Estuary Prawn Trawl Fishery Environmental Impact Statem*ent – Public consultation document, Volumes 1 and 2, Cronulla Fisheries Centre, Sydney.

NSW Fisheries (2001c). *Estuary General Fishery Environmental Impact Statement* – Public consultation document, Volumes 1 and 2, Cronulla Fisheries Centre, Sydney.

*NSW Fisheries (2003). Discussion paper for grey nurse shark protection, July 2003. 4 pp.

*NSW Fisheries Scientific Committee (1999). *Final recommendation to list green sawfish* (Pristis zijsron) *as an endangered species under the Fisheries Management Act*. Ref. No. FR11, File No. FSC 99/19. Prepared for the Minister for Fisheries.

*NSW Fisheries Scientific Committee (2004). *Final recommendation to list southern bluefin tuna* (Thunnus maccoyii) *as an endangered species under the Fisheries Management Act*. Ref. No. FR 26, File No. FSC 03/04. Prepared for the Minister for Fisheries.

*NSW Fisheries Threatened Species Recovery Planning Program (2002). *Grey nurse shark* (Carcharius taurus) *draft recovery plan*. NSW Fisheries, Port Stephens. 102 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999a). *Threatened species information for the black-browed albatross*. NSW National Parks and Wildlife Service, Hurstville, Australia. 3 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999b). *Threatened species information for the black-winged petrel*. NWS National Parks and Wildlife Service, Hurstville, Australia. 4 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999c). *Threatened species information for the little shearwater*. NWS National Parks and Wildlife Service, Hurstville, Australia. 3 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999d). *Threatened species information for the shy albatross.* NWS National Parks and Wildlife Service, Hurstville, Australia. 4 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999e). *Threatened species information for the sooty albatross*. NWS National Parks and Wildlife Service, Hurstville, Australia. 3 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999f). *Threatened species information for the sooty tern.* NWS National Parks and Wildlife Service, Hurstville, Australia. 4 pp.

*NSW National Parks and Wildlife Service (NSW NPWS), (1999g). *Threatened species information for the white-bellied storm petrel.* NWS National Parks and Wildlife Service, Hurstville, Australia. 4 pp.

*NSW National Parks and Wildlife Service (NSW NPWS) (2000a). *Gould's petrel draft recovery plan*. NSW National Parks and Wildlife Service, Hurstville, Australia.

*NSW National Parks and Wildlife Service (NSW NPWS) (2000b). *Little tern draft recovery plan.* NSW NPWS, Hurstville, Australia.

*NSW National Parks and Wildlife Service (NSW NPWS) (2000c). *Recovery plan for the endangered population of little penguins* (Eudyptula minor) *at Manly*. NSW National Parks and Wildlife Service, Hurstville, Australia.

*NSW National Parks and Wildlife Service (NSW NPWS) (2002a). *Declaration of critical habitat for the Endangered population of little penguins at Manly*. NSW National Parks and Wildlife Service, Hurstville, Australia. 20 pp.

*NSW National Parks and Wildlife Service (NSW NPWS) (2002b). *Guidelines and conditions for marine reptile strandings, rehabilitation and release in New South Wales.* NSW National Parks and Wildlife Service – Biodiversity and Research Management Division, Hurstville, Australia. 32 pp plus appendices.

*NSW Scientific Committee (1996). *Wandering albatross - vulnerable species listing*. NSW Scientific Committee - final determination. 2 pp.

*NSW Scientific Committee (2001a). *Southern giant-petrel - endangered species listing*. NSW Scientific Committee - final determination. 4 pp.

*NSW Scientific Committee (2001b). *Antipodean albatross - vulnerable species listing*. NSW Scientific Committee - final determination. 3 pp.

*NSW Scientific Committee (2001c). *Gibson's albatross - vulnerable species listing.* NSW Scientific Committee - final determination. 3 pp.

*NSW Scientific Committee (2002a). *Blue whale - endangered species listing.* NSW Scientific Committee - final determination. 3 pp.

*NSW Scientific Committee (2002b). *Dugong - endangered species listing*. NSW Scientific Committee - final determination. 2 pp.

*NSW Scientific Committee (2002c). *Australian fur-seal - vulnerable species listing.* NSW Scientific Committee - final determination. 3 pp.

*NSW Scientific Committee (2002d). *New Zealand fur-seal - vulnerable species listing*. NSW Scientific Committee - final determination. 3 pp.

*NSW Scientific Committee (2003). *Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments – proposed key threatening process declaration.* 8 pp.

*NSW Waterways Authority (2003a). *NSW State Waters Marine Oil And Chemical Spill Contingency Plan*.

*NSW Waterways Authority (2003b). *Waterways Authority Annual Boating Incident Report 2002-03*.

*Ocean Watch Australia. (2003). *Circle of dependence – protected species handling manual*. Ocean Watch, Pyrmont, NSW.

*Okey, T.A and Harrington, G.A. (1999). Criteria for designing ecosystem-based, experimental management: Bottom trawling and the Bering Sea ecosystem. **In**: *Ecosystem Approaches for Fisheries Management*. Lowell Wakefield Fisheries Symposium Series. **No. 16**: 425-446.

Olmos, F. (1997). Seabirds attending bottom long-line fishing off southeastern Brazil. *Ibis*, **139**: 685-691.

Orenzanz, J. M., Armstrong, J. Armstrong, D. and Hilborn, R. (1998). Crustacean resources are vulnerable to serial depletion – multifaceted decline of crab and shrimp fisheries in the Greater Gulf of Alaska. *Reviews in Fish Biology and Fisheries* **8**:117-176.

Oro, D. (1996). Effects of trawler discard availability on egg laying and breeding success in the lesser black-backed gull *Larus fuscus* in the Western Mediterranean. *Marine Ecology Progress Series*, **132**: 43-46.

Oro, D. and Ruiz, X. (1997). Exploitation of trawler discards be breeding seabirds in the north-western Mediterranean: differences between the Erbo Delta and the Balearic Islands areas. *ICES Journal of Marine Science*, **54**: 695-707.

Oro, D., Jover, L. and Ruiz, X. (1996). Influence of trawling activity on the breeding ecology of a threatened seabird, Audouin's gull *Larus audouini*. *Marine Ecology Progress Series*, **139**: 19-29.

*Otway, N.M. and Burke, A.L. (2004). *Mark-Recapture Population Estimate and Movements of Grey Nurse Sharks*. NSW Fisheries Final Report Series No. 63. ISSN 1440-3544. EA Project No. 30786/86. NSW Fisheries, Nelson Bay, NSW, 53 pp.

*Otway, N.M. and Parker, P.C. (1999). *A review of the biology and ecology of the grey nurse shark* (Carcharias taurus) *Rafinesque 1810.* Fisheries Report Series No. 1. NSW Fisheries Research Institute, Cronulla.

*Otway, N.M., and Parker, P.C. (2000). *The biology, ecology, distribution and abundance, and identification of marine protected areas for the conservation of threatened Grey Nurse Sharks in south east Australian waters.* NSW Fisheries Final Report Series No, 19. NSW Fisheries, Port Stephens.

*Otway, N.M., Burke, A.L., Morrison, N.S. and Parker, P.C. (2003). *Monitoring and identification of NSW critical habitat sites for conservation of Grey Nurse Sharks.* NSW Fisheries Final Report Series No. 47. ISSN 1440-3544, EA Project No. 22499. NSW Fisheries, Nelson Bay, NSW.

Otway, N.M., Bradshaw, C.J.A. and Harcourt, R.G. (2004). Estimating the rate of quasi-extinction of the Australian grey nurse shark (*Carcharias taurus*) population using deterministic age- and stage-classified models. *Biological Conservation* **119**: 341-350.

Oxenford, H.A. (1999). Biology of the dolphinfish (*Coryphaena hippurus*) in the western central Atlantic: a review. *Scientia Marina*, **63**(3-4), pp 277-301.

Palko, B.J., Beardsley, G.L. and Richards, W.J. (1982). Synopsis of the biological data on dolphin-fishes, *Coryphaena hippurus* Linnaeus and *Coryphaena equiselis* Linnaeus. NOAA Technical Report, National Marine Fisheries Service, Seattle, WA (USA). Scientific Publications Office , 32 pp.

*Palmer, M. (2004). Report on Illegal Fishing for Commercial Gain or Profit in NSW. Report prepared for NSW Fisheries. 54 pp.

Parijis, S.M. van and Corkeron, P.J. (2001). Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, *Sousa chinensis*. *Journal of the Marine Biological Association of the United Kingdom*, **81**: 533-538

Parker, P.G. (1994). Rediscovering the Ballina angelfish *Chaetodontoplus ballinae* (Pomacanthidae) Whitley, 1959: two new fish records for Lord Howe Island, Australia. *Freshwater and Marine Aquarium (US)*, **August 1994**: 112-115.

Pascoe, S. (1997). *Bycatch management and economics of discarding*. FAO Fisheries Technical Paper 370, Rome.

Paterson, R. (1982). Tuna spotters' sightings aid sperm-whale count. *Australian Fisheries*, **41(10)**: 40-41.

Patterson, K.R, Zuzunaga, J. and Cardenas, G. (1992). Size of the South American sardine (*Sardinops sagax*) population in the northern part of the Peru upwelling ecosystem after collapse of anchoveta. *Canadian Journal of Fisheries and Aquatic Sciences* **49**: 1762-1769

Pauly, D. and Christensen V. (2002). Ecosystem models. **In:** *Handbook of Fish Biology and Fisheries*. Hart, P.J.B. and Reynolds, J.D (eds). Blackwell Science, Oxford, pp. 211-227.

*Pease, B. and Grinberg, A. (1995). New South Wales Commercial Fisheries Statistics, 1940 to 1992. NSW Fisheries, Fisheries Research Institute, Cronulla. 351 pp

Peres, M.B. and Haimovici, M. (2004). Age and growth of the southwestern Atlantic wreckfish *Polyprion americanus*. *Fisheries Research* **66**: 157-169.

Peres, M.B. and Klippel, S. (2003). Reproductive biology of the southwestern Atlantic wreckfish, *Polyprion americanus* (Teleostei: Polyprionidae). *Environmental Biology of Fishes* **68**: 163-173.

Peterman, R.M. and McAllister, M.K. (1993). A brief overview of the experimental approach to reducing uncertainty in fisheries management - an extended abstract. *Canadian Special Publication of Fisheries and Aquatic Sciences*, **120**: 419-422.

Peterman, R.M. and M'Gonigle, M. (1992) Statistical power analysis and the precautionary principle. *Marine Pollution Bulletin* **24**: 231-234.

Phillips, J.A. (2001). Marine macroalgal biodiversity hotspots: why is there high species richness and endemism in southern Australian marine benthic flora? *Biodiversity and Conservation*, **10**: 1555-1577.

Pimm, S.L. (2001). The World According to Pimm: A Scientist Audits the Earth. McGraw Hill, New York.

Pitcher, T.J. (2001). Fisheries managed to rebuild ecosystems? Reconstructing the past to salvage the future. *Ecological Applications*, **11**: 601-617.

Pitcher, T.J. and Pauly, D. (1998). Rebuilding ecosystems, not sustainability as the proper goal of fishery management. **In:** *Reinventing Fisheries Management.* Pitcher, T.J., Hart, P.J.B. and Pauly, D. (eds), Kluwer Academic Publishers, Dordrecht, pp. 311-330.

Pitcher, T.J., Hart, P.J.B. and Pauly, D. (1998). *Reinventing Fisheries Management*, Kluwer Academic Publishers, Dordrecht, pp. 435.

Pizzey, G. and Doyle, R. (1985). *A Field Guide to the Birds of Australia*, Collins, Sydney. 460 pp.

PlanningNSW (2002). *Aquatic Ecology in EIA*. Report prepared for PlanningNSW by The Ecology Lab Pty Ltd, 4 Green St, Brookvale, NSW. Version 9, October 2002. 91 pp.

PlanningNSW (2003). Guidelines for the Environmental Impact Assessment of Draft Fishery Management Strategies for Commercial Ocean Prawn Trawl, Fish Trawl & Ocean Trap and Line Fisheries.

*Pogonoski, J.J., Pollard, D.A., and Paxton, J.R. (2002). *Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes.* Environment Australia, Canberra.

Polivina, J.J., Howell, E., Parker, D.M., and Balazs, G.H. (2003). Dive-depth distribution of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) sea turtles in the central North Pacific: might deep longline sets catch fewer turtles? *Fishery Bulletin*, **101**: 189-193.

*Pollard, D.A. and Growns, I.O. (1993). *The fish and fisheries of the Hawkesbury-Nepean River System, with particular reference to the environmental effects of the Water Board's activities on this system*. Interim report to the Water Board – April 1993. NSW Fisheries, Fisheries Research Institute, Cronulla. 291 pp. plus appendices.

Pollard, D.A., Lincoln Smith, M.P. and Smith, A.K. (1996). The biology and conservation status of the grey nurse shark (*Carcharias taurus* Rafinesque 1810) in New South Wales, Australia. *Aquatic Conservation: Marine and Freshwater Ecosystems* **1**(177): 1-20.

Polunin, N.V.C. and Pinnegar, J.K. (2002). Trophic ecology and the structure of marine food webs. **In:** *Handbook of Fish Biology and Fisheries*, Hart, P.J.B. and Reynolds, J.D. (eds). Blackwell Science, Oxford.

*Ponder, W., Hutchings, P. and Chapman, R. (2002). *Overview of the Conservation of Australian Marine Invertebrates*. Report for Environment Australia, Australian Museum, Sydney. p. 587.

*Poore, G.C.B. (1995). Biogeography and diversity of Australia's marine biota. **In**: *State of the Marine Environment Report for Australia. Technical Annex 1: The Marine Environment.* Zann, L.P. and Kailola, P. (eds). Great Barrier Reef Marine Park Authority for the Department of Environment, Sport and Territories. p. 75-84.

Poortenaar, C.W., Hooker, S.H. and Sharp, N. (2001). Assessment of yellowtail kingfish (*Seriola lalandi lalandi*) reproductive physiology, as a basis for aquaculture development. *Aquaculture* **201**(3-4), pp. 271-286.

*Porter, G. (1998). Too much fishing fleet, too few fish. A proposal for eliminating global fishing overcapacity. *World Wildlife Fund*, pp 8 & 12

*Powell, R.A., Jensen, R. and Harwood, L. (1989). *The Effects of Policy Change and South-East Trawl Fishing Communities*. Report to the Steering Committee on Long-Term Management of the South East Trawl Fishery. University of New England and Department of Primary Industries and Energy, Canberra.

Priddel, D. (2003). Our seabirds at risk. **In:** *Conserving Marine Environments. Out of sight out of mind.* Hutchings, P. and Lunney, D. (eds). Royal Zoological Society of NSW, Mosman, 140 pp.

Priddel, D. and Carlile, N. (1997). Conservation of the endangered Gould's petrel *Pterodroma leucoptera leucoptera*. *Pacific Conservation Biology,* **3**: 322-329.

Punt, A.E., Walker, T.I. and Prince, J.D. (2002). Assessing the management-related benefits of fixed-station fishery-independent surveys in Australia's Southern Shark Fishery. *Fisheries Research*, **55**: 281-295.

*Queensland Environmental Protection Agency (1999). *Conservation and management plan for the dugong in Queensland 1999-2004*. State of Queensland Environmental Protection Agency.

*Rafic, M. (1999). *Draft recovery plan for blue whales* Balaenoptera musculus *in Australian waters: Phase 1 2000-2004*. Environment Australia – Marine Group, Canberra, Australia. 41 pp.

Reid, D. and Krogh, M. (1992). Assessment of catches from protective shark meshing off NSW beaches between 1950 and 1990. *Australian Journal of Marine and Freshwater Research,* **43**: 283-296.

Reynolds, J.D., Dulvy, N.K. and Roberts, C.M. (2002). Exploitation and other treats to fish conservation. **In:** *Handbook of Fish Biology and Fisheries.* Hart, P.J.B. and Reynolds, J.D. (eds). Blackwell Science, Oxford, p. 320 -340.

Richards, L.J. and Schnute, J.T. (1986). An experimental and statistical approach to the question: is CPUE an index of abundance? *Canadian Journal of Fisheries and Aquatic Science* **55**: 1545-1552.

Richardson, W.J., Greene, C.R.J., Malme, C.I. and Thomson, D.H. (1995). *Marine Mammals and Noise*. Academic Press, San Diego. 576 pp.

Roberts, C.D. (1989). Reproductive mode in the percomorph fish genus *Polyprion* Oken. *Journal of Fish Biology* **34**, pp 1-9.

Roberts, D.E. and Davis A.R. (1996). Patterns of sponge (Porifera) assemblages on temperate coastal reefs off Sydney, Australia. *Marine and Freshwater Research,* **47**: 897-906.

Robertson, G. (1998). Factors influencing breeding performance of the northern royal albatross. **In:** *Albatross: Biology and Conservation*. Robertson, G. and Gales, R. (eds). Surrey, Beatty and Sons, Chipping Norton, Australia. pp. 99-104.

Rochet, M. and Trenkel, V.M. (2003). Which community indicators can measure the impact of fishing? A review and proposals. *Canadian Journal of Fisheries and Aquatic Sciences,* **60**: 86-99.

Rosenberg, A.A. and Restrepo, V.R. (1994). Uncertainty and risk evaluation in stock assessment advice for U.S. marine fisheries *Canadian Journal of Fisheries and Aquatic Sciences* **51**: 2715-2720.

*Rowling, K.R. (1996). *Assessment of the NSW Dropline Fishery, Progress Report - 1993 to 1995*. NSW Fisheries Research Institute, Cronulla.

*Rowling, K.R. (1999). *The fisheries biology and populations dynamics of gemfish* Rexea solandri. Unpublished PhD Thesis, University of New South Wales, 300p.

Rowling, K.R. (2001). Comment on ‘Spawning dynamics of the eastern gemfish (*Rexea solandri*) in relation to regional oceanography’. *Marine and Freshwater Research* **52**: 623-630.

*Rowling, K.R. and Makin, D.L. (2001). *Monitoring of the fishery for gemfish* Rexea solandri, *1996 to 2000.* NSW Fisheries Final Report Series, No. 27. NSW Fisheries Research Institute, Cronulla.

*Rowling, K.R. and Raines, L.P. (2000). *Description of the biology and an assessment of the fishery for silver trevally* Pseudocaranx dentex *off New South Wales.* FRDC Project 97/125 NSW Fisheries Final Report Series No. 24. September, 2000. NSW Fisheries, Cronulla.

*Roy Morgan Economic Survey (RM-ES). (2001). *Economic Survey Results.* Unpublished Research, Roy Morgan Research, Sydney. May/June 2001.

*Ruello, N.V. (1996). *A Study of the Demand and Importance of Seafood Sourced in NSW and Elsewhere to the Catering and Tourism Industries in NSW*. FRDC, NSW. 157 pp.

*Ruello and Associates Pty Ltd (2000). *Retail and Sale Consumption of Seafood*. Report prepared for the FRDC. July 2000. 14 pp.

Sainsbury, K.J. (1988). The ecological basis of multi-species fisheries, and management of a demersal fishery in tropical Australia. **In:** *Fish Population Dynamics* (ed. Gulland J.A.). John Wiley and Sons Ltd, London, p. 349-377.

Sainsbury, K.J., Campbell, R.A., Lindholm, R. and Whitelaw, A.W. (1997). Experimental management of an Australian multi-species fishery: examining the possibility of trawl-induced habitat modification. **In:** *Global trends in fisheries management* (eds Pikitch, E.K., Huppert, D.D. and Sissenwine, M.P.). American Fisheries Society, p. 107-112

Sainsbury, K.J., Punt A.E. and Smith A.D.M. (2000). Design of operations management strategies for achieving fishery ecosystem objectives. *ICES Journal of Marine Science*, **57**: 731-741.

Scammell, M.S. Batley G.E. Brockbank C.I. (1991). A field study of the impact on oysters of tributyltin introduction and removal in a pristine lake. *Archives of Environmental Contamination and Toxicology*, **20**: 276-281

Scammell, S. and Baker, R. (2004). *Code of Practice for Antifouling and In-Water Cleaning and Maintenance - Working Together to Reduce Impacts from Shipping Operations.* ANZECC Strategy to Protect the Marine Environment, Sydney. p.12.

*Scandol, J.P. (2004). *A Framework for the Assessment of Fish Resources in NSW (Draft)*. NSW Fisheries Fishery Resource Assessment Series Cronulla.

*SCFA (2000). Standing Committee on Fisheries and Aquaculture. FRDC ESD Project (Draft) Case Study information Package.

Schmitt, R.J. and Osenberg, C.W. (1996). *Detecting Ecological Impacts – Concepts and Applications in Coastal Habitats*. Academic Press, San Diego, 401pp.

*Schnierer, S. and Faulkner, A. (2002). A description of the aboriginal fisheries of NSW. Centre for Indigenous Fisheries, School of Environmental Sciences, Southern Cross University.

Sedberry, G.R., Carlin, J.L., Chapman, R.W. and Eleby, B. (1996). Population structure in the pan-oceanic wreckfish, *Polyprion americanus* (Teleostei: Polyprionidae), as indicated by mtDNA variation. *Journal of Fish Biology* **49** (Supplement A), pp 318-329.

Sedberry, G.R., Andrade, C.A.P., Carlin, J.L., Chapman, R.W., Luckhurst, B.E., Manooch III, C.S., Menezes, G., Thomsen, B. and Ulrich, G.F. (1999). Wreckfish *Polyprion americanus* in the North Atlantic: fisheries, biology, and management of a widely distributed and long-lived fish. *American Fisheries Society Symposium* **23**: 27-50.

*Selliah, N., Oxenford, H. and Parker, C. (2001). Selecting biodegradable fasteners and testing the effects of escape panels on catch rates of fish traps. **In**: *Proceedings of the Gulf and Caribbean Fisheries Institute Meeting*, Key West, FL (USA), Nov 1999 no. 52, pp. 634-653.

Shaklee, J.B., Phelps, S.R. and Salini, J. (1990). Analysis of fish stock structure and mixed-stock fisheries by the electrophoretic characterization of allelic isozymes. **In**: *Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management* (Ed. D.H. Whitmore) pp. 173-196.

Shark Advisory Group and Lack, M. (2004). *National Plan of Action for the Conservation and Management of Sharks (Shark-plan)*. Report prepared for the Australian Government Department of Agriculture, Fisheries and Forestry, 76 pp.

*Shaughnessy, P.D. (1999). *The action plan for Australian seals*. Environment Australia, Canberra.

Shaughnessy, P.D., Briggs, S.V. and Constable, R. (2001). Observations on seals at Montague Island, New South Wales. *Australian Mammalogy*. **23**: 1-7.

Sheaves, M.J. (1993). Patterns of movement of some fishes within an estuary in tropical Australia. *Australian Journal of Marine and Freshwater Research* **44**: 867-80.

Sheaves, M.J. (1995). Large lutjanid and serranid fishes in tropical estuaries: Are they adults or juveniles? *Marine Ecology Progress Series* **129**: 31-40.

Silberschneider, V. and Gray, C.A. (2005). Arresting the decline of the commercial and recreational fisheries for mulloway (*Argyrosomus japonicus*). Fisheries Final Report Series No. 82. NSW Department of Primary Industries (now incorporating NSW Fisheries), NSW.

Simpfendorfer, C. and Donohue, K. (1998). Keeping the fish in ‘fish and chips’: research and management of the Western Australian shark fishery. *Marine and Freshwater Research*, **49**: 593-600.

Simpfendorfer, C.A., Goodreid, A and McAuley, R.B. (2001). Diet of three commercially important shark species from Western Australian waters. *Marine and Freshwater Research*, **52**: 975-985.

Sinclair, M., Arnason, R., Csirke, J., Karnicki, Z., Sigurjonsson, J., Skjoldal, H.R. and Valdimarsson, G. (2002). Responsible fisheries in the marine ecosystem. *Fisheries Research (Amsterdam)*. **Vol. 58**, No. 3, pp. 255-265.

Slater, J. (1991). *Flotsam and Jetsam. Marine Debris* Bulletin 1. Beach Survey Results January 1990-June 1991. Tasmanian Department of Parks, Wildlife and Heritage, Hobart.

Smith, D.C. (1982). Age and growth of jackass morwong (*Nemadactylus macropterus* Bloch & Schneider) in eastern Australian waters. *Australian Journal of Marine and Freshwater Research* **33**, pp 245-253.

Smith, D.C. (1983). Annual mortality and population structure of jackass morwong (*Nemadactylus macropterus* Bloch & Schneider) in eastern Australian waters. *Australian Journal of Marine and Freshwater Research* **34**, pp 253-260.

*Smith, P.J. (2001). *Review of the conservation status of marine mammal species in NSW*. A report to the NSW Scientific Committee, NSW National Parks and Wildlife Service, Hurstville NSW. 116 pp.

*Smith, A.D.M. and Wayte, S.E. (eds) (2002). *The South East Fishery 2002*. Fishery Assessment Report compiled by the South East Fishery Assessment Group. Australian Fisheries Management Authority, Canberra.

Smith, A., Pepperell, J., Diplock, J. and Dixon, P. (1991). Study suggests NSW kingfish one stock. *Australian Fisheries* **50 (3)**; 34-36.

*Smith, A., Pollard, D. and Gillanders, B. (1996). *The blue groper in NSW*. Fishnote DF/63. NSW Fisheries, Sydney, 2 pp.

*SPCC (1981). *The Ecology of Fish in Botany Bay - Biology of Commercially and Recreationally Valuable Species. Environmental Control Study of Botany Bay*. ISBN 0724058249, 287 pp.

Standards Australia/Standards New Zealand (1999). *Risk management – generic guide for establishing and implementing the risk management process – AS/NZS 4360*. Standards Australia International Ltd, Sydney, Australia and Standards New Zealand, Wellington, New Zealand.

Standards Australia/Standards New Zealand (2000). Environmental *Risk management – principles and processes – HB 203:2000*. Standards Australia International Ltd, Sydney, Australia and Standards New Zealand, Wellington, New Zealand. 81 pp.

Steffe, A.S. and Neira, F.J. (1998). Sciaenidae: croakers and drums. **In**: *Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification* (F.J. Neira, A.G. Miskiewicz and T. Trnski eds.) University of Western Australia Press, Nedlands, Western Australia, pp 278-283.

*Steffe A.S, Murphy J., Chapman D., Tarlington B.E, Gordon G.N.G, Grinberg A. (1996). *An Assessment of the Impact of Offshore Recreation Fishing in New South Wales on the Management of Commercial Fisheries*. NSW Fisheries, Final report to Fisheries Research and Development Corporation No. 94/053, Sydney.

*Stewart, J. and Ferrell, D.J. (2001). *Mesh Selectivity in the NSW Demersal Trap Fishery*. Final report to Fisheries Research and Development Corporation Project No. 98/138. NSW Fisheries Final Report Series No. 35, ISSN 1440-3544.

Stewart, J. and Ferrell, D.J. (2002). Escape panels to reduce by-catch in the NSW demersal trap fishery. *Marine and Freshwater Research* **53**: 1179-1188.

Stewart, J. and Ferrell, D.J. (2003). Mesh selectivity in the NSW demersal trap fishery. *Fisheries Research* **59**: 379-392.

Stewart, J., Ferrell, D.J. and van der Walt, B. (2004). Sizes and ages in commercial landings with estimates of growth, mortality, and yield per recruit of yellowtail kingfish (*Seriola lalandi*) from New South Wales, Australia. *Marine and Freshwater Research* **55**: 489-497.

*Stewart, J., Ferrell, D.J., van der Walt, B., Johnson, D. and Lowry, M. (2001). Assessment of Length and Age Composition of Commercial Kingfish Landings. Final report to Fisheries Research and Development Corporation, Project No. 97/126. NSW Fisheries Final Report Series No. 36, ISSN 1440-3544.

Stewart, J. and Hughes, J.M. (2005). Longevity, growth, reproduction and a description of the fishery for silver sweep *Scorpis lineolatus* off New South Wales, Australia. *New Zealand Journal of Marine and Freshwater Research* **39**: 827-838.

Stobutzki, I., Miller, M. and Brewer, D. (2001). Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. *Environmental Conservation* **28 (2)**: 167-81.

*Tamblyn, C. and Powell, R.A. (1988). *Input and Output Study of the North Coast Agriculture and Fisheries Industries.* NSW Department of Agriculture, Wollongbar.

Tarvey, L. (1993). First nesting records for the leatherback turtle *Dermochelys coriacea* in northern New South Wales Australia, and field management of nest sites. **In:** *Herpetology in Australia: a diverse discipline*. Lunney, D. and Ayres, D. (eds). Surrey Beatty and Sons, Chipping Norton, Australia. pp 233-237.

Thompson, K.R. (1992). Quantitative analysis of the use of discards from squid trawlers by Black-browed Albatrosses *Diomedea melanophris* in the vicinity of the Falkland Islands. *Ibis*, **134**: 11-21.

*Threatened Species Scientific Committee, (2001). *Commonwealth listing advice on loss of climatic habitat caused by anthropogenic emissions of greenhouse gasses.* 4 pp.

*Threatened Species Scientific Committee, (2003). *Commonwealth listing advice for injury and fatality to vertebrate marine life caused by ingestion of or entanglement in, harmful marine debris.* 8 pp. (http://www.deh.gov.au/biodiversity/threatened/ktp/marine-debris.html)

Trites, A.W. (2002). Food webs in the ocean: who eats who and how much? **In:** *Responsible Fisheries in the Marine Ecosystem*, Sinclair, M. and Valdimarsson, G. (Eds), CAB International, Wallingford, FAO Fisheries Report no. **658**, supplement, p. 12.

*Trites, A. W., Livingston, P. A., Vasconcellos, M., Mackinson, S., Springer, A. M. and Pauly, D. (1999). Ecosystem considerations and the limitations of ecosystem models in fisheries management: insights from the Bering Sea. **In:** *Ecosystem Approaches for Fisheries Management*, Alaska Sea Grant Program, p. 609-619.

Underwood, A.J. (1986). What is a community? **In**: *Patterns and Processes in the History of Life*. Raup, D. M. and Jablonski, D., Dahlem Konferenzen, Springer-Verlag, Berlin, p.351-367.

Underwood, A.J. (1989). The analysis of stress in natural populations. *Biological Journal of the Linnean Society* **37**: 51-78

Underwood, A.J. (1990). Experiments in ecology and management: their logics, functions and interpretations. *Australian Journal of Ecology,* **15**: 365-389.

Underwood, A.J. (1992). Beyond BACI: the detection of environmental impact on populations in the real, but variable, world. *Journal of Experimental Marine Biology and Ecology*, **161**: 145-178.

Underwood, A.J. (1995). Ecological research and (and research into) environmental management. *Ecological Applications*, **5**: 232-247.

Underwood, A.J. (1996). Detection, interpretation, prediction and management of environmental marine ecology. *Journal of Experimental Marine Biology and Ecology*, **200**: 1-27.

Underwood, A.J. (1997). Environmental decision-making and the precautionary principle: what does this principle mean in environmental sampling. *Landscape and Urban Planning* **37**: 137-146.

Underwood, A.J. (2000). Experimental ecology of rocky intertidal habitats: what are we learning? *Journal of Experimental Marine Biology and Ecology* **250**: 51-76.

Underwood, A.J. and Chapman, M.G. (eds) (1995). *Coastal Marine Ecology of Temperate Australia*. University of NSW Press Ltd, Sydney, pp. 341

Underwood, A.J. and Chapman M.G. (2003). Power, precaution, Type II error and sampling design in assessment of environmental impacts. *Journal of Experimental Marine Biology and Ecology*, **296**: 49-70.

Voisin, J.F. (1988). Breeding biology of the northern giant petrel *Macronected halli* and the southern giant petrel *M. giganteus* at Ille de la Possession, Iles Crozet, 1966-1980. *Cormorant*, **16**: 65-97.

Vooren, C.M. (1977). Growth and mortality of tarakihi (Pisces: Cheilodactylidae) in lightly exploited populations. *New Zealand Journal of Marine and Freshwater Research* **11(1)**: 1-22.

Walker, T.I. (1998). Can shark resources be harvested sustainably? A question revisited with a review of shark fisheries. *Marine and Freshwater Research*, **49**: 553-572.

Walter, U. and Becker, P.H. (1997). Occurrence and consumption of seabirds scavenging on shrimp trawler discards in the Wadden Sea. *ICES Journal of Marine Science*, **54**: 684-694.

Walters, C.J. (1986). *Adaptive Management of Renewable Resources*. New York, Macmillan Press

Walters, C. and Maguire, J. (1996). Lessons for stock assessment form the northern cod collapse. *Reviews in Fish Biology and Fisheries* **6**: 125-137.

Walters, C. and Pearse, P.H. (1996). Stock information requirements for quota management systems in commercial fisheries. *Reviews in Fish Biology and Fisheries,* **66**: 21-42.

Ward, R.D. and Elliott, N.G. (2001). Genetic population structure of species in the South East Fishery of Australia. *Marine and Freshwater Research*, **52**: 563-573.

Warneke, R.M. (1975). Dispersal and mortality of juvenile fur-seals *Arctocephalus pusillus doriferus* in Bass Strait, southeastern Australia. *Rapports et Proces-Verbaux des Reunions Conseil International pour l'Exploration de la Mer,* **169**: 296-302.

*Warneke, R.M. (1996). Fauna Impact Statement: evaluation of mussel aquaculture in Twofold Bay. In: *Environmental Impact Statement (incorporating Fauna Impact Statement) Evaluating Mussel Aquaculture in Twofold Bay*. Report prepared for South Coast Business Enterprise Centre by Pacific Seafood Management Consulting Group, Melbourne. Appendix IV.

Weimerskirch, H. and Jouventin, P. (1987). Population dynamics of the wandering albatross, *Diomedea exulans*, of the Crozet Islands: causes and consequences for the population decline. *Oikos*, **49(3)**: 315-322.

Whiting, S.D. (1998). Types and sources of marine debris in Fog Bay, northern Australia. *Marine Pollution Bulletin* **36**,904-910.

Whittington, R.J., Jones, J.B., Hine, P.M. and Hyatt, A.D. (1997). Epizootic mortality in the pilchard *Sardinops sagax neopilchardus* in Australia and New Zealand in 1995. 1. Pathology and epizootiology. *Diseases of Aquatic Organisms* **28**(1), pp. 1-16.

Williams, J.G. (1999). Stock dynamics and adaptive management of habitat: an evaluation based on simulations. *North American Journal of Fisheries Management*, **19**: 329-341.

Williams, A. and Bax N.J. (2001). Delineating fish-habitat associations for spatially-based management: an example from the south-eastern Australian continental shelf. *Marine and Freshwater Research,* **52**: 513-536

*Zann, L.P. (1995). State of the Marine Environment Report for Australia. The Marine Environment – Technical Annex 1. Great Barrier Reef Marine Park Authority, 193 pp.

Volume 3

Appendices

This is the third of three volumes of the Environmental Impact Statement on the Ocean Trap and Line Fishery in NSW

TABLE OF CONTENTS

Volume 3 *(Appendices)*

APPENDIX A1 LIST OF PROPONENTS

Appendix A1 List of Proponents (as at 23 January 2006)

Name	Address	Town	Postcode
4 SEAS PTY LTD	PO Box 14	BUDDINA	4575
ABBOTT, J.G. & D. CREIGHTON	54 Hillcrest Avenue	NAROOMA	2546
AISH, Barry Arthur	43 Kanahooka Road	DAPTO	2530
AISH, Craig Anthony	43 Kanahooka Road	DAPTO	2530
AISH'S PTY LTD	43 Kanahooka Road	DAPTO	2530
ALECKSON, Kevin George	1 Anson Avenue	EVANS HEAD	2473
ALLDRITT, John	Coasters Retreat	VIA PALM BEACH	2108
ALLTUNA FISHERIES PTY LTD	Unit 11 'Bondoola'	82-86 RIVER ESP	
ANDERSON, Darren John	4 Old Saddleback Road	KIAMA	2533
ANDERSON, David Peter	25 Mc Phee St	MACLEAN	2463
ANDERSON, Shane Alan	17 Telopea Avenue	YAMBA	2464
APPLEBY, K. & A.R. BROADHURST	24 Alexander Drive	BERMAGUI	2546
ARDLER, Michael John	18 High Street	CARINGBAH	2229
ASQUITH, Raymond	24 Grafton Street	NELSON BAY	2315
ATKINS, David John & Tania Cherie	PO Box 723	WOOLGOOLGA	2456
BAGGALEY, Christopher Derek	4 Barellan Drive	BANORA POINT	2486
BAGNALL, Richard David	1 Cutter Close	CORLETTE	2315
BAGNATO HOLDINGS PTY LTD	C/- 14 Elizabeth St	FIVE DOCK	2046
BAGNATO, Domenico	610/261 Harris Street	PYRMONT	2009
BAGNATO, Paul Vince	97b Victor Road	DEE WHY	2099
BAILEY, Brian Kenneth & Heather Ellen	64 Ormond Street	BELLERIVE	7018
BAKER, Michael James	14 Koongara Street	TOOWOON BAY	2261
BALLANTYNE, Garry & Michael	PO Box 88	PAMBULA	2549

Appendix A1 cont.

Name	Address	Town	Postcode
BARBARIC, Anton & Patricia	1490 Orara Way	NANA GLEN	2450
BARBER, John Thomas & Norma June	26 Cook Drive	SOUTH WEST ROCKS	2431
BARBER, Mark Anthony	1/3 West Promenade	MANLY	2095
BARBER, Matthew Phillip Norman	7 Hawks Nest Place	BATEMANS BAY	2536
BARLOW, David	Birrabang, Olympic Way	JINDERA	2642
BARRY, Mark William & Ian Craig PUCKERIDGE	60 Bilga Crescent	MALABAR	2036
BARTER, Allan Francis	3 Jacaranda Avenue	BENDALONG	2539
BARUNDI PTY LTD	PO Box 191	EDEN	2551
BASS FISHERIES PTY LTD	PO Box 77	STANLEY	7331
BATES, Graham John	43 Church Street	GREENWELL POINT	2540
BATTAGLIOLO, S & R, & V & M BASILE	36 Did-Dell Street	ULLADULLA	2539
BAXTER, Barry Arthur	28 Burns Street	BYRON BAY	2481
BAXTER, Brett Anthony	10 Canty Street	NAROOMA	2546
BAXTER, Edward Albert	10 Canty Street	NAROOMA	2546
BELL, John	22 Bellevue Place	EDEN	2551
BERRY, Ian Edwin	66 Kingsley St	BYRON BAY	2481
BEST, John & Christine Helen	RMB 3 Range Road	CORINDI BEACH	2456
BIELBY, Peter Ernest	8 Glacken Street	HARRINGTON	2427
BILLIN, Troy Samuel	810 Bangalow Road	BANGALOW	2479
BILLINGSLEY, Chris John	8 Little Street	HARRINGTON	2427
BINNS, Geoffrey Leon	73 South Street	ULLADULLA	2539
BLACKBURN BRINSLEY PTY LTD	5 Bonville Station Road	BONVILLE	2441
BLANCH, David John	30 Kestrel Avenue	MOUNT HUTTON	2290

Appendix A1 cont.

Name	Address	Town	Postcode
BLANCH, Phillip	468 Fullerton Cove Road	FULLERTON COVE	2318
BLESSINGTON, Stephen Matthew	8162 Pacific Hwy	URUNGA	2455
BLUE WATER RESOURCES PTY LTD	PO Box 115	SANS SOUCI	2219
BOBELDYK, Anthony & Gerrit Jan	2 Bimbadeen Avenue	BANORA POINT	2486
BOGGIS, Ronald Henry	75 Shirley Street	BYRON BAY	2481
BORDIN, Gary Stephen	30 Horizon Drive	WEST BALLINA	2478
BORDIN, Stephen Anthony	7 Melaleuca Place	EAST BALLINA	2478
BOWLAND, Gregory John	110 Green Point Drive	GREEN POINT	2428
BOYLE, David John	8 Hogan Street	ILUKA	2466
BRADFORD, Christopher Roy	7 Bruce Field Street	SOUTH WEST ROCKS	2431
BRAITHWAITE, Garry	19 West Street	BERMAGUI	2546
BRAMBLE, Graham	1677 Coomba Road	COOMBA BAY	2428
BRAMBLE, Noel James	Lot 310 Camellia Place	GREEN POINT	2428
BRAMBLE, Wayne	11 Simpson St	SOUTH WEST ROCKS	2431
BRANDES, Warren Ernest	35 Tasman Street	BATEMANS BAY	2536
BRETHERTON, John Thomas	13 Charles Place	KINGSWORTH ESTATE	
BRISLANE, Reala John	20 Mann Street	NAMBUCCA HEADS	2448
BROOKS, Jeffrey James	PO Box 3114	BATEHAVEN	2536
BROWN, Denis Noel	9 Matthews Drive	MOUNT WARRIGAL	2528
BRYANT, Robert Douglas	10 Vimiera Close	NORAH HEAD	2263
BRYNE, Robert William	28 Rudder Street	SOUTH WEST ROCKS	2431
BUCHANAN, Mervyn & Susan & INGHAM, Craig & Robyn	12 Centenary Parade	NAMBUCCA HEADS	2448
BULL, Colin Wayne	PO Box 74	CRESCENT HEAD	2440

Appendix A1 cont.

Name	Address	Town	Postcode
BULL, Peter Christopher	20 Timbara Crescent	SURFSIDE	2536
BULMER, Gary John	7 Lochlomond Drive	BANORA POINT	2486
BURKE, Stephen John Drake & John Harold	157 Farmborough Road	FARMBOROUGH HEIGHTS	2526
BURLEY, Graeme John	10 The Jetty	SALAMANDER BAY	2317
BURNES, William Douglas	17 Riverview Street	ILUKA	2466
BUTLER, Christopher John	40 Aubreen Street	COLLAROY PLATEAU	2097
BUTLER, Leonard William	RMB 533 Junee Road	TEMORA	2666
BYRON, Aarne Leslie	PO Box 1105	MONA VALE	1660
CAMILLERI, Raymond Michael	24 The Outlook Road	SURFSIDE	2536
CAMPBELL, Alexander & Nancy May	3 Selwyn Street	TRIABUNNA	7190
CAPPER, Stephen	1 Weeroona Place	DUNDAS	2117
CARR, Clem	24 Brown Street	REDHEAD	2290
CARRISON, Bruce Jason	Maclib Apartments	3 TEDDER AVENUE	
CARTER, John Arthur	3 Empire Bay Drive	KINCUMBER	2251
CARTER, Richard John	Lot 25 Green Valley Way	PIGGABEEN	2486
CASEY, Grant Francis	190 Gregory St	SOUTH WEST ROCKS	2431
CASON, Barry John	22 Ballanda Crescent	ILUKA	2466
CAVALLO, James Richard	4 Cave Street	ILUKA	2466
CETKOVIC, Nikola	PO Box 120	PAMBULA	2549
CHAFFEY, David Colin & Aileen Margaret	42a Blowhole Road	EAGLEHAWK NECK	7179
CHASE, Stuart Gordon	90 Bohnock Road	BOHNOCK	2430
CHASPER INVESTMENTS PTY LTD	7 Diplacus Drive	PALM BEACH, Qld	4221
CHEERS, Micheal Whylie	17 Tropic Gardens Drive	SMITHS LAKE	2428

Appendix A1 cont.

Name	Address	Town	Postcode
CHRISTENSEN, Peter John	3 Lee Ann Crescent	BELMONT	2280
CLARKE, Grahame John	16 Stefan Close	EMERALD HEIGHTS	2456
CLIFF, Gregory Alan	46 Kenrose Street	FORSTER	2428
CLOSE, Stephen William	2 Halls Road	LUSCOMBE QLD	4207
COLLET, Geoffrey Stewart	PO Box 97	EDEN	2551
COLLINS, Brett James	72 Iluka Ave	SAN REMO	2262
COLLINS, Lance Stanley	19 Lake Court	URUNGA	2455
COLLINS, Robert John & Leonard Wayne	11 Ireland St	BURRILL LAKE	2539
COLLIS, Gary John	7 Micalo Street	ILUKA	2466
CONNOLLY, Geoffrey Francis	2 Spofforth Street	ERMINGTON	2115
CORBETT, Clifford James	223 Sandy Flat Road	TINTENBAR	2478
COROCHER, Shane Lenard Allan	90 Wharf Street	MACLEAN	2463
COWEN, Geoffrey David & Therese Edna	28 Micalo Street	ILUKA	2466
CRAMERI, Barry Francis	256 Birrel Street	WAVERLEY	2024
CREEK FISHERIES PTY LTD	48 Bunga Street	BERMAGUI	2546
CROOKS, James Crooks & John	14c Valla Road	VALLA	2448
CUNNINGHAM, Allan	56 Kenrose Street	FORSTER	2428
CUNNINGHAM, Robert Bruce	PO Box 1194	BURLEIGH HEADS	4220
CUPIT , Estate of Douglas Colin	4 Gleneon Drive	FORSTER	2428
CUPIT, Brett Anthony	4 Gleneon Drive	FORSTER	2428
CUTHBERT, Graeme Lanark	7 Rainbow Close	RAINBOW FLAT	2430
DALE, Ashley Richard	52 Dublin Street	PORT LINCOLN	5606
DALEY, Gregory Keith	88 The Scenic Road	KILLCARE HEIGHTS	2257

Appendix A1 cont.

Name	Address	Town	Postcode
DALY, Robert Ian	20a Pirralea Parade	NELSON BAY	2315
DARE, Charles Peter	PO Box J223	COFFS HARBOUR	2450
DARKE, Ronald George	2 Jubilee Avenue	SOUTH WEST ROCKS	2431
DAVIES, Brian John	Kinka Rd	SEAL ROCKS	2423
DAVIES, Leslie Peter	3/69 Riverside Drive	WOOLI	2462
DAVIS, JW, SG, JA & BW	27 Loader Pde	NAROOMA	2546
DEHAAS, Harmen & Janet Barbara	36 Cresswick Parade	DALMENY	2546
DENTON, Christopher David	209 Diamond Beach Road	DIAMOND BEACH	2430
DEWHURST, Rodger Lex	10 McFaul Place	KIAMA	2533
DIMAIO, Peter Anthony	50 Massinger Street	BYRON BAY	2481
DIMENTO, Francesco	53 Perry Street	LEICHHARDT	2040
DORRELL, Bruce Arthur	43 Woodburn Street	EVANS HEAD	2473
DOUCH, Colin Frederick	5 Robinson Avenue	MINNAMURRA	2533
DOYLE, John Desmond	23 Corriston Crescent	ADAMSTOWN HEIGHTS	2289
DUFF, Graham William	3 Forest Way	WOOMBAH	2469
DUNN, David William	PO Box 76	ULLADULLA	2539
DUNN, , Charles Wayne	69 Church Street	ULLADULLA	2539
DWYER, Gavin Paul	2 Pacific Place	BRUNSWICK HEADS	2483
DWYER, Michael Vincent & PACKMAN, Peter James	PO Box 2392	BUNDABERG	4670
DWYER, Peter John	10 Endeavour Street	YAMBA	2464
EARLE, David Robert	12 Endeavour Street	YAMBA	2464
EATHER, Eric Peter	57 Barney Street	KIAMA	2533
EATHER, John Anthony	110 Attunga Avenue	KIAMA HEIGHTS	2533

Appendix A1 cont.

Name	Address	Town	Postcode
ECROYD, Peter William	PO Box 1110	BEGA	2550
EGGINS, Gary Albert	10 Mill Street	LAURIETON	2443
ELFORD, Clifford James	33 North Shore Drive	PORT MACQUARIE	2444
ELFORD, Clifford James & Gregory Wayne	33 North Shore Drive	PORT MACQUARIE	2444
ELFORD, Robert Clyde	33 The Jib	PORT MACQUARIE	2444
EMERY, David Emery & Jennifer	12 Prince Street	BELLINGEN	2454
ENDRES, Michael John	17 Maloney Avenue	SOUTH LISMORE	2480
EVANS, Peter & Barry	21 Lucas Avenue	MALABAR	2036
FANTHAM, Richard	PO Box 83	EDEN	2551
FARCICH, John	13 Michele Street	CROMER	2099
FARMER, Mark John	PO Box 261	EDEN	2551
FARRELL, Allan James	5 Compton Street	ILUKA	2466
FARRELL, Gordon William	41 Riverview Street	ILUKA	2466
FIRKIN, Ronald Oliver	122 Victoria Street	MALABAR	2036
FISHFINDER PTY LTD	12 Sheffield Street	KINGSGROVE	2208
FLEMING, Noel	13 Burns Point Ferry Road	BALLINA	2478
FLETCHER, Anthony Victor	24 Watsonia Ave	COFFS HARBOUR	2450
FORSTER, Anthony Robert	PO Box 189	AVOCA BEACH	2251
FORSTER, Paul Francis	280 Macrae Place	FAILFORD	2430
FORTUNA FISHING PTY LTD	PO Box 933	MOOLOOLABA	4557
FRAPPELL, David William	10 Colin Street	BANGALOW	2479
FULLER, Rodney James	12 Boronia Street	MINNIE WATERS	2462
GARVEN, John Howard	19 Beach Street	YAMBA	2464

Appendix A1 cont.

Name	Address	Town	Postcode
GENDERS, Robert William	23/20 Pacific Highway	BLACKSMITHS	2281
GIBSON, Paul Keith	54 Blue Waters Crescent	TWEED HEADS	2485
GILES, Edward Francis	PO Box 573	NELSON BAY	2315
GIOIA, Felice	26 Frazer Street	LEICHHARDT	2040
GLEN, Eric John	82 Morna Point Road	ANNA BAY	2316
GOGERLY, Daniel Albert	4 Bali Hai Avenue	FORSTER	2428
GOGERLY, Noel Albert	4 Balihai Avenue	FORSTER	2428
GOODALL, Barry John	Villa 2/13a Sea Breeze Pl	BOAMBEE EAST	2452
GRAHAM, Leslie	41 Bangalow Street	NARRAWALLEE	2539
GRAHAM, Rebekah & GOGOVSKI, Tony	96 Mill St	CARLTON	2218
GRANT, Christopher James	38 Morris Street	ULLADULLA	2539
GRAY, Robert Noel	42 Murrah Street	BERMAGUI SOUTH	2546
GRAY, Samuel Robert	21 Bunga Street	BERMAGUI	2546
GRIFFIS, Laurence John	2 Acacia Street	TWEED HEADS SOUTH	2486
GRIFFITHS, Anthony David	7 Angourie Street	ANGOURIE	2464
GRIVINS, Ivan Karl	675 Southbank Road	PALMERS CHANNEL	2463
GROOT, Joseph Antonio	79 Henderson Road	SARATOGA	2251
HAACK, Terry John	1161 Pacific Highway	COWAN	2081
HAGELSTEIN, Gerald	PO Box J242	COFFS HARBOUR	2450
HALLORAN, Anthony Robert	155 Smiths Road	AVOCADO HEIGHTS	
HAPUKU FISHERIES PTY LTD	14 Harbord Street	THIRROUL	2515
HARAPEET, Mark	10 Wattle Avenue	BOGANGAR	2488
HARASYMIW, Oleh Volodimyr	7 Pimelia Court	FRANKSTON	3199

Appendix A1 cont.

Name	**Address**	**Town**	**Postcode**
HAREIDE, Gordon	19 Hiawatha Road	MINNIE WATER	
HARGRAVES, Allan Richard	23 Melittas Avenue	COFFS HARBOUR	2450
HARGRAVES, Richard Robert	3 Alfred Street	WOODBURN	2472
HARRINGTON, Anthony Bruce	Lot 176	COBARGO	2550
HARRINGTON, John Warren	1 Fishery Road	CURRARONG	2540
HARRIS, William John	PO Box 76	EVANS HEAD	2473
HARRISON, Paul Anthony & WALLACE, Paul Charles	Leopold Street	CROWDY HEAD	2427
HART, Jason	8 Bottlebrush Crescent	EVANS HEAD	2473
HAY, Benjamin Lindsay	2 Merino Road	NORAVILLE	2263
HAYWARD, Andrew Ian	160 Yamba Road	YAMBA	2464
HEALEY, Warwick David	PO Box 1088	MOSSMAN	4873
HENDERSON, Graham Leslie	9 Marriot Street	BELMONT SOUTH	2280
HENDERSON, Gregory John	8 Ashley Street	MARKS POINT	2280
HICKS, Allen Ernest	1629 Ocean Drive	LAKE CATHIE	2445
HILLYARD, Graeme John	330 Blackwall Road	WOY WOY	2256
HINE, John Peter	16-20 Bellbrook Crescent	FAIRHAVEN	
HIRST, Michael Gordon	4a Jessie Riley Avenue	ERINA	2250
HOCKING, Stuart Alan	9 Mookara Place	LILLI PILLI	2229
HOLBERT, Raymond & Paul	21 Sylvan Avenue	MEDOWIE	2318
HOLDEN, Richard Clyde	2628 Lakes Way	BUNGWAHL	2423
HOLLIS (Jnr) , Geoffry Charles	55 Dunbar Street	STOCKTON	2295
HOLLIS, Geoff	55 Dunbar St	STOCKTON	2295
HOOKE, James Edwin	PO Box 4317	FORSTER	2428

Appendix A1 cont.

Name	Address	Town	Postcode
HUTCHINSON, Scott	3 Dalton Close	BELMONT NORTH	2280
HYDE, Dennis Maxwell	1 Chapman Street	GRETA	2334
HYNES, Kenneth Bruce	31 Minnamurra Drive	HARRINGTON	2427
INNES, Benjamin	108 Cullendulla Drive	LONG BEACH	2536
INNES, Neil Anthony	57 Cullendulla Drive	BATEMANS BAY	2536
INNES, W.J., R.A., I.M. & C.H.	12 Bartlett Drive	GREENWELL POINT	2540
JENNER, Wayne Maxwell	Unit 11 Park Royale		
JOBLIN, John Stephen	23 River Drive	WARDELL	2477
JOHNSTON, Stephen Lyle	15 Lentara St	FINGAL BAY	2315
JONES, Brad John	666 Marsh Road	BOBS FARM	2316
JONES, Warwick S	11 Crowdy Street	HARRINGTON	2427
JORDAN, Vincent Mark	55 Straight Street	HAT HEAD	2440
JOYCE, John Edward	68 Railway Street	BOMADERRY	2541
JUBB PTY LTD	22 Sinclair Street	BERMAGUI	2546
JUDD, Christopher Leslie Aubrey	258 Empire Bay Drive	EMPIRE BAY	2257
KADZIELSKI, Henry Thomas	C/O Cartwright Tuna Pty Ltd	93 PROSPERITY PLACE	
KARSTENS, Hans Rolf & Mark Steven	2 Cave Street	ILUKA	2466
KAY, Robert Ian	97 Spencer Street	ILUKA	2466
KEPPIE, Lester John	10 Granter Street	HARRINGTON	2427
KERR, K, DC, MK, WM, PM & SD	26 Micalo St	ILUKA	2466
KILP, Michael Joseph & Peter William OFFNER	Lot 212 Patonga Street	KINCUMBER	2251
KING, Bernard John	Kinka Road	SEAL ROCKS	2423
KING, Craig David	92 Lakeview Parade	PRIMBEE	2502

Appendix A1 cont.

Name	Address	Town	Postcode
KING, Ross Alan	2 Robertson Street	PORT KEMBLA	2505
KNIGHT, Alan Lloyd	24 Louden Close	COFFS HARBOUR	2450
KNOWLDEN, Adrian Edward	143 Tandys Lane	MULLUMBIMBY	2482
KOLO, Daniel Allan & Lynnete Francis	107 Riverside Drive	BALLINA	2478
KORNER, Bruce	PO Box 229	BERESFIELD	2322
KOROKNAY, Gyula	181 Princes Highway	NAROOMA	2546
KURZ, John Desmond	78 Charles Street	ILUKA	2466
LAMASON, Robert Lloyd	37-39 Aumuller Street	PORTSMITH QLD	4870
LAMMERINK, Edwin Derek	59 Bunberra St	BOMADERRY	2541
LENGYEL, Louis & Kala	8 Beach Street	KOGARAH	2217
LEWIS, Ernest Stephen	39 Gladstone Street	ARAKOON	2431
LEWIS, Garth Duncan	10 Michael Place	SOUTH WEST ROCKS	2431
LIFE, Paul Graeme	37 Arunta Avenue	KARIONG	2250
LINDFIELD, David John	48 Shelly Beach Road	EMPIRE BAY	2257
LITTLE, Heath John Opie	24 Goondooloo Drive	OCEAN SHORES	2483
LIVET, Bruce Raymond	PO Box 469	YAMBA	2464
LOADER, Barry B	PO Box 545	NORTH NAROOMA	2546
LOUGHNAN, Ian Anthony	32 Keating Drive	BERMAGUI	2546
LUCKE, Mathew Russell	12 Mount Ousley Road	FAIRY MEADOW	2519
LUKE, John Edward & Troy Vincent	62 Forfar Street	STOCKTON	2295
M & C FISHERIES PTY LTD	31 Burrawan Drive	WAUCHOPE	2446
MADDALENA, Brian Russell	6 Deborah St	CROWDY HEAD	2427
MADGE, William Stanley	5 Short Street	SPIONKOP	2327

Appendix A1 cont.

Name	Address	Town	Postcode
MAHER, Mark Anthony	788 Main Road	COLEDALE	2515
MAIORANA, Antonio	11 Reiby Road	HUNTERS HILL	2110
MAIORANA, Giuseppe	5 Morella Place	CASTLE COVE	2069
MALIN, Arthur Sedric	101 Bangalow Road	BYRON BAY	2481
MANDRAGLIN PTY LTD	9 Matthews Drive	MOUNT WARRIGAL	2528
MANSON, Richard James	22 Calga Crescent	BATEMANS BAY	2536
MANWARING, Nigal Allan	397 Tomakin Road	MOGO	2536
MARKANE PTY LTD	16 Brunswick Street	BALLINA	2478
MARYVALE, Leslie David	39 Dorrigo Avenue	EAST WOONONA	2517
McCRAY, Peter Eric	234 Kirkwood Road	SOUTH TWEED HEADS	2486
McINTOSH, Kevin Bruce	19 Macquarie Grove	CAVES BEACH	2281
McNALLY, Anthony Ian	40 Cedar Street	EVANS HEAD	2473
McPHERSON, Graham John	20 Cook Street	YAMBA	2464
MENMAR PTY LTD	25 Frances Street	GWYNNEVILLE	2500
MERLINO, John Frank & Lucy	26 Mill Street	BERMAGUI	2546
MERRIMAN, Alan Durant & Leigh	32 Dover Road	WAMBERAL	2260
MICK'S FISHING ENTERPRISES PTY LTD	11 Seamist Lane	EVANS HEAD	2473
MILLIKEN, Marc Robert	23 Drydon Street	WALLSEND	2287
MONCRIEFF, Stephen Roy	285 Mitchell Street	STOCKTON	2295
MONK, Darrell	2a Austin Street	SOUTH WEST ROCKS	2431
MONKLEY, Mark Daniel	6 Beresford Street	CONISTON	2500
MOODY, Harry	PO Box 9	KENDALL	2439
MOORE, John Thomas	40 Montague Avenue	KIANGA	2546

Appendix A1 cont.

Name	**Address**	**Town**	**Postcode**
MORGAN, David John	43 The Boulevarde	DUNBOGAN	2443
MORGAN, Joseph Robert	5 Glen Haven Drive	LAURIETON	2443
MORLEY, Terry	2 Benelong Street	BULLI	2516
MORRISON, Kevin A & Alexander C	12 Bemago Street	NAMBUCCA HEADS	2448
MORRISSEY, Paul Michael	68 North Creek Rd	LENNOX HEAD	2478
MORTIMER, Anthony James	45 Grafton Street	COPMANHURST	2460
MOYCE, Edward Sydney	19 Goorawahl Avenue	LA PEROUSE	2036
MOYCE, Jason Edward	19 Goorawahl Avenue	LA PEROUSE	2036
MUELLER HOLDINGS PTY LTD	11/82 River Esplanade	MOOLOOLABA	4557
MULLER, Leslie Arnold	111 Campbell Street	NAROOMA	2546
NAOMI STAR PTY LTD	15 Forest Way	WOOMBAH	2469
NORTH, Ian	8 Park Street	COLEDALE	2515
NORTHERNER ENTERPRISES PTY LTD	2a Hungerford Lane	KINGSCLIFF	2487
O'BRIEN, John Leonard & Kevin John	67 Melaleuca Drive	YAMBA	2464
O'KEEFFE, John Patrick	42 Mcphail Avenue	KINGSCLIFF	2487
O'SULLIVAN, Edward James	PO Box 160	TATHRA	2550
OUTWIDE FISHING CHARTERS PTY LTD	5 Alkira Road	CARLINGFORD	2118
PACIFIC OCEAN RANCH PTY LTD	PO Box 869	COOLANGATTA QLD	4225
PADDOCK WOOD PTY LTD	PO Box 1091	BUDERIM	4556
PADDOCKMIST PTY LTD	PO Box 6281	TWEED HEADS SOUTH	2486
PANDORA ENTERPRISES PTY LTD	PO Box 186	MOOLOOLABA	4557
PARKINSON, Kevin James	14 Tallyan Point Road	BASIN VIEW	2540
PATANE, Alfie	436 Marsh Road	BOBS FARM	2316

Appendix A1 cont.

Name	Address	Town	Postcode
PAUL, Andrew William	1 Brill Crescent	ULLADULLA	2539
PAVIA, Vince	14 Harbord Street	THIRROUL	2515
PAYNE, Glen	78 Edwards Rd	BATEHAVEN	2536
PEARSON, David & Matthew	23 Day Street	WARILLA	2528
PEMBERTON, Graham John	14 Highview Drive	FARMBOROUGH HEIGHTS	2526
PEMBERTON, Paul John	200 Charles Avenue	MINNAMURRA	2533
PENNISI, Sebastiano & Colleen	PO Box 298	ULLADULLA	2539
PERESE, Steven	56 Highview Drive	DOLPHIN POINT	
PERRY, Samuel George	PO Box 1163	SOUTH COAST MC	2521
PETERSON, Mark Neil	35 Patonga Street	PATONGA	2256
PETERSON, Richard George	1 Royal Crescent	WOONONA	2517
PETRIE, Gavin James	128 Sandy Point Road	CORLETTE	2315
PHELPS, Mark Alan	14 Armidale Ave	NELSON BAY	2315
PHILPOTT, Robert John	64 Grant Street	PORT MACQUARIE	2444
PICKFORD, Allan John	441 Coralville Road	MOORLAND	2443
PINSAK, Dean & Sally	Lot 102 Wycombe Road	TERRIGAL	2260
PIRRELLO, Francesco (Jnr), Maria, Frank & Michael	117 North Street	ULLADULLA	2539
PLUMMER, Brad	25 Crowdy Road	HARRINGTON	2427
POLLOCK, Kevin Stanley	15 Nurrawallee Street	ULLADULLA	2539
POOLE, Heather Jean	6 Wharf Street	LAURIETON	2443
PRAJA, Zoran Hermann	63 Nurrawallee Street	ULLADULLA	2539
PRESTON, Chris	39 Main Street	WOOLI	2462
PRICE, Wayne	24 Findlay Avenue	CHAIN VALLEY BAY NORTH	2259

Appendix A1 cont.

Name	Address	Town	Postcode
PRINDABLE, Ronald James	54 Riverview Street	ILUKA	2466
PROBERT, Rodney	55 Surfview Avenue	FORSTER	2428
PUGLISI, Claudio	34 Wason Street	ULLADULLA	2539
PUGLISI, C, E, F, JM, DJ, SM, BM & I	PO Box 13a	BERMAGUI	2546
PUSTAVRH, Anthony Francis	17 Mathew Parade	BATEHAVEN	2536
RAGNO, Peter Anthony	18 Rennie Crescent	TUNCURRY	2428
RASCHILLA, Rosemarie Raschilla & Salvatore F	16 Pankhurst Avenue	FAIRY MEADOW	2519
RAY, Robert Alwyn John	38 Tumbi Creek Road	BERKELEY VALE	2261
RD & CA STEWART PTY LTD	13 Nelson Street	WOOLGOOLGA	2456
REDDIE, Estate Of Ian Douglas	17 Lillian Road	ANNANGROVE	2156
REED, Allan Jefferey	29 Lake Road	TUGGERAH	2259
REILLY, Darin Scott	28 Cedar Street	WOODBURN	2472
RICHARDSON, Thomas Michael	24 Andrew Close	BOAT HARBOUR	
RICHARDSON, William Stanley	20 Graham Street	BOAT HARBOUR	
RIES, Peter Bruce	PO Box 144	BYRON BAY	2481
RIGDEN, Ronald William	48 Long Street	COFFS HARBOUR	2450
RIPLEY, Adrian Clarence	39 Rigney Street	SHOAL BAY	2315
RITCHIE, Anthony	37 Main Street	HALLIDAYS POINT	2430
ROACH, Phillip Louis	1 Eden Place	TUNCURRY	2428
ROBERT MURRAY PTY LTD	11 Craignair Close	WALLSEND	2287
ROBERTS, Corey Wayne	105 Duke Street	ILUKA	2466
ROBERTS, John	45 Main Road	GREENWELL POINT	2540
ROBINSON, Alan Ronald	12 Bridge Street	SAWTELL	2452

Appendix A1 cont.

Name	Address	Town	Postcode
ROBINSON, Glenn Raymond	16 Koombala Street	TUGUN	4224
ROBINSON, Peter Francis	50 Garden Grove Parade	ADAMSTOWN HEIGHTS	2289
ROETH, David	46 Coomba Road	COOMBA PARK	2428
ROLPH HOLDINGS PTY LTD	PO Box 86	MOOLOOLABA QLD	4557
ROSE, Steven Douglas & Tony James	21 Tilba Street	NAROOMA	2546
ROSSETTI, Santo Vincent	3 Victoria Street	NORAH HEAD	2263
ROSSKELLY, Frank Clement	5 The Lakes Way	FORSTER	2428
ROSSKELLY, Steven	4 Panorama Crescent	FORSTER	2428
ROWBOTHAM, Kenneth Beaumont	19 Simmons Drive	ULLADULLA	2539
ROYLE, Aaron Stephen	6 Barkala Crt	OCEAN SHORES	2483
RUMSEY, Edward Glenn	18 Cooloon Crescent	SOUTH TWEED HEADS	2486
SANDERS, Mitchell William	19 Eloora Road	THE ENTRANCE	2261
SANDY, Paul Michael	12 Woolley Close	THORNTON	2322
SCHAECHE, Dale Russell	PO Box 193	PORT MACQUARIE	2444
SCHMITH, Darryl James	48 Miles Street	KIRRA	4225
SCHNEIDER, Neil	93 Gan Gan Road	ANNA BAY	2316
SCHOTT, Barry John	3 Cooloola Avenue	LENNOX HEAD	2478
SCOTT, Stephen Michael	Cooper Street	SPENCERVILLE	
SEAMIST 1 PTY LTD	38 Amber Drive	LENNOX HEAD	2478
SEGGAR, Grant Lewis	29 Regatta Avenue	FORSTER	2428
SEIFFERT, Douglas Edward	5 Dacre St	MALABAR	2036
SETTREE, John Raymond	9 Field Street	HUSKISSON	2540
SEWELL, Keith Walter	51 Arnheim Rd	ALLAMBIE HEIGHTS	2100

Appendix A1 cont.

Name	**Address**	**Town**	**Postcode**
SHANAHAN, Kevin & Wendy Therese	29 Urara Street	YAMBA	2464
SHANKLAND, Gavin Barry	PO Box 442	YAMBA	2464
SHANKLAND, Stewart George	PO Box 407	MACLEAN	2463
SHEA, George Ronald	436 Junction Road	KARALEE QLD	4306
SHILLITO, John Edward	35 West Street	GREENWELL POINT	2540
SHIP AGENCIES AUSTRALIA PTY LTD	PO Box 1093	FREMANTLE	6959
SJOSTROM, Byron	Lot 114	PEBBLEY BEACH	
SKOLJAREV, Ivo & Carole Ruth	45 Thurlow Avenue	NELSON BAY	2315
SLOCKEE, Robert John & Janette Pamela	69 Phillip Street	CHINDERAH	2487
SMITH, Bradley George	429 Candoormakh Creek Rd	NABIAC	2312
SMITH, David John & Kim Maree	2 Tom Thumb Place	YAMBA	2464
SMITH, Douglas Alexander	4 Cypress Street	EVANS HEAD	2473
SMITH, Jeffery Bruce	18 Taree Street	TUNCURRY	2428
SMITH, Rodney Cecil	7 Casuarina Close	ANNA BAY	2316
SMITH, Wayne Murray & Jennifer Patricia	PO Box 362	BERMAGUI	2546
SNAPE, Ronald Phillip	Braeside	CENTRAL TILBA	2546
SOMMERFELD, Colin Fred & Paul Desmond PORTER	113 Links Ave	EAST BALLINA	2478
SOUNNESS, Steven Wayne	20 Windsor Street	TARBUCK BAY	
SOUTH SEAS TUNA CO. PTY LTD	14 Bligh Avenue	CAVES BEACH	2281
SPEDDING, John William Ernest	12 Barellan Drive	BANORA POINT	2486
SPEIRS, Anthony John	64 Queens Lane	ILUKA	2466
SPORNE, A.S & P.M	29 Mayers Drive	TUNCURRY	2428
SPYROU, Clem, Mark LENNON & Alan Leslie WILSON	21 Ocean Beach Road	SHOAL BAY	2315

Appendix A1 cont.

Name	Address	Town	Postcode
STACE, Ronald Francis	42 Lake Street	LAURIETON	2443
STANFORD, Damien	38a Queen Lane	ILUKA	2466
STANFORD, Darren John	1 Ewin Close	ULLADULLA	2539
STANTON, Peter Graham	170 Albatross Road	NOWRA	2541
Steven John BURT & Estate Of Athol Stan COWAN	17 Boundary Street	PORT MACQUARIE	2444
STEVENS, Paul Douglas	16 Green Point Drive	GREEN POINT	2428
STEWART, Daniel David	31 South Street	WOOLGOOLGA	2456
STEWART, Garry Peter	51 Trafalgar Street	NELSON BAY	2315
STOREY, Ian Douglas	PO Box 225	BRUNSWICK HEADS	2483
SULLIVAN, Paul Andrew	50 Captain Cook Drive	KURNELL	2231
SUTHERLAND, Jock Cameron	14 Peel Street	TUNCURRY	2428
SUTTON, Denis Norman	13 Partridge Street	MACKSVILLE	2447
SWAN, Robin Neil	14 Thompson Street	ILUKA	2466
SWEET, Richard	PO Box 208	COTTON TREE	4558
T HARGRAVES FISHERIES PTY LTD	PO Box 6634	COFFS HARBOUR	2450
TAMMJARV, Alan	5/12 Alman Place	CRESCENT HEAD	2440
TARRANT, Alfred Colin	36 Kerrigan Street	NELSON BAY	2315
TARRANT, Glyn Edward	58 Rigney Street	SHOAL BAY	2315
TARRANT, Gregory Wayne	723 Marsh Road	BOBS FARM	2316
TARRANT, Michael Wayne	36 Kerrigan Street	NELSON BAY	2315
TASMANIAN BLUEFIN PTY LTD	PO Box 86	MOOLOOLABA	4557
TAYLOR, Neville Keith	PO Box 1467	KINGSCLIFF	2487
TELGARRY PTY LTD	PO Box 43	HARWOOD ISLAND	2465

Appendix A1 cont.

Name	**Address**	**Town**	**Postcode**
TESAR, Karl	699 North Bank Road	PALMERS ISLAND	2463
THOMSON, Christopher John & Gregory John OLIVER	429 Middle Pocket Rd	BILLINUDGEL	2483
THOMSON, James Martin	56 Highview Drive	DOLPHIN POINT	
THOMSON, Peter Grahame	210 Wybong PO Hall Rd	WYBONG	2333
THORNCRAFT, Garry	24 Murson Crescent	NORTH HAVEN	2443
THORNTON, Andrew Parkes	16 Mitchell Street	EDEN	2551
TIDSWELL, Simon Kenneth	PO Box 676	LAKES ENTRANCE	3909
TILLEY, Patrick James	25 Imperial Close	BELMONT NORTH	2280
TILLOTT, Leon Bruce	PO Box 610	COOLANGATTA QLD	4225
TOAD HALL ENTERPRISES PTY LTD	C/- Southern Moves Pty Ltd	PO BOX 596	
TOOVEY, Phillip Edwin	61 Arrawarra Road	MULLAWAY	2456
TRELOAR, David Humphrey	9 Shelly Street	ANGOURIE	2464
TROTTER, David James	30 Idlewoods Crescent	RAINBOW FLAT	
TROY ROBSON BRICKLAYING Pty Ltd	PO Box 80	EVANS HEAD	2473
TULLY, Graeme Leslie	84 Reardons Road	CUDGEN	2487
USHER, Gary John	83 Mc Mahons Road	NORTH NOWRA	2541
VANAGAS, Algernon Joseph	402 Terrigal Drive	TERRIGAL	2260
VARELA, Andrew Robert	46 Anderson Street	EAST BALLINA	2478
VERNON, Russell	12 Campbell Lane	YAMBA	2464
VIDLER, Leslie Wayne	1150 River Drive	SOUTH BALLINA	2478
WALKER, Pavo	31 East Crescent	MCMAHONS POINT	2060
WALLER, Mark A	35 Straight Street	HAT HEAD	2440
WALPOLE, John	5 Oxley Rd	KILLARNEY VALE	2261

Appendix A1 cont.

Name	Address	Town	Postcode
WARREN, Bradley	9 Park Street	MEREWETHER	2291
WARREN, Leslie James	PO Box 227	EDEN	2551
WATERS, Neville Arthur	33 Lisle Street	NARRABEEN	2101
WATSON, John Samuel	PO Box 3198	WAMBERAL	2260
WEBBER, Daniel Henry	34 Halls Road	COFFS HARBOUR	2450
WEBBER, Luke Frederick	22 Louden Close	COFFS HARBOUR	2450
WEBBER, Rodney Frederick	22 Louden Close	COFFS HARBOUR	2450
WELSH, Bernard Noel	441 Congarinni Road	VIA MACKSVILLE	2447
WESTLEY, Scott & Malcolm Lionel GORRY	119 River Road	SUSSEX INLET	2540
WESTON, Wendell Mark	PO Box 163	MILTON	2538
WETZEL, Detlef	9 George Street	BERKELEY	2506
WETZEL, Hans	9 George Street	BERKELEY	2506
WHAN & BOXSELL PTY LTD	PO Box 557	MOOLOOLABA	4557
WILLIAMS, Barry James	13 Panorama Avenue	SOUTH WEST ROCKS	2431
WILLIAMS, Graeme Edward	13 Gardenia Ave	PORT MACQUARIE	2444
WILSON, Alan Leslie	15 Horace Street	SHOAL BAY	2315
WINDSHUTTLE, Frank Herman	61 Bardo Road	NEWPORT	2106
WINDSOR, Alan John	8/42 Karuah Avenue	COFFS HARBOUR	2450
WOODS, David John	5 Westlands Drive	BALLINA	2478
WOODWARD, David James	RMB 2248 Cox's Lane	FULLERTON COVE	2318
WRAIGHT, Mark Leslie	11 Bower Street	BRUNSWICK HEADS	2483
ZACCAGNINI, Paul Francis	PO Box 66	CURRARONG	2540
ZACCAGNINI, Phillip Ernest	PO Box 23	CURRARONG	2540

Appendix A1 cont.

Name	Address	Town	Postcode
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ZACCARIA, Robert	38 Amaroo Ave	GEORGES HALL	2198
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ZARRELLA, Claudio Luciano	21 Princess Street	CALLALA BEACH	2540
ZOLEZZI, Paul Joseph	Worrells Accountants	GPO BOX	2228

APPENDIX A2

DEPARTMENT OF PLANNING'S GUIDELINES

planningnsw

Guidelines for the Environmental Impact Assessment of Draft Fishery Management Strategies for Commercial Ocean Prawn Trawl, Fish Trawl & Ocean Trap and Line Fisheries

February 2003

NSW Department of Planning

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Disclaimer

FOREWORD

The Environment Impact Assessment process under the *Environmental Planning and Assessment Act 1979* provides a framework for assessing whether management strategies prepared under the Fisheries Management Act 1994 will deliver ecologically sustainable commercial fisheries. The Environmental Impact Statement is an important tool as it informs proponents of likely impacts and allows for the consideration of alternative management and mitigation measures when formulating the fishery management strategy. It enables the community to review the proposed strategy, its objectives and management regimes and to provide input. It also informs decision makers of the likely costs and benefits of the proposed strategy and of the need for mitigation measures.

These guidelines outline the issues to be addressed in environmental impact statements for the ocean prawn trawl, fish trawl, and ocean trap and line fisheries management strategy.

These guidelines have been issued by the Director-General under clause 230 (1)(a) of the Environmental Planning and Assessment Regulation 2000 and must be considered by those parties responsible for preparing an EIS to assess the likely significance of impacts of implementing a Fishery Management Strategy. The guidelines replace the general requirements for the contents of an EIS under Schedule 2 of the EP&A Regulation 2000 and the more general guideline issued in 2001 for Commercial Fishery Management Strategies.

These guidelines prescribe the matters to be addressed in the EIS and remove the need to further consult the Director-General under clause 231 (3) of the EP&A Regulation.

These guidelines have included relevant matters to meet the Commonwealth "Benchmarks and Terms of Reference for Environmental Assessment of Fisheries" and to satisfy the Commonwealth Government "Guidelines for the Ecologically Sustainable Management of Fisheries" for the purposes of *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). The guideline has also highlighted the importance of identifying if the fishery activity is likely to affect the matters of national environmental significance set out in the EPBC Act. Matters of national environmental significance includes World heritage areas, declared Ramsar wetlands, listed threatened species and ecological communities, listed migratory species, nuclear actions and the environment of the Commonwealth marine area. If fisheries are likely to affect matters of national environmental significance (including listed marine species), the Commonwealth will need to be consulted to determine whether approval is required under the EPBC Act.

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1. FISHERY MANAGEMENT STRATEGIES FOR COMMERCIAL OCEAN TRAWL AND OCEAN TRAP AND LINE FISHERIES

1.1 Overview

The *Fisheries Management (FM) Act 1994* requires a management strategy to be developed for all major commercial fisheries. These strategies are to set out the management objectives and goals of each fishery, the management rules, performance indicators and monitoring regimes to determine if the strategy's objectives are being achieved. Information on the current operation and status of the fisheries, and the vision for future management of the fishery will be considered. The strategy will include all controls affecting the operation of the fishery and will focus on achieving sustainable performance objectives.

This guideline applies to the EIS and fisheries management strategy (FMS) for the Ocean Prawn Trawl, Fish Trawl, and Ocean Trap and Line fisheries.

Prior to its finalisation, the draft strategy must undergo environmental assessment under the provisions of Part 5 of the *Environmental Planning and Assessment (EP&A) Act 1979*. The environmental assessment is an examination of the environmental impacts of the fishing activities and considers biological, biophysical, economic and social issues. It must also consider the impact on the resource from other fisheries and non-fishing activities.

The environmental assessment will rely on best available information to predict impacts of the proposed activities on the environment. The assessment may highlight areas where further information should be gathered, where practices should be changed and where alternative management regimes may be required. The broader community as well as the endorsement holders, Management Advisory Committees (MAC), Advisory Councils and the Fisheries Resource Conservation and Assessment Council (FRCAC) will be given an opportunity to comment on the EIS and the draft management strategy.

Licences and authorisations issued in accordance with the strategy are exempted from having to undergo environmental assessment of the impacts of fishing under each individual licence. There is a transitional period until exempting individual licences from the need for environmental assessment to provide NSW Fisheries time to prepare fisheries management strategies for commercial fisheries. After that time, environmental assessment will be required prior to issuing each individual license or authorisation which is not consistent with the strategy or in all fisheries where a strategy is not in place.

1.2 Purpose of a Fishery Management Strategy

A fishery management strategy is a document outlining the management goals, objectives, controls and other measures for achieving the objectives, performance measures and monitoring programs applying to a particular commercial designated fishing activity. The strategy must contain the "management tools" applying to the commercial fishery, as well as data collection protocols and triggers for the review of the strategy.

The strategy should be an informative document detailing the future vision for the management of the particular designated fishing activity – including:

short, mid and long term vision for the fishery;

regulatory controls, management arrangements and other measures for achieving the vision including setting target effort or fishing capacity of each fishery and any restructuring program;

the framework for providing fishers and other stakeholders with greater certainty about the rules and administrative arrangements applying to the fishery; and,

An information resource for the endorsement holders as well as the broader community on a particular fishery

The strategy is to be prepared in accordance with section 7E of the Fisheries Management Act and this guideline. The Minister must consult with the Fisheries Resource Conservation and Assessment Council on the preparation or revision of a fishery management strategy.

Under section 7E of the FM Act, the Fishery Management Strategy is to:

Describe the objectives of the Strategy

Describe the designated fishing activity

Outline any likely interaction of the designated fishing activities with other fishing activities

Outline the fishing regulatory controls or proposed fishing regulatory controls which apply to the designated fishing activity including:

Provisions in the Fisheries Management Act or Regulations

Any management plan or draft management plan

Fishing closures under section 8 of the FM Act

Fishing approvals

Any determinations of the TAC Committee under Division 4 of Part 2 of the FM Act

Policies approved by the Fisheries Minister

Any relevant provisions in environmental planning instrument

Identify performance indicators to monitor whether the objectives of the strategy are being achieved

Describe how the designated fishery activity is to be monitored

Specify at what point a review of the strategy is required when a performance indicator is not being satisfied.

1.3 Management tools

Fisheries management involves the implementation of policies and rules that affect fisher behaviour. A range of management tools are available under the FM Act or Regulation including provisions limiting who has access to the fishery, where and when fishing can occur, input controls such as gear and boats or output controls such as the size, number and type of fish which may be taken (see Appendix 5). Other controls may be specified in management plans developed under the provisions of the FM Act or Regulation for share management fisheries and any associated determination made by a relevant Total Allowable Catch (TAC) Committee.

Management tools may include provisions relating to aquatic and other reserves under the FM Act or National Parks and Wildlife (NPW) Act, or marine parks under the Marine Parks Act 1997 or environmental planning instruments under the EP&A Act, or under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act. Other legislation and policies provide environmental protection measures relevant to the management of the fisheries are summarised in Appendix 5.

2. THE EIA PROCESS AND PROCEDURES

2.1 Steps in the EIA Process

The four steps below summarise steps in preparing and assessing a Commercial Fishery Management Strategy and in its review and updating.

Step 1

Assembles information– stock issues, habitat issues, current fishing practices and environmental impacts, threats and other issues to provide the basis for developing a draft FMS and for consulting on the scope of the EIS

Consults with the endorsement holders and MAC and identifies alternative management regimes and develops the first draft of the FMS

Consults with MAC and Advisory Council and develops the second draft FMS.

Step 2

Assesses the impact on the environment of the draft FMS (and the fishing activities undertaken under it) within the terms of the Environmental Assessment Guidelines and consult with FRCAC, EA and key stakeholders regarding the draft strategy and environmental assessment. Organise for independent peer review of key components of the draft strategy and environmental assessment.

NSW Fisheries exhibits the EIS and the draft FMS for public comment and advertises it nationally.

Consult with FRCAC, and notifies and /or consults with endorsement holders, the relevant Advisory Council and MAC, relevant Aboriginal Land Councils and other stakeholders. FRCAC may recommend modifications to the FMS as a result of comments from stakeholders.

Step 3

NSW Fisheries sends submissions received as a result of exhibition to PlanningNSW and Environment Australia

Submissions and other advice is reviewed and if appropriate the FMS is modified in the light of the submissions and any advice from the FRCAC. Prepare a Preferred Strategy Report that outlines the response to issues raised in submissions or by FRCAC and any proposed changes in the FMS as a result to improve its sustainability.

PlanningNSW reviews submissions, EIS, FMS and Preferred Strategy Report and may (i) provide recommendations to NSW Fisheries, (ii) prepare a Director-General's Assessment Report with recommendations or (iii) the Minister for Planning can call a Commission of Inquiry or (iv) the Minister for Planning may trigger the provisions for declaring the Minister for Fisheries to be the "proponent" resulting in the provisions of Division 4 Part 5 applying. In this case, the approval of the Minister for Planning is required for the FMS.

Environment Australia reviews the submissions, EIS, FMS and Preferred Strategy Report and provides a preliminary decision.

NSW Fisheries reviews submissions and any advice received from PlanningNSW or EA and determines whether the draft strategy should be recommended for approval. If an approval is required from the Minister for Planning or under Commonwealth legislation, the recommendation must be consistent with these approvals.

If amendments to the FMS are proposed at this stage, NSW Fisheries may need to undertake a supplementary assessment (and approvals) if there are likely to be changes in the environmental impacts. If the changes are significant, the supplementary environmental assessment should be exhibited in accordance with Step 3.

Commonwealth Minister makes a determination under Commonwealth legislation.

Minister for Fisheries makes a determination under Part 5 of the EP&A Act and an approval of the finalised FMS under the Fisheries Management Act.

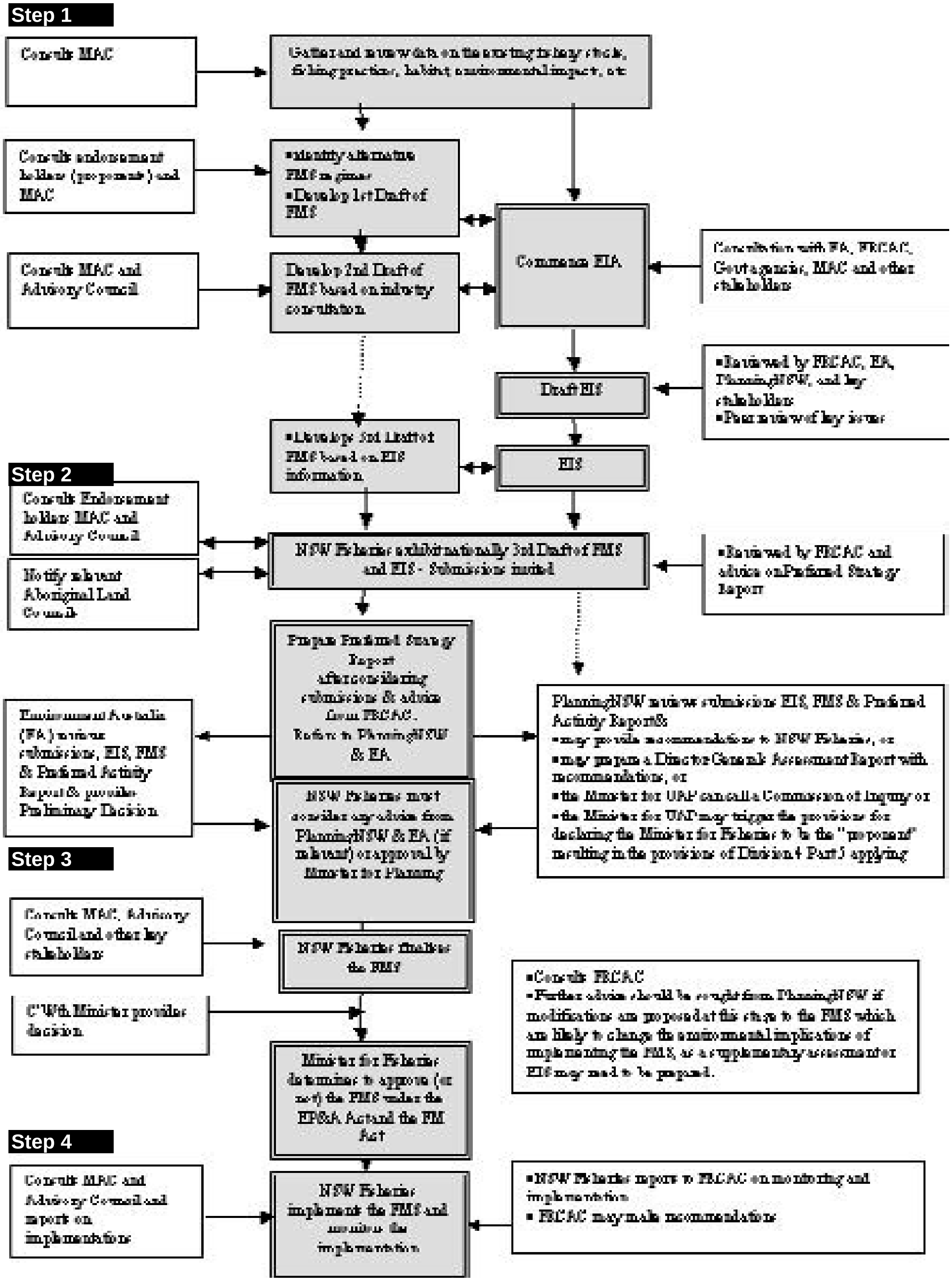
Step 4

NSW Fisheries prepares relevant management plans and amends any existing management tools (e.g. regulations which are not consistent with the Strategy) necessary to give effect to the approved strategy. NSW Fisheries consults with FRCAC, relevant Advisory Councils, MACs and other stakeholders and if relevant the general community in finalising the management plans. Minister for Fisheries approves management plans.

NSW Fisheries monitors the implementation of the Strategy and reports to FRCAC, relevant Advisory Councils, MACs and stakeholders on the resource and environmental management performance.

NSW Fisheries reviews the Strategy or aspects of the strategy (based on triggers in the FMS).

Figure 2 Steps in undertaking Environmental Assessment



2.2 A strategic approach in the assessment of fisher activities

The environmental impacts of issuing approvals under the provisions of the Ocean Prawn Trawl, Fish Trawl, and Ocean Trap and Line Fishery Strategy are to be assessed in accordance with this guideline and the provisions of Division 5 Part 5 of the EP&A Act. The environmental assessment is to consider the impacts of the fishery as a whole rather than the impacts of individual fishers. However where there are significant regional/zone differences, the impacts of the fishers within these areas should be identified and assessed.

The environmental assessment should test the sustainability of the proposed level of fishing activities authorised under the proposed fishery management strategy. This assessment must consider the cumulative implications of issuing approvals for the designated fishing activity along with interactions with the impacts of other fisheries on the fishery resources. The assessment must not only predict and consider the acceptability of the estimated impacts on target species, but must also consider effects on species taken incidentally, important habitat and the general environment. It must also consider the impact on the resource from other non-fishing related activities likely to affect the sustainability of the fishery.

The impact of commercial fishing on fish stocks (and in some cases the surrounding environment) to a lesser or greater extent depends on the management regime. The environmental assessment of the Strategy aims to identify the level of impact, and the appropriate level of control of fishing activities that ensures the impact is acceptable and the fishery is sustainable. The EIS should consider the relative impact of different level and type of controls and justify the preferred approach on biophysical, social and economic grounds.

2.3 Factors to be considered when preparing an EIS

The Environmental Assessment Guidelines lists specific issues that are potentially important when assessing the impacts of the strategy and in fine-tuning management rules for the fishery. The issues listed are not exhaustive and the degree of relevance of each issue will vary with the type of commercial fishery.

The term environment includes biophysical, economic and social aspects and hence broader issues in addition to a stock assessment must be considered in the environmental assessment. The environmental assessment should deal with those issues of key importance to the particular fishery but should generally consider:

Impacts of activation of latent effort or from effort shifts.

Impacts on retained, bycatch and bait species.

Impacts on the broader aquatic ecology, habitat and the environment.

Economic issues associated with the fishery.

Cost effectiveness of management across all fisheries.

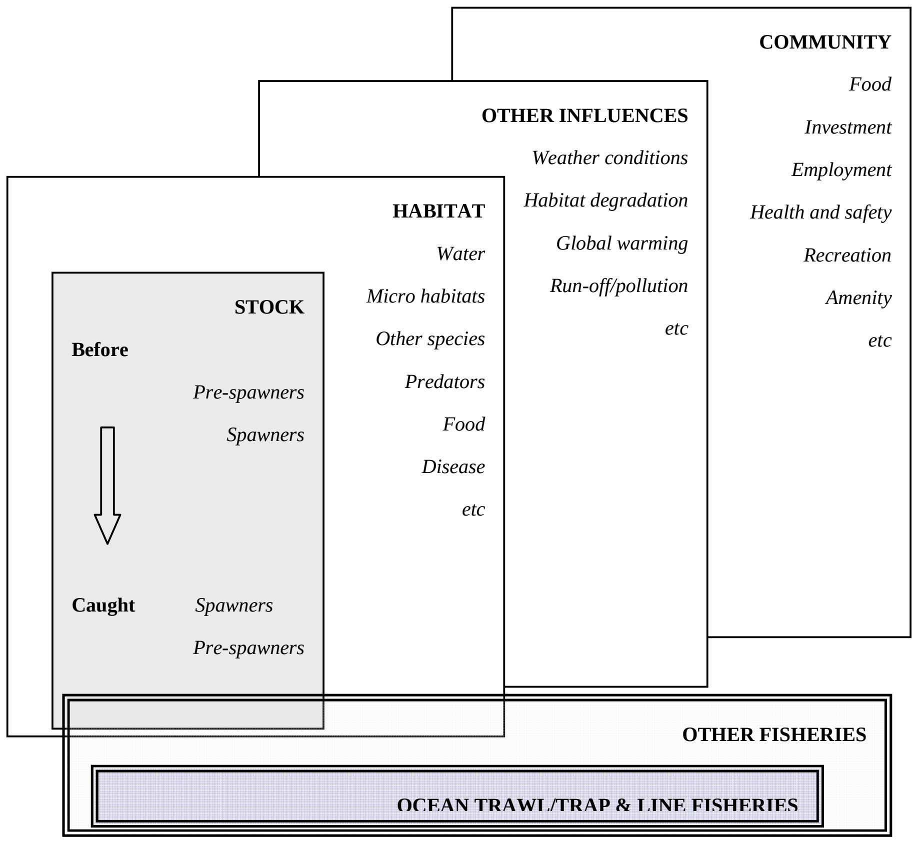
Protection of key habitats and protected or threatened species, habitats or communities.

Influences of other activities on the fishery.

Social issues associated with the fishery.

The assessment should rely on the best available information to predict impacts. However where information is inadequate, the precautionary principle must be invoked and a cautious approach taken until such time as additional data collection, research and analysis can provide a sounder basis for management decision making. Nonetheless, when predicting the potential impacts, worst case scenarios should be considered as well as normal operational conditions.

Figure 2 Interrelationships and influences to be considered in the assessment.



General principles when undertaking assessment include:

Available scientific information including catch and effort trends, information from any scientific study sites, estimates of the catch of other user groups, and the life history, distribution and dynamics of the fished stock/s should be used in predicting likely impacts on stock/species and likely effectiveness of management tools/measures.

Impact prediction should consider- the magnitude, duration, and the extent of the impacts (and whether impacts are reversible or permanent).

The assessment should take into account any relevant and significant regional or zonal differences and seasonal effects.

The assessment should take into consideration the potential impact on habitat, habitat fragmentation and broader ecological issues.

Environmental risks and uncertainties in predicting impacts should be clearly stated including the levels of confidence in predictions and the likely resilience of the environment and the potential for recovery from impacts.

In the absence of quantitative data, qualitative or delphic impact assessments (ie. categorisation into high, medium or low) based on best available information should be used.

Proposed management and monitoring arrangements should be cost-effective and take into consideration costs incurred in other fisheries.

The proposed management measures for resource allocation and to mitigate impacts should be justified taking into consideration the ESD principles.

2.4 Overview of the environmental impact assessment

The following matters should be addressed in the environmental assessment of a Draft Fishery Management Strategy (FMS) for a designated commercial fishery:

Describe the existing fishery (including any existing “rules”, current management plans, historical events, seasonal patterns and marketing factors likely to affect fisher behaviour) and undertake a risk based assessment of existing operations to identify areas where existing practices or management should be modified or changed.

Consider alternative regimes (including alternative fishing methods, alternative funding of management responses or research programs).

Describe the proposed regime under the Draft FMS including goals, objectives and proposed management rules and responses. Identify performance indicators, triggers for reviewing the Draft FMS and the proposed monitoring regime for measuring the likelihood of the strategy meeting the goals of the Draft FMS, including an assessment of the adequacy or appropriateness of the indicators, triggers and monitoring regime.

Assess the impacts of implementing the Draft FMS taking into consideration likely future performance, particularly in relation to high risk aspects/factors.

Justify the Draft FMS and its management arrangements in terms of biophysical, economic and social factors and the principles of ecological sustainable development.

3. THE CONTENTS OF THE EIS AND FMS

The Draft FMS is to contain six sections. The first (Section A) is the executive summary. The second (Section B) is a review of the existing ecological, economic and social aspects of the fishery, together with a risk-based assessment of its impacts. The risk-based assessment is to consider both the likelihood of an impact and the consequence should that impact occur. The third (Section C) is to consider a range of feasible alternative management regimes and approaches for the fishery. The fourth (Section D) is the Draft Fishery Management Strategy (Draft FMS), which includes the proposed future management regime for the fishery, together with detailed performance reporting. The fifth (Section E) is a risk based assessment of the impacts of the Draft Fishery Management Strategy with a focus on how the Strategy mitigates risks identified in Section B. The sixth (Section F) is the justification for the management options selected in the Draft FMS.

A EXECUTIVE SUMMARY

An executive summary should be provided and be available separately for public information. The summary should give a short overview of the Draft Fishery Management Strategy (Draft FMS) and the potential ecological, biophysical, social and economic impacts of implementing the strategy. It should include identification of the major risks to the environment from the fishing activity, and the impacts of implementing the Draft FMS on the economic viability of operators (including identifying the likely increased management cost to fishers). It should be written in non-technical language to facilitate understanding by the general public.

B REVIEW OF EXISTING OPERATIONS

The aim of this section of the EIS is to provide sufficient background to understand the nature of the fisheries, where they occurs, and review the performance of the fisheries as they currently operate. A risk-based assessment should be used to identify aspects of the existing operation of the fishery to identify areas where existing practices or management should be modified or changed. The risk-based assessment should take into consideration the likelihood/frequency of an environmental impact and the consequence (including its irreversibility) should the impact occur.

1. GENERAL INFORMATION

Using available information, describe the following:

(a) The number of fishers endorsed in the fisheries on a State and regional basis.

(b) The harvesting methods used in the fisheries including gear, equipment and boats.

(c) Describe by way of indicative maps:

- (i) The area where the fisheries can operate, including any major regions or zones.
- (ii) The major ports used by the fisheries.
- (iii) Any aquatic reserves, marine parks, or any other permanent closures that impact the fisheries.

(d) Describe the management regime currently in place for controlling the level of take in the fishery, and how this regime incorporates harvest from all fishing sectors.

(e) Describe interactions between fishers in these fisheries and other fisheries:

(i) Under NSW jurisdiction (e.g. Estuary Prawn Trawl Fishery).

(ii) Under adjacent State (e.g. Queensland East Coast Trawl Fishery) or Commonwealth (e.g. South East Fishery) jurisdiction.

(iii) Briefly discuss how any relevant fisheries are managed in the other jurisdictions and how any recent management changes in these jurisdictions (e.g. Queensland East Coast Trawl Plan) impact the operation of the relevant fishery in NSW.

(f) Describe the existing management regime for the fishery including:

(i) The aims and objectives of any previous management.

(ii) Outline current performance reporting and monitoring provisions for the harvest from these fisheries including any requirements for the reporting of catch and effort by the fishers (e.g. logbook returns), any observer programs and any fisheries independent monitoring.

(iii) Describe the process for review and assessment of the dynamics and status of the fishery, including the nature and frequency of the review and assessment events.

(iv) Outline any current major research initiatives related to management of the fishery.

(g) Outline and discuss recent trends in the operation of the fisheries including:

(i) Total fishing effort on a state-wide and regional basis.

(ii) Total landed value of the catch and of the principal target species on a state-wide and regional basis.

(iii) Factors that influence how and where the fishery operates.

(h) Outline current administrative arrangements in relation to enforcement and compliance, cost recovery, and community contribution payments.

2. ECOLOGICAL ISSUES

2.1 Primary and secondary species

(a) Identify the historic and existing NSW harvest levels of primary, secondary and key secondary species in these fisheries.

(b) Identify the life history stage or stages (e.g. juvenile, sub-adult, and/or adult) of primary and key secondary species taken by the fisheries.

(c) Identify the stocks of primary and key secondary species and document the relevant biology and ecology of the major target species.

(d) Identify the information sources (e.g. logbooks, observer programs, fisheries independent studies) on the level of take of primary and key secondary species in the fisheries and their reliability.

(e) Identify whether the primary and key secondary species are harvested in other fisheries in adjacent jurisdictions and if so, the recorded level of the harvest in these other fisheries.

(f) Describe the status of the primary and key secondary species as either: overfished (recruitment and/or growth), fully fished, under-fished, or unknown and identify whether any one of these fisheries is the main contributor to the identified status. Provide an estimate of the reliability of species that are assigned overfished, fully fished or underutilised.

(g) Identify existing management measures for primary and key secondary species (e.g. minimum legal sizes).

(h) Describe significant natural factors (e.g. recruitment dynamics, oceanographic factors) external to the fisheries that may significantly influence the abundance and dynamics of the primary and key secondary species.

(i) Summarise the overall risks from the operation of the fishery on the primary, key secondary, and relevant secondary species taking into consideration the likelihood/frequency of impacts and the consequence should the impact occur.

2.2 Bycatch species

(a) Identify the bycatch species impacted directly by the fisheries, and any management, monitoring or mitigation measures for bycatch species.

(b) Identify the information sources (e.g. observer programs, fisheries independent studies) on the level of bycatch in the fisheries and their reliability.

(c) Identify the biological characteristics of the bycatch species that may make their populations susceptible to the impacts from the fisheries.

(d) Identify in general terms the likelihood of bycatch species subsequently surviving when discarded.

(e) Identify whether discarded bycatch species represent a source of food for other animals (e.g. birds, dolphins) and if so, identify the animals and the likely impacts on these populations and behaviour that such food provisioning may be having.

(f) Summarise the overall risks from the operation of the fishery on bycatch species, taking into consideration the likelihood/frequency of impacts and the consequence should the impacts occur.

2.3 Bait sources

(a) Identify the species, volume and sources of bait used in the fisheries (if relevant). Identify any pests and diseases that may be introduced as a result of bait introductions.

(b) Consider the likely effectiveness of any existing management regime to minimise the risk of introduction of pests and diseases in the bait organisms including procedures to ensure the measures are implemented.

(c) Summarise the overall risks from the operation of the fishery on bait sources and the effects of any non-fish sources of bait (e.g. chicken gut) on the environment, taking into consideration the likelihood/frequency of impacts and the consequence should impacts occur.

2.4 Protected and threatened species and communities

(a) Identify protected and threatened species, populations and ecological communities and their habitat listed under the Fisheries Management Act, Threatened Species Conservation Act, National Parks and Wildlife Act or Environment Protection and Biodiversity Conservation Act which may be affected by the fisheries.

(b) Identify the information sources (e.g. surveys, studies etc.) on the level of interaction between the fishery on endangered, threatened or protected species and threatened ecological communities (and the reliability of this information).

(c) Identify any measures in place to avoid impacts on endangered, threatened or protected species and threatened ecological communities.

(d) Summarise the overall risks from the operation of the fishery on these species taking into consideration the likelihood/frequency of impacts and the consequence should the impacts occur.

2.5 Species assemblages, species diversity and ecological processes

(a) Identify any species assemblages that are likely to be significantly affected directly or indirectly by the fishing activity.

(b) Describe the possible impacts of the fisheries on these species assemblages; and, how the impacts might affect species diversity.

(c) Identify (where possible) the major ecological processes which may be altered as a result of the fisheries.

(d) Describe the possible impacts of the fisheries on these ecological processes and how the fishery might alter them.

(e) Identify the likelihood and impacts of ghost fishing from lost fishing gear (particularly fish traps) on species assemblages, species diversity and ecological processes.

(f) Summarise the overall risks from the operation of the fishery (including ghost fishing) on species assemblages, species diversity and ecological processes.

2.6 Aquatic habitats

Identify the primary habitat areas impacted by the fisheries.

(a) Describe the spatial scale of the habitat impacts of the fisheries relative to the general overall area of these habitats.

(b) Identify the nature, intensity, magnitude, frequency and duration, and reversibility of impacts from the fisheries on aquatic habitats.

(c) Identify any other habitat areas that may be affected by the fisheries, in particular any areas registered in the National Estate or State Heritage Register, habitat issues associated with marine mammals and migratory birds that are not covered above under 2.4(a).

(d) Summarise the overall risks from the operation of the fisheries on aquatic habitats taking into consideration the likelihood/frequency of impacts and the consequence should the impacts occur.

3. THE BIOPHYSICAL ENVIRONMENT

Undertake an assessment to identify the likelihood and consequence of the current fishery operations causing impacts on :

- Water quality.
- Noise and light regimes.
- Air quality or greenhouse gas emissions.

Where risk is identified as unlikely and/or not of significant consequence, this position should be justified. Where this position is identified and justified, no further discussion of that impact is necessary in this section of the EIS.

Where risk is identified to be likely and/or of a significant consequence for a factor identified in the part 3(a) of these Guidelines, the following detail should be included for that factor.

The assessment of these issues in the Estuary General or Ocean Haul EIS should contribute and the risk assessment.

3.1 Water quality

(a) Identify sources of pollutants/contaminants from the operation of the fisheries likely to affect the water quality, and outline the characteristics, magnitude and probable frequency of these events.

(b) Identify the use of substrate treatments (e.g. anti-fouling agents).

(c) Identify any incidences of accidental or deliberate discharge of chemicals, fuel or bilge water, and dumping of debris (plastics, gear and general waste).

(d) Identify the likely assimilation capacity of the receiving water impacted by any pollutants/contaminants.

(e) Describe any existing management measures to mitigate any adverse impacts from the fisheries on water quality and assess the adequacy of these measures.

3.2 Noise and light regimes

(a) Identify any potential fixed or mobile noise and light sources (and indicative hours of operation).

(b) Identify any birds or mammals whose behaviour (e.g. roosting, feeding and migration) is likely to be significantly or permanently modified in response to noise or light from the fishery activities.

(c) Identify any residential areas likely to be affected by the noise or light.

(d) Describe any existing management measures to mitigate any adverse impacts from noise and light generated in the fishery and assess the adequacy of these measures.

3.3 Air quality, energy and greenhouse gas emissions

(a) Outline any sources of odours or other air impacts, and identify the conditions under which any sensitive land uses are likely to be affected by the odour.

(b) Outline any existing measures to manage air impacts to an acceptable level and assess the adequacy of these measures.

(c) Consider the efficiency of energy use and greenhouse gas emissions taking into consideration issues relating to boat/motor performance.

(d) Outline existing measures and approaches to maximise energy efficiency (e.g. those outlined in the Eco-efficiency Agreement established between Environment Australia and the NSW commercial fishing industry, and associated work implemented under this agreement), minimise the emission of greenhouse gases, and assess their adequacy.

4. ECONOMIC ISSUES

(a) Outline the investment in the fishing fleet on a state-wide and regional scale.

(b) Outline location, age and investment of fishing associated businesses and infrastructure such as processing facilities and slipways, transport (water and road), berthing facilities, maintenance and repairs and cold stores.

(c) Identify direct (e.g. boat owners, skippers and crew) and indirect (e.g. traders and suppliers) employment by regions including the proportion of fishers with income from other commercial fisheries and/or other non-fishing employment, the seasonality of employment and the demographic profile of those directly and indirectly employed in the fishery.

(d) Outline the economic return from the fishery including its contribution to individual, regional and state income; and the value of licences currently held by individual fishers in the fisheries.

(e) Existing economic multiplier effects, economic rents and community contributions.

(f) Outline the markets for fish species (and the marketing forms) harvested in this fishery and the contribution these fisheries make towards supplying seafood to consumers on a State and regional basis.

(g) Summarise the overall risks to the economic viability of the fishery from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

5. SOCIAL ISSUES

5.1 Fishers social capital

(a) Outline the community values associated with the commercial fishery, in particular; social capital issues, skill base and transferability of skills.

(b) Outline community views and perceptions of the fishery and include a brief analysis of how these views and perceptions were formed.

(c) Determine the importance of social identity and job satisfaction as a reason for being a commercial fisher in these fisheries.

(d) Summarise the overall social risk to fishers from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

5.2 Health and safety

(a) Outline the health risks to fishers and related workers (e.g. processors of product) from current practices/methods and existing measures to minimise risk.

(b) Identify any health risks to consumers and existing measures for minimising or removing these risks up to the point of transfer of the product to the processor or receiver.

(c) Summarise the overall health and safety risk to fishers, related workers and consumers from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

5.3 Indigenous peoples

(a) Identify the interests of Indigenous people in the resources harvested by the fisheries and in habitats that may be impacted by the fisheries.

(b) Identify any important Aboriginal heritage sites/places likely to be affected by fishers operating within the fisheries and outline any existing protocols/measures that aim to minimise risk of harm to these sites.

(c) Outline whether the fisheries affect traditional fishing and access to fisheries resources, and if so, how this occurs.

(d) Identify the involvement of Indigenous peoples in the existing commercial fisheries.

(e) Describe Government policies and strategies on Indigenous fishing, including the NSW Indigenous Fisheries Strategy.

(f) Summarise the overall risk to Indigenous people from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

5.4 European heritage sites

(a) Identify any shipwreck sites or other sites of historic heritage that are affected by fishing activities and outline existing protocols/measures to minimise impacts to these sites.

(b) Summarise the overall risk to European heritage sites from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

C CONSIDERATION OF ALTERNATIVE MANAGEMENT REGIMES

Taking into consideration the key issues identified in the review of the fisheries (Section B) and the risk assessment undertaken in relation to these issues, consider alternatives to current practices in the fishery to reduce the level of risk or improve the sustainability of the fish stock and their economic and social viability. In this context, describe and discuss the feasible alternatives, including:

(a) The no fishery alternative.

(b) No changes to existing management arrangements.

(c) Alternative effort regimes.

(d) Alternative approaches to performance monitoring and reporting regimes, including linking performance indicators to specific objectives rather than broad goals.

(e) Alternative management responses to address significant areas of risk identified in the EIS.

(f) Alternative arrangements for the cost-effective delivery of management of the fisheries including alternative funding sources.

D THE DRAFT COMMERCIAL FISHERY MANAGEMENT STRATEGY

The aim of this section of the Guidelines is to set out the structure of the Draft Fishery Management Strategy. When finalised, the Draft Fishery Management Strategy will stand alone from the EIS. As such it should contain sufficient background information to communicate the context of the management actions and performance reporting it contains. It should respond to issues identified as having significant risks in the review of the current fishery operation and to alternatives to improve the management of these and other issues. Any new management measures should identify whether additional costs are involved and if so, who are likely to pay these additional costs.

1. GOALS AND OBJECTIVES OF THE FMS

The goals and objectives should be outcomes-based and linked to operational actions.

2. DESIGNATED FISHING ACTIVITY

2.1 Impacts on stocks of primary and key secondary species, and bycatch

(a) Identify the primary, key secondary and bycatch stocks to be harvested and/or affected by the fishery.

(b) Identify bycatch species that may be considered at risk from existing fishing operations.

(c) Using available information, describe the status of the primary and key secondary stocks as under-fished, fully fished or overfished.

(d) For the primary and key secondary species provide a table which documents the known status (and the level of certainty) for the following stock assessment and biological parameters:

- (i) Size and age at maturity.
- (ii) Distribution and stock structure.
- (iii) Age and growth information (including catch at age).
- (iv) Yield and/or egg per recruit.
- (v) Natural mortality.
- (vi) Fishing mortality.
- (vii) Spawning season.
- (viii) Spawning areas.
- (ix) Stock recruitment relationship.
- (x) Movements and migration.

2.2 Proposed Future Operational area under the Draft FMS

Provide indicative maps identifying the future operational areas, key environmental protection areas and areas closed to the fishery including:

(a) The area where the fishery will operate.

(b) Major ports from where fishers will operate and any major processing facilities.

(c) Aquatic reserves, marine parks, or any other permanent closures that impact the fishery and any permanent closures that impact the fishery. If the area of operation of the fishery as defined in the Draft FMS is not modified from that presented in Section B of these Guidelines then cross-referencing back to that information is sufficient.

2.3 Operation of the fishery

Outline the following as they affect the operation of the fishery:

(a) Any proposed enforcement and compliance measures (including any Strategic Compliance Plans and the process for review of these plans).

(b) Any proposed fees, charges, or community contribution payments.

(c) Any relevant provisions in the FM Act or Regulations including any fishing closures under Section 8 of the FM Act or policies approved by the Fisheries Minister.

(d) Any relevant bycatch or threatened/protected species plans or recovery programs and any programs in place to mitigate the impacts of the operation of the fishery on threatened/protected species or communities.

(e) Consultation and participation by stakeholders in management.

3. MANAGEMENT RESPONSES

The Draft FMS is to identify specific management responses aimed at minimising risk to the environment and the sustainability of the fishery. Each management response should:

(a) Describe the current situation for the issue to be addressed by the management response.

(b) Outline the management response itself.

(c) Identify whether the management responses are likely to require additional funding and the potential and likely sources of this additional funding.

(d) Identify how the management response will be implemented and timeframe for implementation

(e) Outline the predicted outcome(s) from the management action.

4. PERFORMANCE REPORTING

Performance reporting should link back to the management actions and objectives of the Draft FMS. The following approach is modified from the FRDC ESD Reporting Framework "How to Guide" (see www.fisheries-esd.com). The proponent should be guided by existing applications of the approach to other fisheries for identifying the level of detail required for each component. Performance reporting and monitoring should be cost-effective within and across fisheries.

Performance reporting should link back to the management actions and goals/objectives of the FMS. Performance reporting must include the following:

(a) For each objective or goal, an indicator(s) is to be identified. This can be a direct measure of performance (e.g. employment numbers for employment) or a surrogate (e.g. catch per unit effort as an estimator of stock abundance).

(b) A trigger point (= reference point) which is necessary to define how to interpret the indicator to assess whether performance against the objective is acceptable or not. In some instances, it may also be desirable to identify "triggers for contingency action" for particular situations when there is an unusual event or changing practices (e.g. new technology) when contingency management intervention is considered necessary.

(c) A brief justification for the selected indicator and performance measure.

(d) The data requirements and availability of data for the indicator. This is to be depicted using a table or matrix:

Data Required	Availability
Description of indicator/supporting data.	Time period for which data are available or when data will become available. Details of the existing or proposed monitoring program (and their sources or proposed sources of funding).

(e) The robustness of the proposed indicator and performance measure. The robustness of an indicator is to be described as high, medium or low (with a brief textual justification for the assigned category).

(f) The action(s) that will result if a performance measure is exceeded.

(g) A description of any significant external drivers - factors that are known to potentially impact on performance of the fishery but which are outside of the responsibility of NSW Fisheries.

5. RESEARCH AND DEVELOPMENT PLAN

A research program must be developed as part of the Draft FMS and should take into consideration any existing and relevant research plans. The research plan should consider issues of cost-effective research delivery and prioritisation:

(a) Identify the significant knowledge gaps for the ecological, economic and social aspects of the fishery.

(b) Identify and prioritise the research and development projects for filling the significant knowledge gaps and the desired timeframe for commencing and completing these projects.

(c) Identify the potential sources of funding to undertake the research and development projects.

E ASSESSMENT OF THE POTENTIAL IMPACTS OF IMPLEMENTING THE DRAFT FMS

This section of the Guidelines sets out the information required for assessing the potential impacts that may occur as a result of implementing the Draft FMS. This section should be informed by and linked to the risk assessment undertaken as a component of Section B of the Guidelines. It should focus on the likely change in impacts and when those impacts are likely to be adverse, the adequacy of monitoring and management measures in the Draft FMS.

1. ECOLOGICAL ISSUES

1.1 Primary and key secondary species

(a) Identify any likely changes in impacts on primary and key secondary species as a result of implementing the Draft FMS compared with the current regime including in relation to their status, the likelihood that the stock will be overfished or fragmentation or contraction of the species range will occur. When the impacts are likely to be adverse, consider the adequacy of monitoring and management measures in the Draft FMS, and their ability to promote stock recovery if the stock is overfished.

(b) Assess whether the risk to the sustainability of the primary and key secondary species has changed (and the potential magnitude of this change) by the management measures in the Draft FMS.

1.2 Bycatch species

(a) Identify any likely changes in impacts on bycatch species as a result of implementing the Draft FMS compared with the current regime, the likelihood that the stock will be overfished or the fragmentation or contraction of the species range will occur. When the impacts are likely to be adverse, consider the adequacy of monitoring and management measures in the Draft FMS.

(b) Assess whether the risk to the sustainability of the bycatch species has changed (and the potential magnitude of this change) by the management measures in the Draft FMS.

1.3 Bait sources

(a) Identify any likely changes in impacts on and from bait sources as a result of implementing the Draft FMS compared with the current management arrangements.

(b) Assess whether the risk on and from bait sources has changed (and the potential magnitude of this change) by the management responses in the Draft FMS.

1.4 Protected and threatened species and communities

(a) Identify any likely changes in impacts on threatened species, populations and ecological communities and their habitat listed under the Threatened Species Conservation Act, National Parks and Wildlife Act or Environment Protection and Biodiversity Conservation Act which may be affected by fishing activities.

(b) For each species, provide a brief summary of the known biology and ecology of species, populations or communities and systematically address each of the following factors in The Eight-Part Test (also see Appendix 3):

(i) in the case of a protected or threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

(ii) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

(iii) in relation to the regional distribution of the habitat of a protected or threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

(iv) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a protected or threatened species, population or ecological community,

(v) whether critical habitat will be affected,

(vi) whether a protected or threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

(vii) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

(viii) whether any protected or threatened species, population or ecological community is at the limit of its known distribution.

Note: Where one or more of the factors are not relevant to the species in question, identify this as “not applicable”.

(c) Discuss the effectiveness of any mitigation measures in the Draft FMS, in particular of measures to protect species listed under Threatened Species Conservation Act, Fisheries Management Act or Environment Protection and Biodiversity Conservation Act.

1.5 Species assemblages, species diversity and ecological processes

(a) Identify any likely changes in impacts on species assemblages, species diversity and ecological processes as a result of implementing the Draft FMS compared with the current regime.

(b) Assess whether the risk of significant impacts attributable to the fishery has been changed (and the potential magnitude of this change) by the management responses in the Draft FMS.

1.6 Aquatic habitats

(a) Identify any likely significant changes in impacts of the fishery on aquatic habitat areas as a result of implementing the Draft FMS compared with the current regime.

(b) Assess whether the risks to aquatic habitats have been changed (and the potential magnitude of the change) by the management measures in the Draft FMS.

2. THE BIOPHYSICAL ENVIRONMENT

2.1 Water quality

(a) Identify any likely changes in water quality impacts as a result of implementing the Draft FMS compared with the current regime. Describe how the management actions in the Draft FMS mitigate any adverse impacts from the fishery. Assess the adequacy of mitigation and management measures.

2.2 Noise and light regimes

(a) Identify any likely changes in noise and light impacts as a result of implementing the Draft FMS compared with the current regime. Describe how the management actions in the Draft FMS mitigate any adverse impacts on noise and light levels from the fishery. Assess the adequacy of mitigation and management measures.

2.3 Air quality, energy and greenhouse gas emissions

(a) Identify any likely changes in air quality as a result of implementing the Draft FMS compared with the current regime. Describe how the management actions in the Draft FMS mitigate any adverse air quality impacts resulting from the fishery. Assess the adequacy of mitigation and management measures.

(b) Outline measures in the Draft FMS to increase energy use efficiency and minimise greenhouse gas emissions to an acceptable level; assess the adequacy of mitigation and management measures.

(c) Outline how the Draft FMS impacts on the achievement of the objectives of the Environment Australia and NSW Fishing Industry Eco-efficiency Agreement.

3. ECONOMIC ISSUES

(a) Outline the potential change in economic viability of operators as a result of implementing the Draft FMS with a focus on assessing:

(b) The ability of fishers to pay increased management costs in this fishery while taking into account increased management costs accrued in other NSW fisheries (e.g. Estuary Prawn Trawl).

(c) Likely changes in patterns of investment (directly in fishing as well as in associated businesses such as processing facilities and slipways) on a State and regional basis as a result of implementing the Draft FMS.

(d) Likely changes in employment in the fisheries on a State and regional basis as a result of implementing the Draft FMS.

(e) Likely changes in economic returns to fishers on an individual, regional and State basis as a result of implementing the Draft FMS.

(f) Estimate the likelihood of any new markets being developed for bycatch species and the likelihood the fishery could increasingly target these species if new markets are developed.

(g) The impacts to seafood markets of any changes in seafood supply as a result of the Draft FMS while taking into consideration changes caused by other Fishery Management Strategies and major initiatives such as the implementation of recreational fishing havens.

(h) Summarise the change in risks to the economic viability of the fishery from the management changes described in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

4. SOCIAL ISSUES

4.1 Fishers social capital

(a) Identify any likely changes in social impacts (on fishers, their families or any local communities) as a result of implementing the Draft FMS.

(b) Assess whether the level of job satisfaction among commercial fishers is likely to change as a result of the management measures in the Draft FMS.

(c) Outline the likely employment fate of any fishers exiting the industry as a result of implementation of the Draft FMS.

(d) Assess whether the risk of social impacts are changed (and the magnitude of this change) by the management measures in the Draft FMS.

4.2 Health and safety

(a) Outline changes to the health risks to fishers and related workers (e.g. processors of product) from current practices/methods by the management measures in the Draft FMS.

(b) Outline changes to consumer health risk by the management measures in the Draft FMS.

(c) Summarise changes in the overall health and safety risk to fishers, related workers and consumers from management measures in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

4.3 Indigenous peoples

Identify the impacts of the Draft FMS on:

(a) The interests of Indigenous people in the resources harvested by the fisheries and in habitats that may be impacted by the fishery.

(b) Any important Aboriginal heritage sites/places likely to be affected by fishers operating within the fisheries.

(c) Traditional fishing and access to fisheries resource.

(d) Involvement of Indigenous peoples in the existing commercial fisheries.

(e) Government policies on Indigenous fishing, including the NSW Indigenous Fisheries Strategy.

(f) Summarise the overall risk to Indigenous people from the management measures in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

4.4 European heritage sites

Identify the impacts of the Draft FMS on:

(a) Any shipwreck sites or other sites of historic heritage that are/were affected by fishing activities.

(b) Summarise the overall risk to European heritage sites from the management measures in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

5. PERFORMANCE REPORTING, MONITORING AND RESEARCH

(a) Evaluate the likely effectiveness of performance reporting and monitoring to provide the appropriate information for monitoring the ecological, economic and social impacts of the Draft FMS.

(b) Evaluate the likely effectiveness of the research plan to identify and prioritise research to meet significant knowledge gaps for the sustainable management of the fishery under the Draft FMS.

F JUSTIFICATION FOR DRAFT FMS

Provide a clear and sufficient discussion demonstrating that the selection of the preferred options in the Draft FMS is justified. Specifically, justify the carrying out of the fishing activity as described in the Draft FMS, having regard to biophysical, economic and social considerations, including the principles of ESD:

(a) the preferred management objectives;

(b) the preferred suite of management actions in the strategy;

(c) the preferred resource access and allocation approach.

Appendix 1 Relevant Acts, Authorities and Regulatory Provisions.

Act	Relevant Authority	Regulatory provisions
NSW Legislation		
Fisheries Management Act 1994	NSW Fisheries	Fishing authorisations, fishing closures, declaration and management of aquatic reserves, protection of certain fish including threatened and protected species.
Environmental Planning and Assessment Act 1979	Department of Planning (PlanningNSW) and Local Councils	Administration of the environmental impact assessment and project approval system. Development of environmental planning instruments which may protect wetlands or certain other areas.
Marine Parks Act 1997	Marine Parks Authority	Declaration and management of marine parks
National Parks and Wildlife Act 1974 and Threatened Species Conservation Act 1995	National Parks and Wildlife Service	Declaration and management of nature reserves and national parks, protection of certain mammals, birds and foreshore species including threatened and protected species
Port Corporation and Waterways Management Act 1995	Waterways Authority or relevant Port Corporation	Use of ports, wharfs, berths, moorings etc, licensing of vessels and maintenance of safe navigation in waterways
Crown Lands Act 1989 and Rivers and Water Act 2000/ Foreshores Protection Act 1948	Department of Land and Water Conservation	Use of Crown land for wharfs, berths or moorings and protection of river, estuary and coastal foreshores.
Food Production (safety) Act 1998	Safefood	Fish products safe for human consumption
Commonwealth Legislation		
Environment Protection and Biodiversity Conservation (EPBC) Act 1999	Environment Australia	Environmental Assessment of matters of national significance including those affecting protected or threatened species, Ramsar wetlands, bird and mammal species protected under international agreements

Appendix 2 - Glossary

Associated and/or dependent species	Species associated with or dependent upon harvested species, for example species which are predator or prey of the harvested species.
Biological diversity, biodiversity	the variability among living organisms from all sources (including marine and other aquatic ecosystems and the ecological complexes of which they are part). Includes 1) diversity within species and between species; and 2) diversity of ecosystems.
Bycatch	species that are discarded from the catch or retained for scientific purposes, and that part of the "catch" that is not landed but is killed as a result of interaction with fishing gear. This includes discards of commercially valuable species.
Designated fishing activities	As defined in the Fishery Management Act, are: Category 1 Share Management Fisheries including abalone fishery and the lobster fishery Category 2 Share Management Fisheries including ocean prawn trawl fishery, ocean fish trawl fishery, ocean hauling fishery, ocean trap and line fishery, the estuary general fishery and the estuary prawn trawl fishery. Charter boat fisheries Recreational fisheries Fish stocking Shark meshing, and Other fishing activities proclaimed by the Governor on the recommendation of the Minister for Fisheries to be designated fishing activities.
Discards	Are those components of a fish stock thrown back after capture. The level of discard mortality is highly variable between species and fisheries
Ecologically sustainable development, ESD	Ecologically sustainable development, ESD, is using, conserving and enhancing the community's resources so that the ecological processes, on which life depends, are maintained and the total quality of life now and in the future, can be increased (National Strategy for ESD, Council of Australian Governments 1992). Ecologically sustainable use of natural resources means the use of components of biological diversity in a way and at a rate that does not lead to the long term decline of biological diversity and to sustain natural processes within their capacity while maintaining the life-support systems of nature thereby maintaining their potential to meet the needs and aspirations of future generations. A sustainable fishery is consistent with ESD if that fishery conserves and enhances the community's resources so that the ecological processes, on which life depends, are maintained and the total quality of life now and in the future, can be increased Principles of Ecologically Sustainable Development The precautionary principle— Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. ***In the application of the precautionary principle, public and private decisions should be guided by:*** careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and an assessment of the risk-weighted consequences of various options.

Intergenerational equity— the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations

Intragenerational equity- equity within a generation.

Conservation of biological diversity and ecological integrity— conservation of biological diversity and ecological integrity should be a fundamental consideration.

Improved valuation, pricing and incentive mechanisms—

environmental factors should be included in the valuation of assets and services,

polluter pays— those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

Ecologically related species	Species which, while not associated with or dependent upon a harvested species, nevertheless are affected by the fishing operation.
Ecologically viable stock	Ecological viable stock has a general rather than a specific meaning. It refers to the maintenance of the exploited population at high levels of abundance designed to maintain productivity, provide margins of safety or error and uncertainty and maintain yields over the long term in a way that conserves the stock's role and function in the ecosystem.
Ecosystem	The biotic (living) community and its abiotic (non-living) environment.
Fish	Fish are marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead) and include oysters and other aquatic molluscs, crustaceans, echinoderms, and beach worms, and other aquatic polychaetes. Fish does not include whales, mammals, reptiles, birds or amphibians.
Fishery	A unit determined by an authority or other entity that is engaged in raising and /or harvesting fish. Under the Fisheries Management Act 1994, fishery is a class of fishing activity identified by reference to any one or more of the following: species or class of fish, area of water or seabed, method of fishing, class of boats, class of persons and purpose of activities.
Fishing activity	Fishing activity is the activity of taking fish and includes: searching for fish, any activity likely to result in locating, aggregating or taking of fish or carrying fish by boat from the places where they are taken to the place where they are to be landed.
Fishing effort	Represents the amount of fishing gear of the specific type used on the fishing grounds over a given unit of time e.g. hours trawled per day, number of hooks set per day or number of hauls of a beach seine per day
Fish stock / resources	Means the living resources in the community or population from which catches are taken in a fishery. Fish stock may include one or several species of fish but may also include commercial invertebrates and plants. Recruits to a stock are the young fish entering the exploited component of the stock for the first time.
FRCAC	The Fisheries Resource Conservation and Assessment Council is a statutory body appointed by the Minister for Fisheries that will advise on the preparation, review and assessment of fishery

	management strategies.
Key secondary species	A species that is not the principal target species in a fishery, but is captured, retained and marketed instead of being discarded. A key secondary species may also be called a byproduct species. In multi species fisheries (e.g. trawl fisheries), the catch of key secondary species may be critical for the economic viability of fishing businesses.
Management Advisory Committee (MAC)	MAC have been established for each share management or restricted fishery. Members are elected by the commercial fishers of the fishery or appointed by the Minister. The MAC advises the Minister on the fishery matters including the preparation of regulations or management strategy, monitors their implementation and assists in reviewing the regulations or strategy.
Management regime	In this document, refers to the policies, plans, action plans, strategic research plans, and all documentation that relates to the operations and management of the fishery.
Ministerial Advisory Council	Ministerial Advisory Councils for commercial, recreational, research and aquaculture sectors are appointed by the Minister to advise him on any matter relating to the sector for which the council has been established.
Overfishing	can be defined in two ways which can act independently or concurrently:
	"recruitment overfishing", where fishing activities are causing a reduction in recruitment in succeeding years and cause the mortality of too many fish in total, too many pre-productive fish, or too many fish that have only spawned a few times. The end result is that the stock can no longer replenish itself adequately.
	"growth overfishing": where fishing activities lead to a reduction in the size of the individuals of a species, as a consequence of which few specimens grow to the size for optimum yield.
Precautionary recovery strategy	management and operational strategy, designed to increase numbers within the stock, that incorporates the precautionary approach and includes mechanisms to avoid or mitigate adverse ecosystem effects.
Protected species	are species protected under the NSW legislation (FM Act or NPW Act) or Commonwealth legislation (Environment Protection and Biodiversity Conservation (EPBC) Act)
Productivity	when applied to fish stocks the term productivity gives an indication of the birth, growth and death rates of a stock.
Stock	In the strict sense, a distinct, reproductively isolated population. In practice, a group of individuals of a species in a defined spatial range that is regarded as having a relatively low rate of exchange with others of the species.
Threatened species, populations or ecological communities	Are listed as vulnerable, endangered or presumed extinct under the FM Act 1993 or Threatened Species Conservation Act 1995 or Environment Protection and Biodiversity Conservation (EPBC) Act.

Appendix 3 - The Eight-Part Test.

The “8 Part Test” under s5A of the EP&A Act must be used by the determining authority in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats. The 8 Part Test provides guidance on determining when a species impact statement (SIS) is required. An SIS must accompany any proposal where there is likely to be a significant effect on threatened species, populations or ecological communities or their habitats. The questions constituting the 8 Part Test are as follows:

- In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction;
- In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;
- In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;
- Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;
- Whether critical habitat will be affected;
- Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;
- Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process; and

Whether any threatened species, population or ecological community is at the limit of its known distribution.

Appendix 4 - Extract from Section 7E of the Fisheries Management Act

The Fisheries Management Strategy is to:

Describe the objectives of the Strategy

Describe the designated fishing activity

Outline any likely interaction of the designated fishing activities with other fishing activities

Outline the fishing regulatory controls or proposed fishing regulatory controls which apply to the designated fishing activity including:

- Provisions in the Fisheries Management Act or Regulations
- Any management plan or draft management plan
- Fishing closures under section 8 of the FM Act
- Fishing approvals
- Any determinations of the TAC Committee under Division 4 of Part 2 of the FM Act
- Policies approved by the Fisheries Minister
- Any relevant provisions in environmental planning instrument

Identify performance indicators to monitor whether the objectives of the strategy are being achieved

Describe how the designated fishery activity is to be monitored

Specify at what point a review of the strategy is required when a performance indicator is not being satisfied.

Appendix 5 - Fishery Management Tools

Limiting who has access	*Limited access regimes* can be used to limit entry to participants in a particular fishery or part of a fishery. They usually include eligibility rules and rules relating to the transfer of entitlements.
	Restructuring programs can provide a concentrated or focused change in management procedures to achieve an accelerated change in expected outcomes[8]. These may include minimum entitlement holdings, buy back schemes and restructuring through transferability programs.
Limiting where and when the fishing can occur	*Fishing closures* which restrict commercial and/or recreational fishing for a specified period of time, any fishing or fishing for certain classes of fish in any waters or from specified waters.
	Recreational fishing havens which are a form of fishing closure may give preferential fishing rights to recreational fishers and may partly or totally restrict commercial fishers
	Recognised fishing grounds are areas used regularly or intermittently for net fishing by commercial fisheries and which have been mapped and approved by the Director and where commercial net fishers are given priority under clause 105 of the FM Regulation.
Input controls limiting the equipment used to take fish	*Gear restrictions* limit the size and type of gear (in possession or that can be used to take fish) such as size and number of nets/traps/lines/etc, mesh or size configurations, gear design, and marking of gear
	Boat controls limit the size and engine capacity of boats
Output controls limiting the amount and type of fish able to be landed	*Total allowable catch* (TAC) is a specified total catch for a share management fishery determined by an independent Total Allowable Catch Committee fished on a competitive basis or by people holding individual quotas.
	Species size limits restricts the minimum size, maximum sizes or range of sizes specified for fish of a particular species that can be landed (by measurement or weight);
	Bag limit is the maximum quantity of fish of a specified species or of a specified class that a person may take on any one day. – daily limit.
	Possession limit is the maximum quantity of fish of a specified species or specified class that a person may have in possession in any specified circumstances
	Protected fish are certain species of fish completely prohibited from being in a person's possession.
	Protected fish from commercial fishing are certain species of fish completely prohibited from commercial fishing and from taking for sale.
	Quality assurance controls are the controls on the harvest of shellfish such as mussels and pipis to protect health
Protection of ecosystems	*Protected or threatened species, populations and ecological communities and their habitats* (e.g. fish, aquatic vegetation, marine mammals, platypus, birds etc). listed under the FM Act, NPW Act or EPBC Acts.
	Marine protected areas in estuarine or oceanic areas managed to conserve biodiversity and habitat. These include aquatic reserves, marine parks and marine components of national parks and nature reserves (Note: fishing restrictions may only apply in certain zones in marine parks and aquatic reserves)
	Planning controls in Environmental Planning Instruments (e.g. LEPs, SEPPs) under the EP&A Act that could limit where fishing could occur and /or protect foreshore vegetation and wetlands from disturbance or destruction.

[8] Definition extracted from Metzner, R. & Rawlinson, P. (1998) Fisheries Structural Adjustment: towards a national framework. Commonwealth Department of Primary Industries and Energy, Canberra, p.2.

APPENDIX B1

DESCRIPTIONS AND 30 YEAR CATCH TRENDS OF THE PRIMARY AND KEY SECONDARY SPECIES

Appendix B1 Overview of the primary and key secondary species in the Ocean Trap & Line Fishery

This section provides an overview of the primary and key secondary species caught in the Ocean Trap & Line Fishery (OTLF). The following descriptions of each of these species includes graphs showing catch between other commercial fisheries, seasonal trends, and the main gear types used in harvesting each of these species for the 2003/04 financial year as well as recent catch trends.

The information in the following section has been extracted from a variety of sources including the scientific literature, some as yet to be published information, and the NSW DPI Catch Statistics Database.

Note that this section was prepared as a stand-alone document within the EIS and, as such, includes updated information that is not presented elsewhere. However, conclusions should not be made on the status of the species, as it appears in the assessment of the existing activity or the assessment of the FMS, based solely on the updated data presented here.

Primary species

Banded rock cod (*Epinephelus ergastularius*) or bar cod

Heemstra and Randall 1993, Rowling 1996

Banded rock cod are only known to occur in the southwest Pacific off the eastern coast of Australia between 18°S and 36°S.

Adults are found at depths of 110-370 m and juveniles are found at depths of 15-130 m. The largest reported size of banded rock cod is 157 cm total length (TL) and 66 kg. There is little information on the biology of banded rock cod, which needs to be rectified as this is a primary species in the Ocean Trap and Line Fishery.

Over 98% of the commercial harvest of banded rock cod is derived from the Ocean Trap and Line Fishery (Fig. 1). Since this species was listed separately on reporting forms in July 1990 total reported landings of this species has fluctuated between 10 tonnes and 30 tonnes (Fig. 2). Monitoring of the NSW commercial droplining catch at the Sydney Fish Markets from 1993 to 1995 showed that the majority of fish were between 40 and 70 cm fork length (FL), which is equivalent to 2-5 kg. Only a very small proportion of the catch comprised of fish larger than 80 cm (FL). There was a sharp decline in reported landings of banded rock cod between 2002/03 (30 tonnes) and 2003/04 (17 tonnes). The winter months provide for the highest catches of banded rock cod (Fig. 3) with fish landed in the OTLF caught mainly by line methods (Fig. 4).

Banded rock cod (*Epinephelus ergastularius*) or bar cod

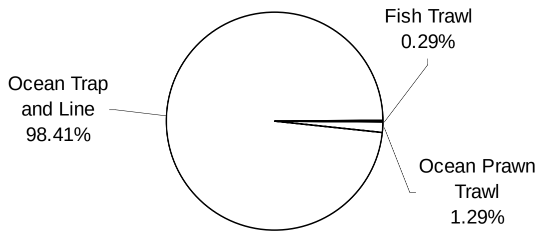


Figure 1 Percent contribution of each NSW commercial fishery to the harvest of banded rock cod.

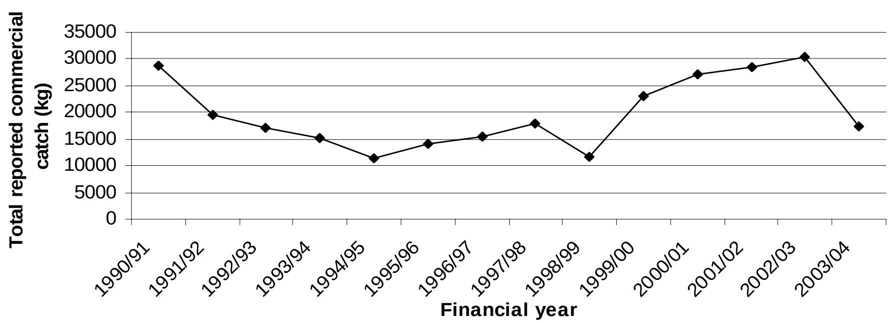


Figure 2 Total reported commercial catch for banded rock cod from 1990/91 – 2003/04.

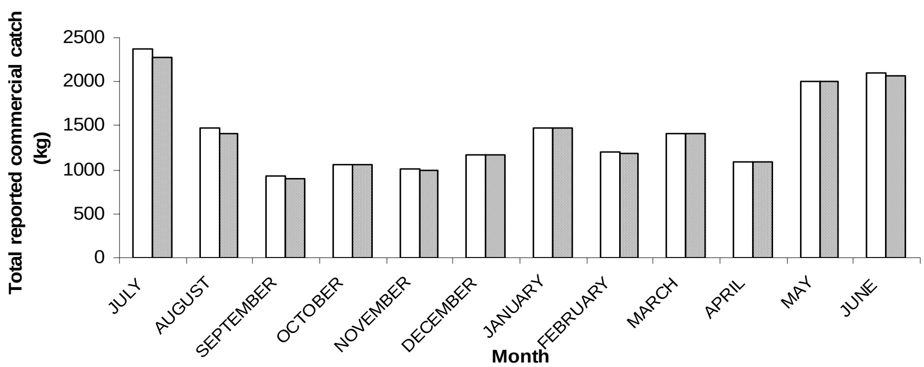


Figure 3 Reported commercial catch per month of banded rock cod in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

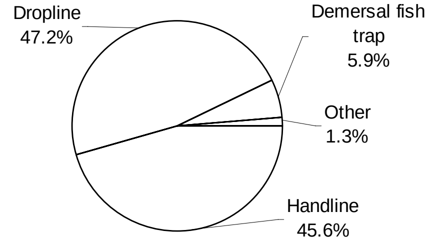


Figure 4 Percent contribution of each method type used in the OTLF to the harvest of banded rock cod.

Blue-eye (*Hyperoglyphe antarctica*)

Kailola *et al.* 1993, Duffy *et al.* 2000, Ward and Elliott 2001, Smith and Wayte 2002.

Blue-eye are distributed in continental slope waters off southern South America, South Africa, New Zealand and Australia. Their Australian distribution stretches along the southern continental margin in waters from Moreton Island in Queensland to 30°S in Western Australia. Blue-eye also occur on the seamounts off eastern Australia and south of Tasmania, Lord Howe Island and probably Norfolk Island.

Adults and sub-adults occur in mid-water at depths of around 500 m and are associated with rocky ground on the continental slope where the majority of fish are found between 200 and 600 m, but a small number have been reported to occur at depths of up to 900 m. Juveniles have been found at the surface but many occur in the mid-water region. The colour of juvenile blue-eye (3-6 cm FL) was reported to be remarkably similar to the colour of kelp, and this has led to the suggestion that some juvenile blue-eye are dependent on drift algae for shelter.

Analysis of blue-eye samples from Tasmania indicate that 72 cm is the size at maturity for females (corresponding to about 11-12 years of age) and is 62 cm for males (8-9 years of age). However, it is unclear what proportion of fish mature at these sizes (e.g. 50% or 100% of fish). Most spawning activity occurs in the waters from central NSW to north-eastern Tasmania, with evidence that spawning also takes place in southern Australia. Spawning occurs in summer-autumn but timing varies regionally, with spawning occurring in NSW waters from April-June. Female blue-eye are highly fecund with females producing 2-11 million eggs per year. Allozyme surveys on the genetic structure of the blue-eye stock revealed that there was no population differentiation in samples examined from NSW, Tasmania and South Australia.

Within the Australian Fishing Zone, estimated ages of blue-eye in commercial catches is thought to range from 2 to 3 years at first capture, to 42 years for females and 39 years for males with great variation in the size of fish at age.

Approximately 99% of the blue-eye caught in NSW managed commercial fisheries was from the Ocean Trap and Line Fishery (Fig. 5). Approximately 43 tonnes of this species was caught in the commercial sector (NSW managed) in 2003/04 which is the lowest reported catch since the mid-1980s (Fig. 6). The winter months provide the majority of the reported catch of blue-eye (Fig. 7). Droplining is the primary method by which this species is taken in the Ocean Trap and Line Fishery (Fig. 8), and is also the main method that fishers use to target this species in the Commonwealth managed fishery.

Blue-eye (*Hyperoglyphe antarctica*)

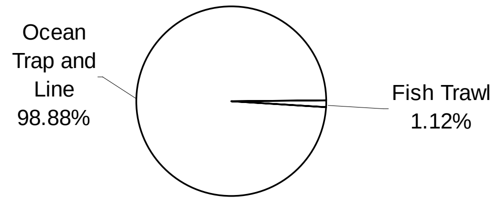


Figure 5 Percent contribution of each NSW commercial fishery to the harvest of blue-eye.

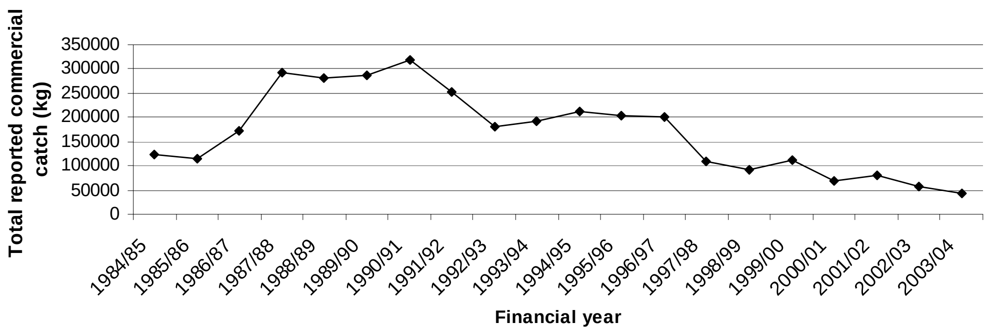


Figure 6 Total reported commercial catch for blue-eye from 1984/85 – 2003/04.

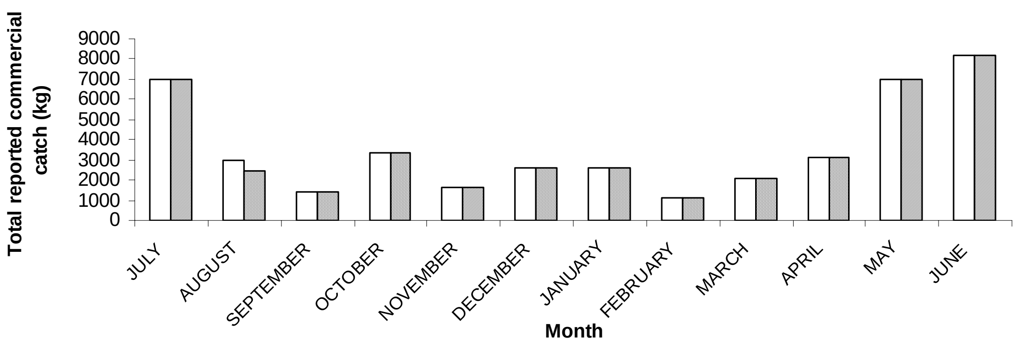


Figure 7 Reported commercial catch per month of blue-eye in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

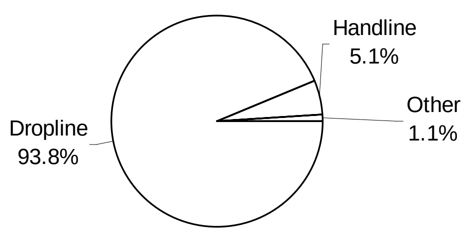


Figure 8 Percent contribution of each method type used in the OTLF to the harvest of blue-eye.

Australian Bonito (*Sarda australis*)

Collette and Nauen 1983, James and Habib 1979.

Bonito are restricted in their distribution to the waters of southeastern Australia (southern Queensland to Tasmania) and Norfolk Island. Specimens of this species were reported from New Zealand in 1979.

Fish are thought to mature and spawn from January through to April. The maximum length of bonito is about 100 cm (FL) and about 9.4 kg. There is no other information on the biology of Australian bonito, a situation that will be addressed by NSW DPI as this is a primary species in the Ocean Trap and Line Fishery (and also a target species in Ocean Hauling).

Over 99% of the Australian bonito caught by the commercial sector was by fishers in the Ocean Trap and Line Fishery (Fig. 9). Since bonito was separately listed on catch returns in the early 1990s, the majority of the annual commercial landings of this species have been between 100 tonnes and 150 tonnes (Fig. 10). Since the peak in commercial landings of bonito in 1998/99 (275 tonnes), the current level of reported catch is in line with historical levels. In the 2003/04 financial year, the peak period for harvesting bonito was from March to June (Fig. 11). Line methods within this fishery account for the majority of the catch (Fig. 12).

Australian Bonito (*Sarda australis)*

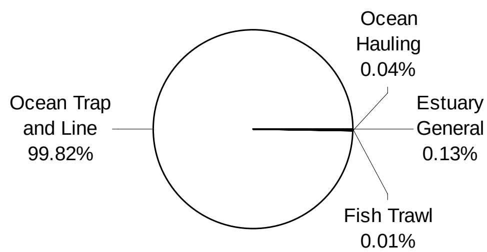


Figure 9 Percent contribution of each NSW commercial fishery to the harvest of bonito.

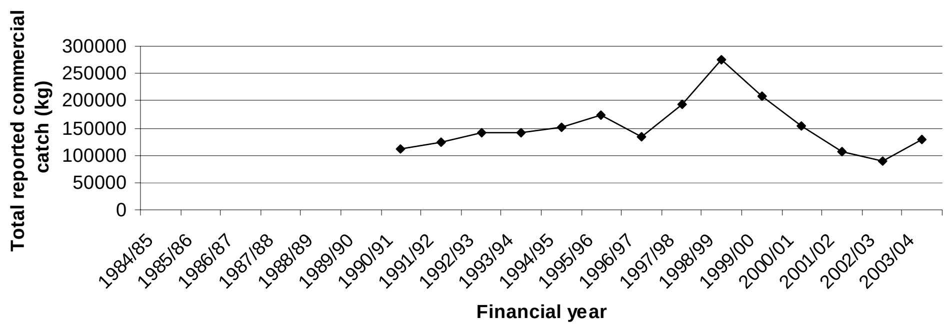


Figure 10 Total reported commercial catch for bonito 1984/85 – 2003/04.

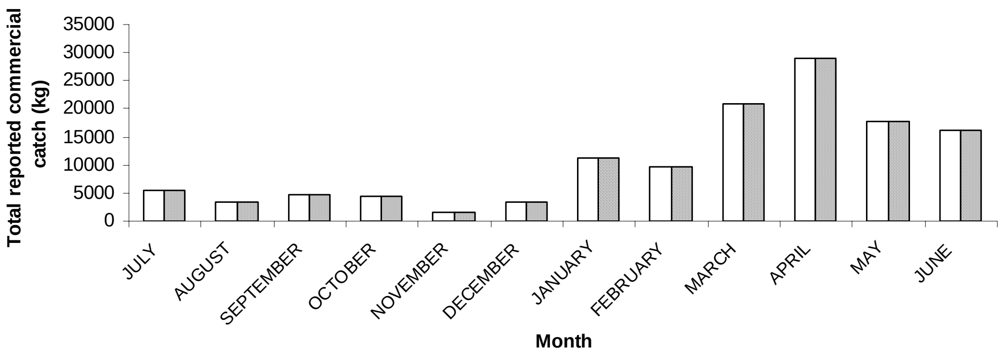


Figure 11 Reported commercial catch per month of bonito in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

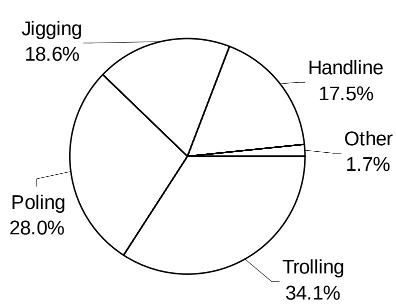


Figure 12 Percent contribution of each method type used in the OTLF to the harvest of bonito.

Gummy shark (*Mustelus antarcticus)*

Moulton *et al.* 1992, Kailola *et al.* 1993, Last & Stevens 1994, Simpfendorfer & Donohue 1998, Simpfendorfer *et al.* 2001, Gardner & Ward 2002, Punt *et al.* 2002.

Gummy sharks are distributed in temperate Australian waters from Geraldton in Western Australia, around the southern Australian coast northwards to at least Port Stephens in NSW. They may also be found in Queensland waters. They are demersal and are found from intertidal water to depths of 80 m, although they have been recorded from depths up to 350 m.

Gummy sharks are ovoviviparous where the young develop from eggs that mature internally before being born live. Gestation is thought to last 11-12 months and pregnant females carry an average of 14 young with older females carrying more embryos than younger ones. Pups are about 30-35 cm when born and it is believed that females reach a total length of up to 175 cm and males up to 145 cm. The length at which 50% of female gummy sharks were pregnant has been estimated at 120 – 130 cm in Western Australian waters, although alternative information suggests that females mature at around 85 cm and males at 80 cm. The maximum recorded weight for this species (up to 1993) is 24.8 kg and they can live up to 16 years of age.

Analysis on the stomach contents of gummy sharks off southwestern Western Australian showed that their diet was dominated by benthic and epibenthic prey, including crabs, lobsters, tetraodontid fishes and octopus. It is presumed that the species studied is here the same species of gummy shark, *M. antarcticus*, identified below.

The relationships of *Mustelus* species in Australian and New Zealand waters were investigated by analysis of allozymes, mitochondrial DNA (mtDNA), and precaudal vertebrae counts. The existence of four *Mustelus* species in this region was found: a non-spotted *Mustelus* sp. A (a single specimen genetically examined from the North-West Shelf off Western Australia), and three spotted species-*M*. sp. B (from Western Australia, the North-West Shelf south to Perth - extending its known range); *Mustelus antarcticus* (from Bunbury in Western Australia around the southern Australian coast and as far north as Townsville, Queensland), and *M. lenticulatus* from New Zealand.

The shark fishery off southern Australia, in Commonwealth waters, is concentrated on school and gummy sharks. Gillnets were introduced into this fishery in the mid-1960s and have remained the primary method of harvest since the 1970s. The use of gillnets in NSW ocean waters was banned in the late 1970s. Commercial shark fishing began in southwestern WA in 1941 with gummy sharks being targeted by demersal longlines and also caught using droplines and handlines. Gillnets were introduced into this fishery in the late 1950s.

In 2003/04, the Ocean Trap and Line Fishery accounted for over 48% of the commercial harvest of gummy sharks that were reported on NSW catch records (Fig. 13). Since 1990/91, catches of gummy sharks have increased to a maximum of 70 t (in 1995/96) with subsequent decreases in catch occurring up to 2003/04 (23 t, Fig. 14). The autumn-winter period of 2003/04 produced the greatest catches for that year, with Ocean Trap and Line fishers contributing to over 50% of that catch for 4 of those 6 months (Fig. 15). Line methods account for almost all the gummy sharks caught in this fishery (Fig. 16).

Gummy shark (*Mustelus antarcticus)*

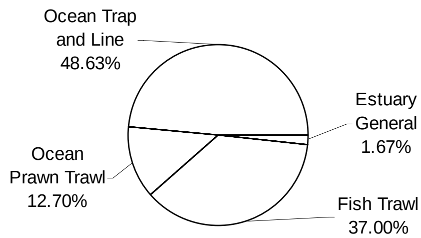


Figure 13 Percent contribution of each NSW commercial fishery to the harvest of gummy shark.

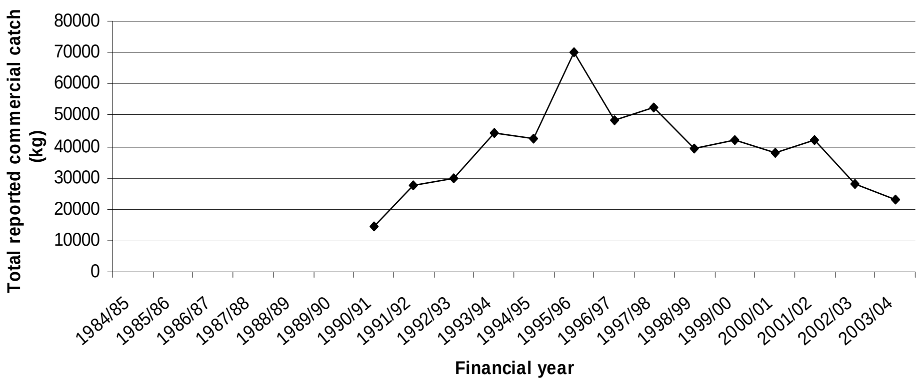


Figure 14 Total reported commercial catch for gummy shark 1984/85 – 2003/04.

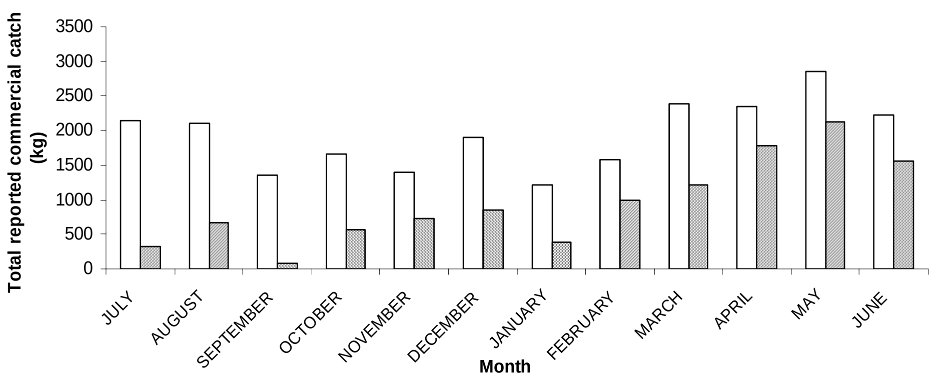


Figure 15 Reported commercial catch per month of gummy shark in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

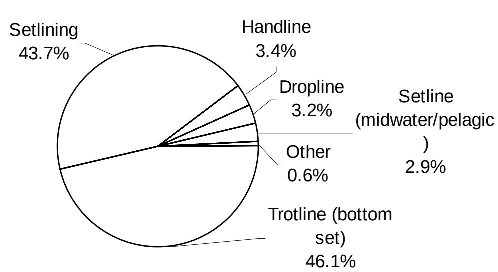


Figure 16 Percent contribution of each method type used in the OTLF to the harvest of gummy shark.

Leatherjacket (mixed species)

Including: chinaman/ocean leatherjacket (*Nelusetta ayraudi*), black reef leatherjacket (*Eubalichthys bucephalus*), rough leatherjacket (*Scobinichthys granulatus*) and velvet leatherjacket (*Parika scaber*).

Lindholm 1984, Grove-Jones & Burnell 1991, Kailola *et al.* 1993, Klaer 2001, Stewart & Ferrell 2001, Froese & Pauly 2005.

A number of leatherjacket species are taken by the Ocean Trap and Line Fishery in NSW waters. Leatherjackets are cryptic species that can be difficult to correctly identify. They can range in size up to around 1 m. In recent years, leatherjacket landings have been dominated by Chinaman/Ocean jackets. Ocean jackets are distributed in southern Australian waters from Cape Moreton in Queensland to North West Cape in Western Australia (including Tasmania). They can be found in waters from 2 m to 200 m in depth. Juveniles of this species have been caught in seagrass, over sand and rocky reefs and occur close to shore in bays and estuaries. Research from the Great Australian Bight also suggests that this species schools in size classes with larger fish occurring in deeper water. The diet of this species has been recorded as consisting of fish, invertebrates and salps. Most of the leatherjacket species caught in the Ocean Trap and Line Fishery are thought to be reasonably wide ranging in their distribution, and occur in inshore and shallower continental shelf waters.

Analysis of historical steam trawl catch and effort data for 1918-23, 1937-43 and 1952-57 from the Australian South East Fishery showed that ocean jackets were abundant in the early years of the fishery and then virtually disappeared from catches in later years. NSW trap fishers landed up to 1000 t annually of leatherjackets during the 1950s however this level of harvesting appeared to be unsustainable.

Leatherjackets caught in the Ocean Trap and Line Fishery are reported as ‘Black-reef’, ‘Chinaman’ or ‘Unspecified’ on their monthly catch reporting form. For the purposes of review, all catches have been combined and presented as ‘Leatherjackets (mixed species)’ here, although it should be noted that the majority of fish are Chinaman/Ocean leatherjackets. In 2003/04, the Ocean Trap and Line Fishery harvested 80% of the reported commercial harvest of leatherjackets (Fig. 17). Since 1984/85, commercial catches of leatherjackets ranged between 150 tonnes and 200 tonnes. Since 2000/01, catches have increased to be between 250 t and 300 t (Fig. 18). This is confirmed by NSW trap fishers who, in recent years, commonly target large aggregations of Chinaman/Ocean leatherjackets. It was observed that very few Chinaman/Ocean leatherjackets were discarded in the trap fishery and that those that were discarded were smaller than 25 cm FL. The majority of leatherjackets are taken in the winter months (Fig. 19) with fish trapping accounting for over 90% of the catch taken in the Ocean Trap and Line Fishery (Fig. 20).

Leatherjacket (mixed species)

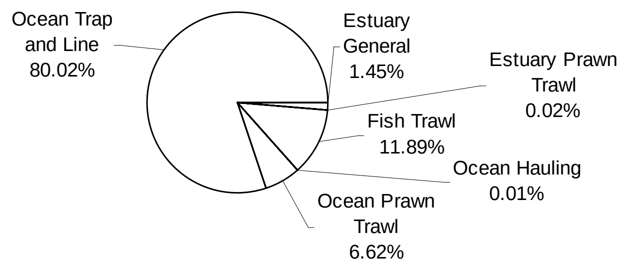


Figure 17 Percent contribution of each NSW commercial fishery to the harvest of leatherjackets.

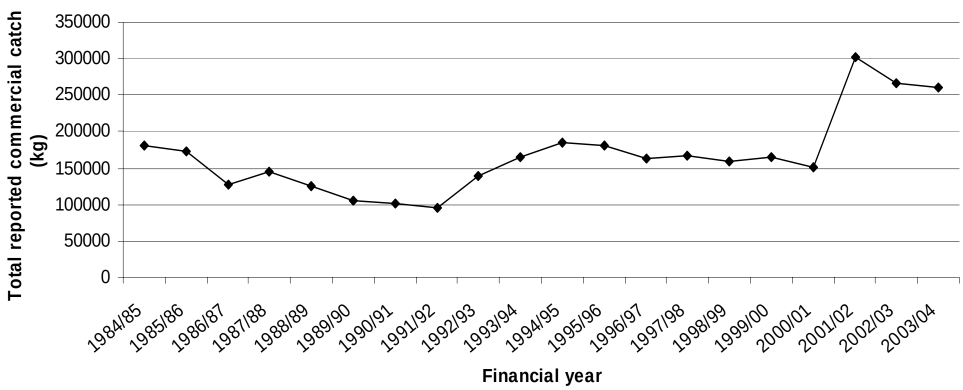


Figure 18 Total reported commercial catch for leatherjackets 1984/85 – 2003/04.

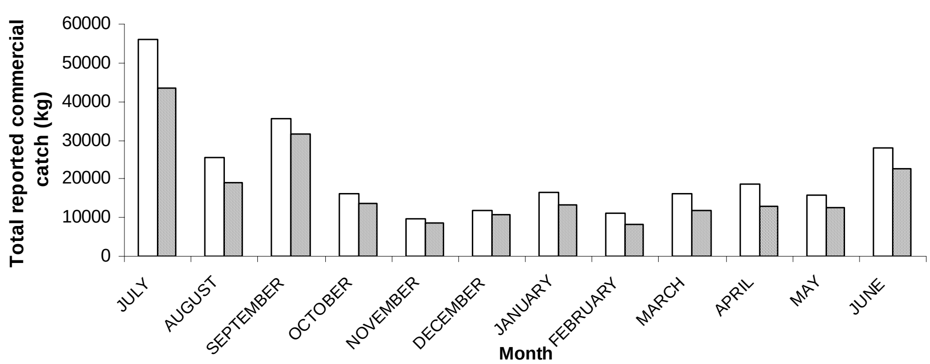


Figure 19 Reported commercial catch per month of leatherjackets in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

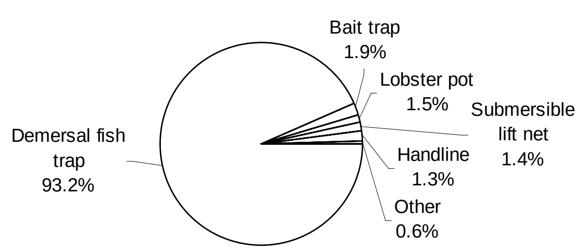


Figure 20 Percent contribution of each method type used in the OTLF to the harvest of leatherjackets.

Rubberlip morwong (*Nemadactylus douglasii*)

Kailola 1993, Froese & Pauly 2005.

Rubberlip morwong are distributed along the south-eastern Australian coastline in continental shelf waters from Moreton Bay in Queensland to Wilsons Promontory in Victoria. They can also be found along the east coast of Tasmania to Storm Bay and are also present around the north island of New Zealand.

The biology and life history characteristics of this species is poorly understood in Australian waters. They are demersal fish commonly caught near reefs at depths of 10-100 m. Fish, crustaceans and invertebrates are the primary food items consumed by this species in New Zealand waters. The maximum length and weight for this species is approximately 81 cm and 4 kg, respectively. No information is available on the spawning and larval development of this species, and there is no information on growth rates or maximum age. Information on the stock structure of rubberlip morwong in Australia is also unavailable.

The commercial rubberlip morwong fishery is generally limited to NSW in waters from Ballina to Eden. In 2003/04, more than 80% of the commercial harvest of rubberlip morwong was taken in the Ocean Trap and Line Fishery (Fig. 21). The commercial harvest of this species has decreased from over 500 tonnes in the mid-1980s to around 50 tonnes in 2003/04 (Fig. 22), and the recreational harvest of this species is thought to be at least twice as much. For the 2003/04 period, catches of rubberlip morwong were similar between months with the autumn period showing a decrease in the Ocean Trap and Line proportion of the catch (Fig. 23). The majority of rubberlip morwong caught in this fishery is by the demersal fish trap method (Fig. 24).

Rubberlip morwong (*Nemadactylus douglasii*)

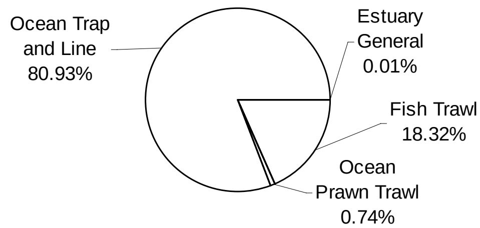


Figure 21 Percent contribution of each NSW commercial fishery to the harvest of rubberlip.

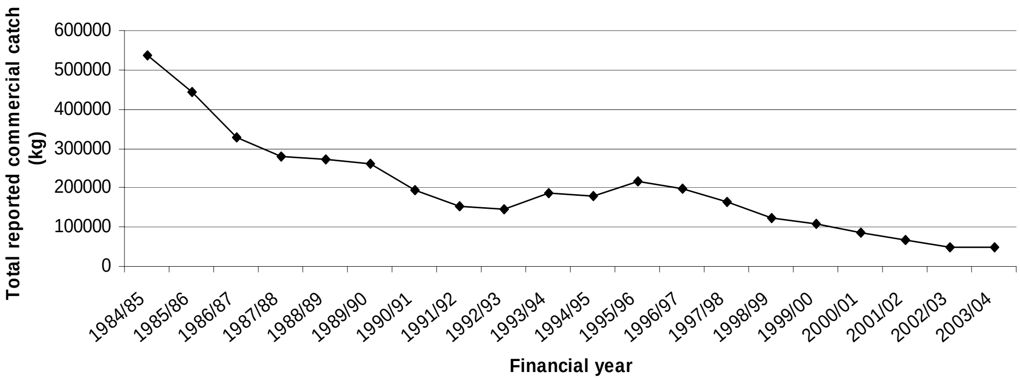


Figure 22 Total reported commercial catch for rubberlip 1984/85 – 2003/04.

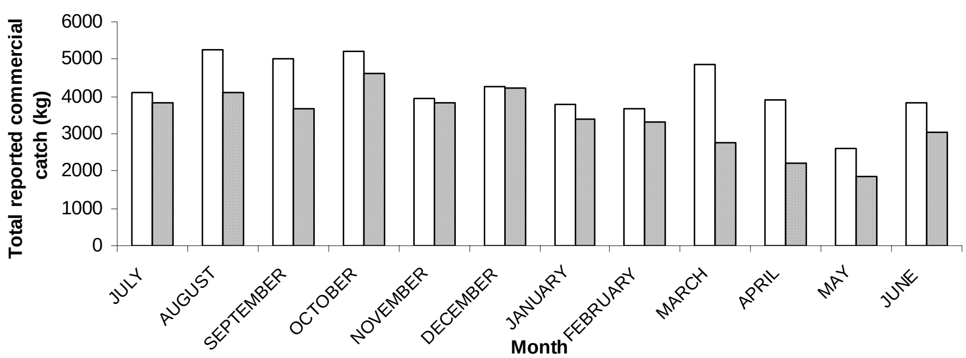


Figure 23 Reported commercial catch per month of rubberlip in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

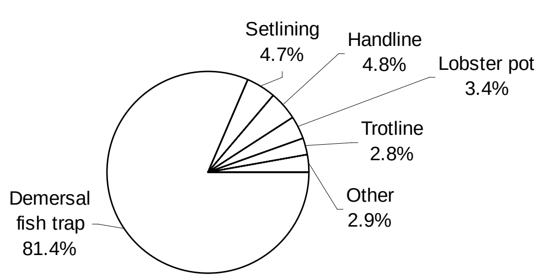


Figure 24 Percent contribution of each method type used in the OTLF to the harvest of rubberlip.

Silver trevally (*Pseudocaranx dentex*)

James 1984, Kailola *et al*. 1993, Rowling & Raines 2000, Stewart & Ferrell 2001

Silver trevally occur in estuarine and coastal waters from North West Cape in Western Australia to southern Queensland (including Tasmania), and in northern New Zealand. Most of the Australian catch is taken in NSW and eastern Victoria. Silver trevally is a schooling species which inhabits mainly sandy substrata. They feed on benthic invertebrates including, worms and molluscs, and also on benthic and planktonic crustaceans.

Silver trevally is a relatively long lived, slow growing species, attaining a maximum age in excess of 20 years. In NSW, trevally up to 24 years were aged, although sampling did show very few fish greater than 50 cm FL, while a maximum age of 46 years was estimated for silver trevally in New Zealand. In NSW coastal waters fish of this species reach a maximum size of around 65 cm fork length and weight of around 4 kg, however they can reach up to 94 cm in length. They spawn from spring to autumn with females having moderate fecundity (50 000 – 200 000 eggs per spawning). Larvae occur in coastal waters throughout this period and may enter estuaries before settling out as juveniles. Fish less than 10 cm in length were found in samples taken from Botany Bay between December and August, however the life history of this species is poorly understood. Maturation can occur at very small sizes (18 – 20 cm FL), however maturation appears to be progressive for both sexes, with full maturation not achieved until a length of 26 - 28 cm (FL). Silver trevally appear to be partial spawners, with several batches of eggs being released over an extended period from spring to autumn. Although mature fish occur most often in ocean waters, they do enter estuaries at certain times.

A preliminary assessment of the current status of the silver trevally stock determined that the trawl fishery was the most significant sector of the fishery, but trap and line and estuarine sectors were also important (Fig. 25) as was the recreational sector. From 1997 to 1999, the average size of silver trevally in commercial catches was 28.4 cm (FL) which is equivalent to about 500 g. Trevally older than ten years were estimated to comprise just 7% of the commercial catch in this same period. The size and age composition of trevally caught varied among the various fishery sectors, with catches by the estuary and trawl sectors showing the highest proportion of small (less than 30 cm FL) fish. Observer work carried out in the Ocean Trap and Line Fishery showed that the sizes of silver trevally caught in fish traps ranged from 16 – 61 cm (FL) with the majority of fish being between 26 and 33 cm (FL).

There has been a decline in the total landings of silver trevally from the mid-1980s (upwards of 1000 tonnes) to the present (2003/04 – approximately 400 tonnes; Fig. 26). There is seasonal variation in the catches of trevally with late spring to autumn showing the highest catches overall but with the highest catches in the Ocean Trap and Line Fishery occurring in late spring (Fig. 27). Within the Ocean Trap and Line Fishery, fish trapping is the main method by which trevally are caught (Fig. 28)

Silver trevally (*Pseudocaranx dentex*)

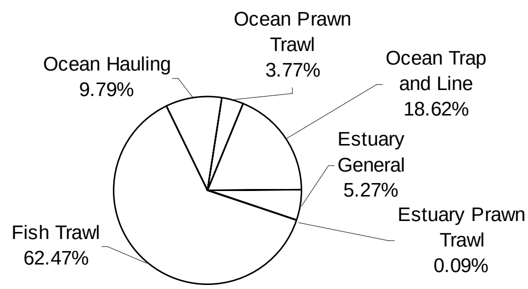


Figure 25 Percent contribution of each NSW commercial fishery to the harvest of silver trevally.

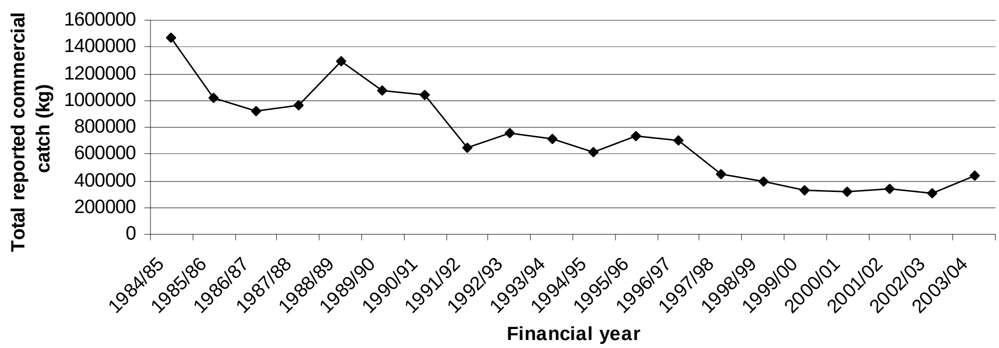


Figure 26 Total reported commercial catch for silver trevally 1984/85 – 2003/04.

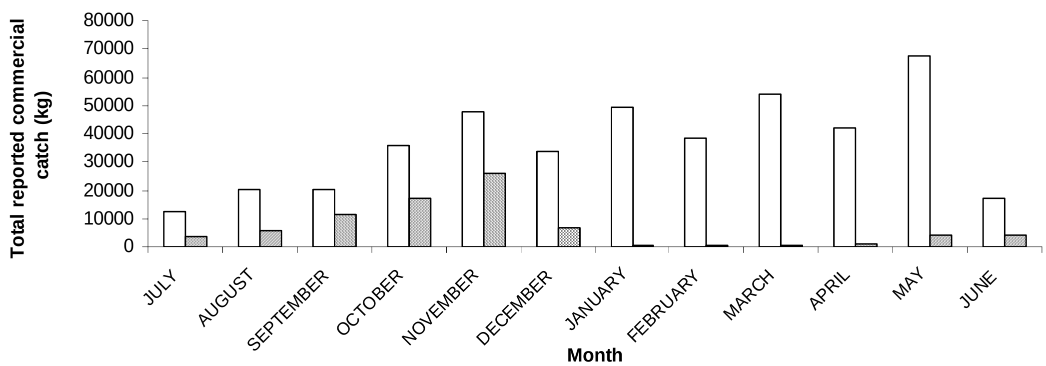


Figure 27 Reported commercial catch per month of silver trevally in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

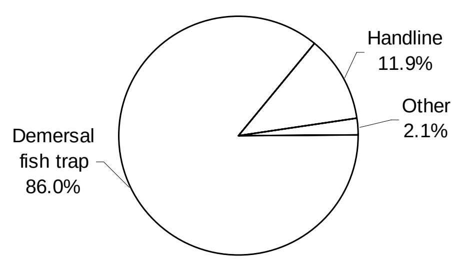


Figure 28 Percent contribution of each method type used in the OTLF to the harvest of silver trevally.

Snapper (*Pagrus auratus*)

Johnson *et al.* 1986, Kailola *et al.* 1993, Ferrell & Sumpton 1997, Fowler & Jennings 2003, Stewart & Ferrell 2001

Snapper is distributed in the Indo-Pacific region from Japan and the Philippines to India and Indonesia, and New Zealand. In Australia, snapper are distributed in waters from Hinchinbrook Island in Queensland to Barrow Island in Western Australia and occasionally found off the north coast of Tasmania.

Juveniles can be found around inlets, bays and other shallow, sheltered marine waters, often over mud and seagrass. Adults can be found near reefs, over mud and sand substrata and offshore to the edge of the continental shelf, across a depth range of 1-200 m. Some level of genetic sub-structuring is thought to exist for snapper in Western Australia, however snapper on the east coast of Australia is thought to constitute one stock.

Snapper spawn repeatedly during the spawning season i.e. they are serial spawners, with the number of eggs females spawn increasing exponentially with size. Therefore, larger females are much more fecund. The length at which 50% of female snapper from Queensland reach sexual maturity is 22 cm FL (about 25 cm TL and 2 years of age), although it is thought to be at a larger size in NSW, and length at maturity of this species in Western Australia is recorded as 41 cm. This difference may be due to the genetic sub-structuring referred to above.

Snapper are relatively long-lived with fish over 40 years estimated in Australia and snapper up to 60 years of age estimated in New Zealand. This species can reach 1.3 m in length, 16 kg in weight and feed on crustaceans, bivalve molluscs and small fish.

In NSW snapper are assessed to be growth-overfished and most fish caught are close to the size limit (half of snapper caught are within 3 cm of the current 30 cm TL MLL). Landings from the commercial and recreational fishery are dominated by young fish and less than 1% of fish survive to live to 10 years. The rate of growth of snapper at the current 30 cm TL MLL is between 3 and 4 cm per year.

Over 96% of snapper harvested from the commercial sector are taken by the Ocean Trap and Line Fishery (Fig. 29). Since the mid-1980s, the commercial harvest of snapper has decreased from around 750 tonnes and has stayed at around 200 tonnes for the past few years (Fig. 30). The main harvest season for snapper in the commercial sector is winter-spring (Fig. 31). Research on fish trapping, the method that is used to catch the majority of snapper (Fig. 32), showed that snapper of sizes 17 cm to more than 60 cm FL were captured but that the majority of fish were within the 21-28 cm FL size range in the years 1999 and 2000.

Snapper (*Pagrus auratus*)

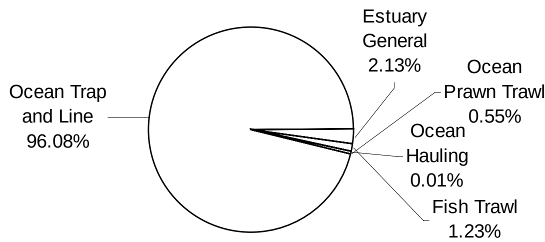


Figure 29 Percent contribution of each NSW commercial fishery to the harvest of snapper.

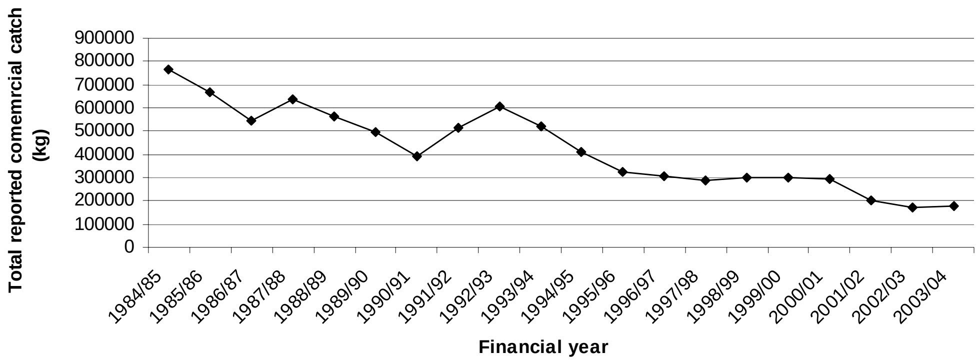


Figure 30 Total reported commercial catch for snapper 1984/85 – 2003/04.

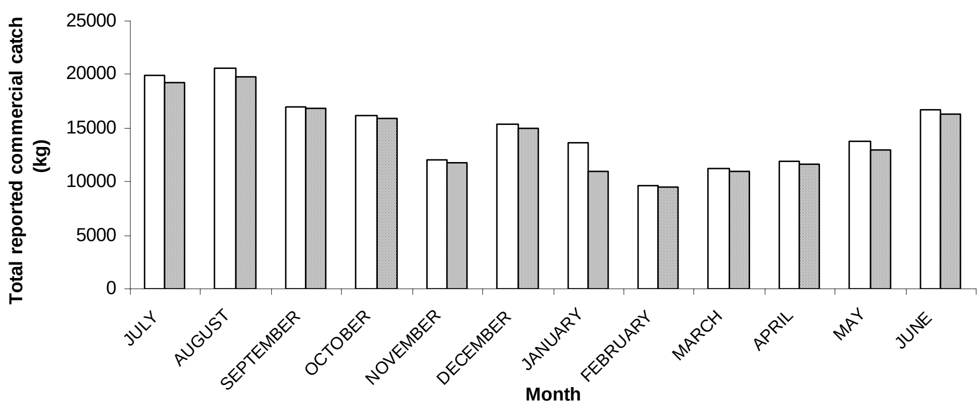


Figure 31 Reported commercial catch per month of snapper in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

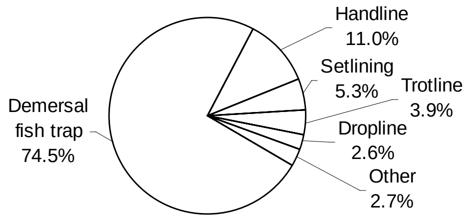


Figure 32 Percent contribution of each method type used in the OTLF to the harvest of snapper.

Spanner crab (*Ranina ranina)*

Kailola *et al.* 1993, Chen and Kennelly 1999, Kennelly and McVea 2001, Dempster *et al.* 2004.

Spanner crabs are distributed throughout the Indo-Pacific region in coastal waters, up to 70 m, on sandy substrata in which they bury. On the east coast of Australia, spanner crabs are distributed from Yeppoon in Queensland to Nowra in NSW and, on the west coast, from Quinn rocks (north of Perth) to the Houtman Abrolhos and Geraldton in Western Australia.

The prime maturation and spawning period for spanner crabs is from October to February, and large females are able to produce two batches of eggs each season with each batch averaging around 120 000 eggs. Female crabs mature at about 2 years of age which is equivalent to 70-75 mm (carapace length, CL) or 100 g.

Spanner crabs are opportunistic feeders with their diet consisting of urchins, bivalve molluscs, crustaceans, polychaete worms, and fish. Growth estimates based on NSW sampled spanner crabs suggest that males reach a maximum size of 140 (CL) and females reach a maximum size > 110 (CL). Growth to these maximum lengths is thought to take approximately 10 years.

Within the Queensland fishery for spanner crabs, the size distribution of males is in the range 50-162 mm (CL) with peak catches in the 100-109 (CL) size class. The size distribution of females ranged from 55 mm to 122 mm (CL) with peak frequency in the 80-99 mm (CL) size classes. Sampling of spanner crabs in both NSW and Queensland has also shown that the commercial catch consists predominantly of males.

Virtually all spanner crabs are caught in the Ocean Trap and Line Fishery (Fig. 33). Commercial harvest of spanner crabs declined between 1994/95 and 2001/02, although reported landings were still within historical levels, but have shown an increase in recent years (Fig. 34). July through to October in 2003/04 provided for the majority of the spanner crab harvest with the increase in catch in June 2004 accounting for the onset of the ensuing season (Fig. 35). With the exception of incidental catches of spanner crabs in other gear, all spanner crabs are caught using a spanner crab net (also know as a dilly, Fig. 36).

Spanner crab (*Ranina ranina*)

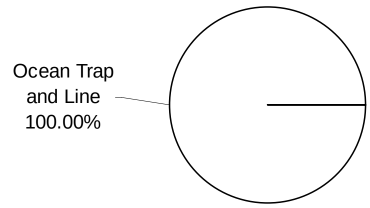


Figure 33 Percent contribution of each NSW commercial fishery to the harvest of spanner crab.

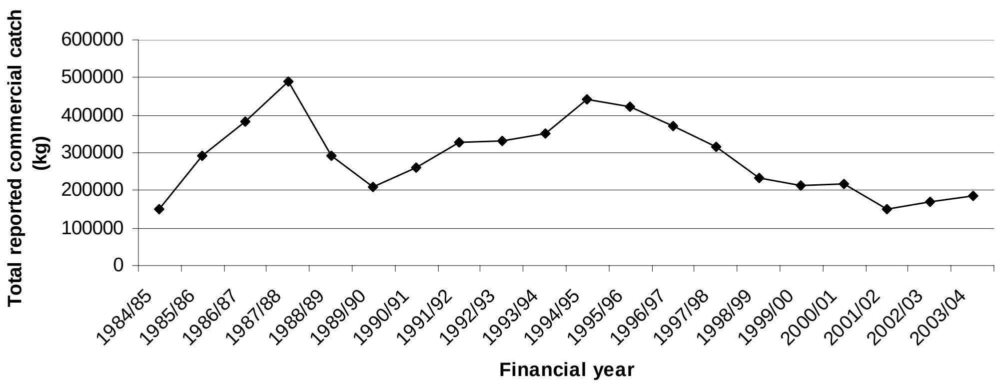


Figure 34 Total reported commercial catch for spanner crab 1984/85 – 2003/04.

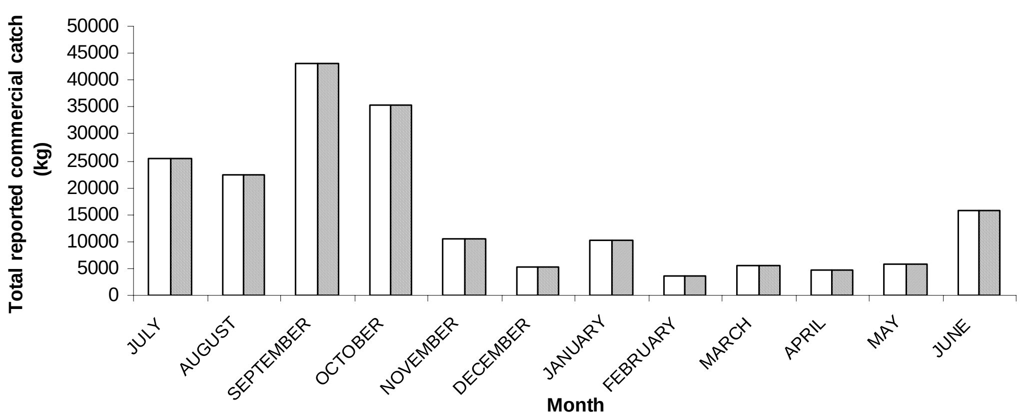


Figure 35 Reported commercial catch per month of spanner crab in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

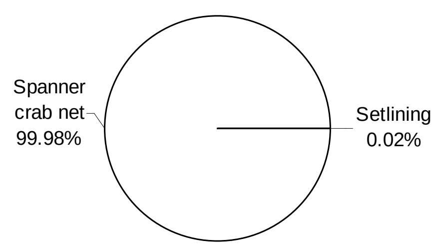


Figure 36 Percent contribution of each method type used in the OTLF to the harvest of spanner crab.

Yellowfin bream (*Acanthopagrus australis*)

SPCC 1981, Kailola *et al.* 1993, Pollard & Growns 1993, Pease & Grinberg 1995, Gibbs 1997, Gray *et al.* 2000.

Yellowfin bream are endemic to Australia and occur from Townsville in Queensland to the Gippsland Lakes in Victoria. In NSW waters, yellowfin bream are found primarily within estuaries and along nearshore beaches and rocky reefs, although they sometimes occur within the lower freshwater reaches of coastal rivers. Within estuaries, this species is found in association with all types of habitat, including seagrass beds, mangroves, bare substrata and rocky reefs. They eat a wide variety of foods, including small fish, molluscs, crustaceans and worms.

Spawning occurs in surf zones near estuary entrances, typically during winter-summer. The larvae enter estuaries and settle out of the plankton at about 1.3 cm (TL). Small juveniles live in sheltered shallow water habitats (particularly seagrass beds and mangrove channels) while larger juveniles occur in slightly deeper waters, and are particularly common around rocky reefs. Yellowfin bream grow slowly, taking about 5 years to attain 23 cm (FL). They mature at around 22 cm and undertake extensive pre-spawning migrations. Maximum length is about 66 cm (TL) and the maximum age for this species, sampled from NSW waters, was estimated as 22 years.

The majority of the commercial harvest of bream is taken by the Estuary General fishery, however, this species is an important component of the Ocean Trap and Line Fishery, with this fishery taking about 5% of the reported catch in 2003/04 (Fig. 37). From the mid-1980s to the mid-1990s there was a degree of fluctuation in the total NSW catch of yellowfin bream with catches ranging from 500-700 tonnes per year (Fig. 38). Reduction in catch since the early 1990s may be partly attributed to the phasing out of pound nets in Port Stephens and adjoining coastal waters, but a general decline in the reported estuarine fishing effort and environmental conditions may also have contributed to the decline. Despite the reduction in reported landings during this period, the age compositions of catches have remained relatively stable, indicating no declines in the number of older fish. In more recent years the total commercial catch has stayed around 330-335 tonnes per year. The majority of yellowfin bream is caught during winter in the estuaries while the main period in the Ocean Trap and Line Fishery is in summer-autumn (Fig. 39) where the main method used is the demersal fish trap (Fig. 40).

Black bream are a similar species to yellowfin bream and are found in estuarine waters on the NSW coast south of Myall Lakes. They are almost exclusively found in estuarine waters and generally only enter ocean waters after flood periods. Black bream are often reported as yellowfin bream during catch reporting since correct identification between the two species can be difficult. Black bream only constitute a small component (less than 5%) of the overall estuarine bream catch.

Yellowfin and black bream are recorded under the same species on the monthly catch return forms. The presence of black bream in Ocean Trap and Line landings is considered to be negligible.

Yellowfin bream (*Acanthopagrus australis)*

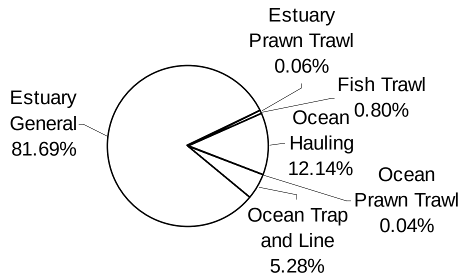


Figure 37 Percent contribution of each NSW commercial fishery to the harvest of bream.

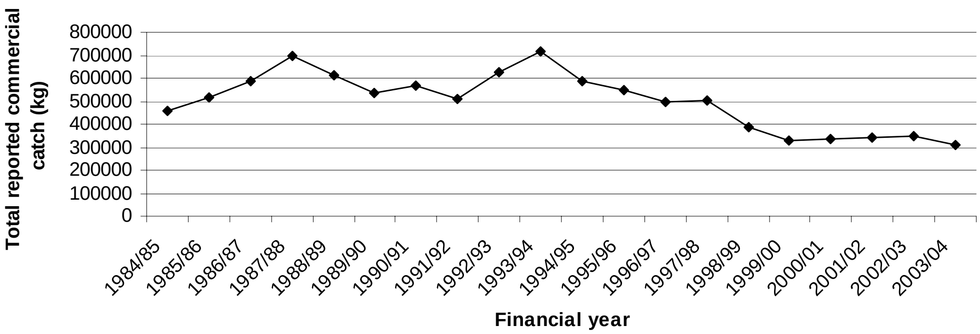


Figure 38 Total reported commercial catch for bream 1984/85 – 2003/04.

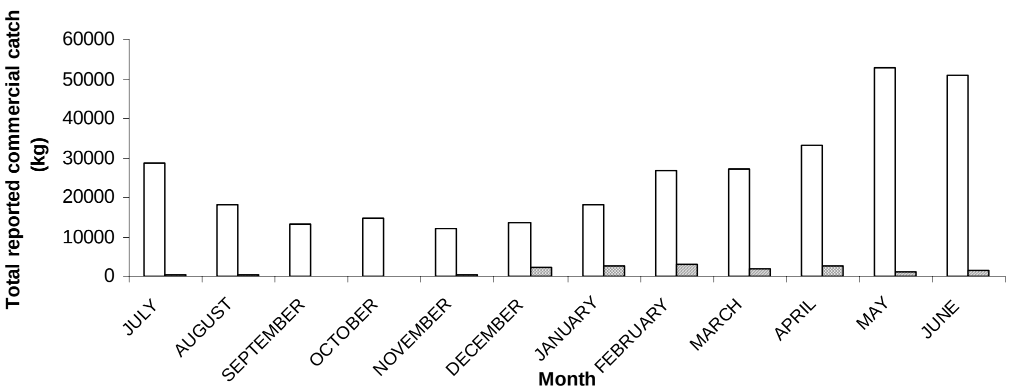


Figure 39 Reported commercial catch per month of bream in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

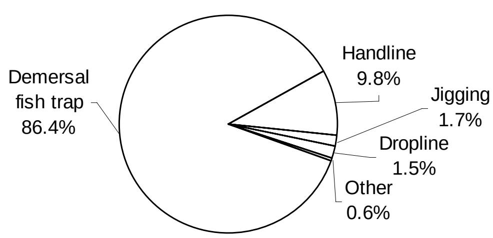


Figure 40 Percent contribution of each method type used in the OTLF to the harvest of bream.

Yellowtail kingfish (*Seriola lalandi)*

Kailola 1993, Stewart *et al.* 2004, Gillanders *et al.* 1999a, b.

Yellowtail kingfish are distributed throughout temperate waters of the Pacific and Indian oceans. In Australian waters they are distributed from southern Queensland to central Western Australia, including the east coast of Tasmania, and around Lord Howe and Norfolk islands.

Kingfish are spring-summer spawners with pelagic eggs that are about 1.4 mm in diameter. Larval kingfish hatch within 2-3 days at 4 mm in length. Schools of juvenile kingfish can be found in offshore waters around the continental shelf while solitary or small groups of adults can be found near rocky shores, reefs and islands. While it is reported that adults can reach about 190 cm in total length (TL) and can weigh up to 70 kg, it is thought that fish of this size are rare. Maximum age is thought to be in excess of 21 years. Kingfish are opportunistic daytime feeders with fish, squid and crustaceans forming a large part of their diet. Tagging programs have shown widespread movements of kingfish from NSW to New Zealand (and vice versa) and many large scale movements (> 500 km) along the NSW coast.

The estimated size at which 50% of females and males are sexually mature is around 83 cm and 47 cm FL respectively. For males, this size at maturity occurs at an age of less than 1 year old. Growth is rapid, being nearly linear between 1 and 11 years old, with fish reaching the 60 cm minimum legal length (MLL) at around 2 years of age.

Kingfish is an important commercial and recreational species with the recreational harvest being comparable to the commercial harvest. The Ocean Trap and Line Fishery contributes about 99% of the total catch in the commercial sector (Fig. 41). The commercial harvest of kingfish has decreased from around 600 tonnes in the mid-late 1980s to around 100 t (Fig. 42). A 60 cm MLL was imposed for kingfish in NSW waters in 1990, and kingfish traps were banned in 1996. The peak period of capture is December through May (Fig. 43) with line methods being the main capture method (Fig. 44). More than 47 tonnes of kingfish were measured as part of a research project on kingfish between 1998 and 2000. About 60% of measured landings were within 10 cm of the MLL (60 cm TL or 52 cm FL) and, when this was compared to kingfish measured between 1985 and 1990, showed that there has been little change in the size of fish available to the fishery. Thus, the fishery is dominated by 2 and 3 year old fish (91% of landings consist of kingfish younger than 7 years of age) with fish of up to age 21 (measured at 136 cm FL) being represented.

Yellowtail kingfish (*Seriola lalandi*)

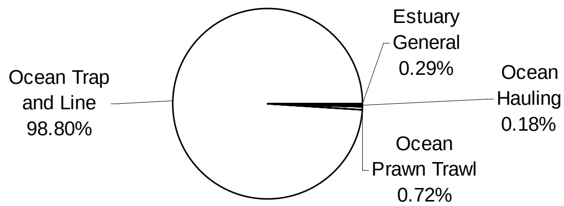


Figure 41 Percent contribution of each NSW commercial fishery to the harvest of kingfish.

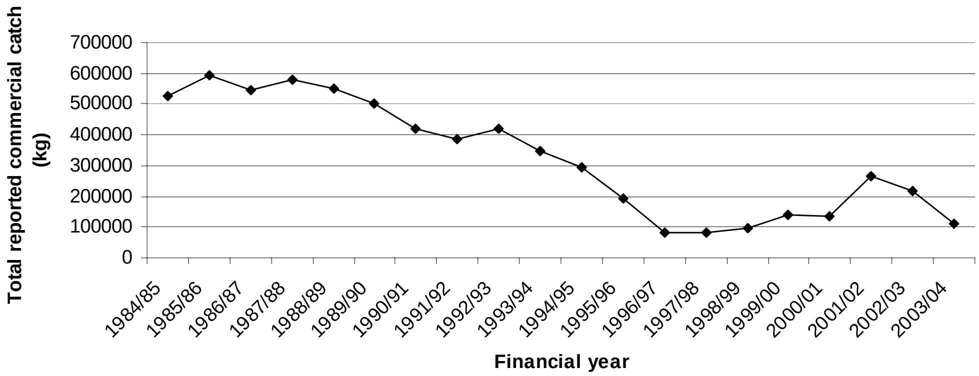


Figure 42 Total reported commercial catch for kingfish 1984/85 – 2003/04.

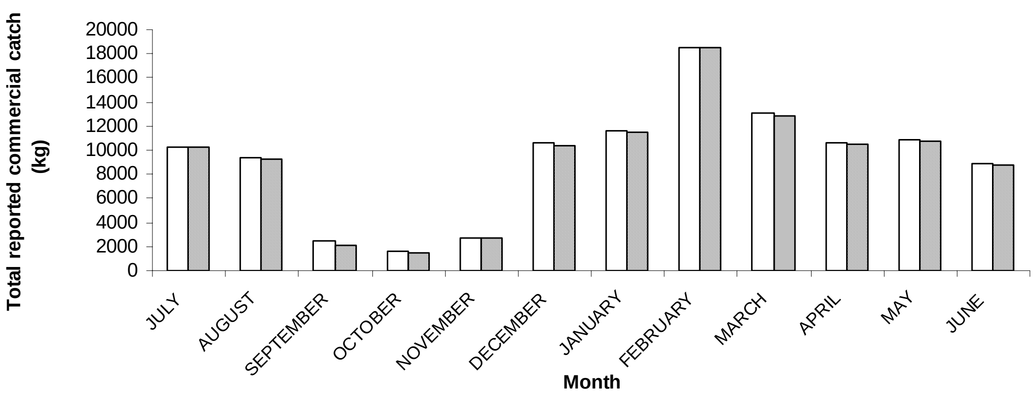


Figure 43 Reported commercial catch per month of kingfish in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

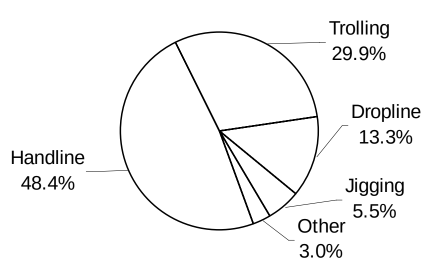


Figure 44 Percent contribution of each method type used in the OTLF to the harvest of kingfish.

Key Secondary species

Bass groper (*Polyprion americanus*)

Ball *et al.* 2000, Peres & Klippel 2003, Peres & Haimovici 2004.

Bass groper are distributed in the North and South Atlantic Ocean, the Mediterranean Sea, southern Indian Ocean and in the south-western Pacific. In Australia it is distributed around southern ocean waters. There is no available information on the biology of bass groper in Australia.

Information from studies based elsewhere show that the eggs, larvae and juveniles are pelagic and presumably drift with oceanic surface currents. Bass groper switch from a pelagic to demersal existence at about 50 cm (TL). Females mature first at 78 cm (TL), which is equivalent to 10 years, and all are mature by 90 cm TL or 15 years. Males mature first at 74.9 cm or 9 years of age, and all are mature by 80 cm TL or 10.9 years. Bass groper are a gonochoristic multiple spawner and the gonadal cycle is synchronized at the population level. Spawning occurs from late July to early October along the continental slope of the southwestern Atlantic region (<300 m). Ovarian fecundity varies from 3 to 11.9 million and increases exponentially with length.

Bass groper studied from the southwestern Atlantic showed that an opaque band is laid down in late winter to summer. Growth of this species in the southwestern Atlantic was different between sexes with females reaching a larger size than males at the corresponding age. In this same study, the maximum reported ages were 76 and 62 for males and females respectively.

The use of microsatellite genetic markers revealed three genetically distinct stocks of this species: the North Atlantic and Mediterranean group, Brazil group and the South Pacific (Australia and New Zealand) group.

All of the bass groper landed in NSW managed fisheries is from the Ocean Trap and Line Fishery (Fig. 45) and changes to the 1997/98 catch return forms enabled this species to be reported. Since this time, catches of bass groper fluctuated between 2-6 tonnes until 2000/01 with catches steadily increasing in more recent times to over 7 tonnes (Fig. 46, see “Hapuku” for mixed bass groper/hapuku catch data). The commercial harvest, by weight, of bass groper is relatively small and this species is often caught with blue-eye. In the 2003/04 season, the main months of harvest were May and June (Fig. 47) which also corresponds to main months of harvest for blue-eye. Over 96% of bass groper is caught by the method of droplining (Fig. 48).

Bass groper (*Polyprion americanus*)

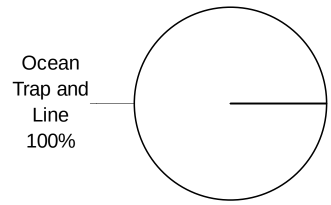


Figure 45 Percent contribution of each NSW commercial fishery to the harvest of bass groper.

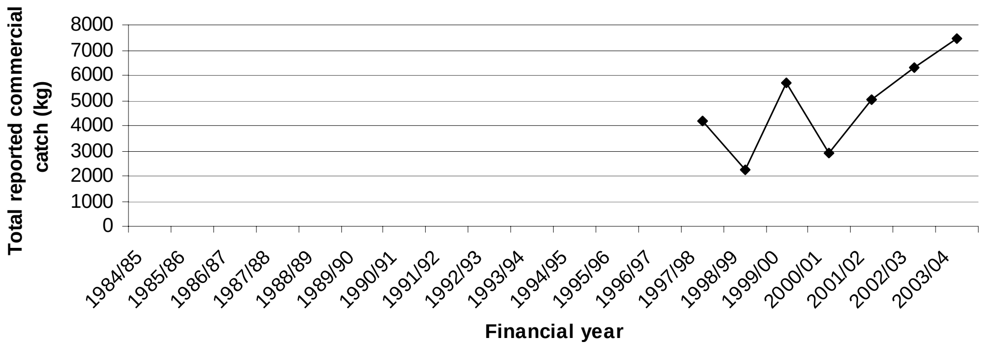


Figure 46 Total reported commercial catch for bass groper 1984/85 – 2003/04.

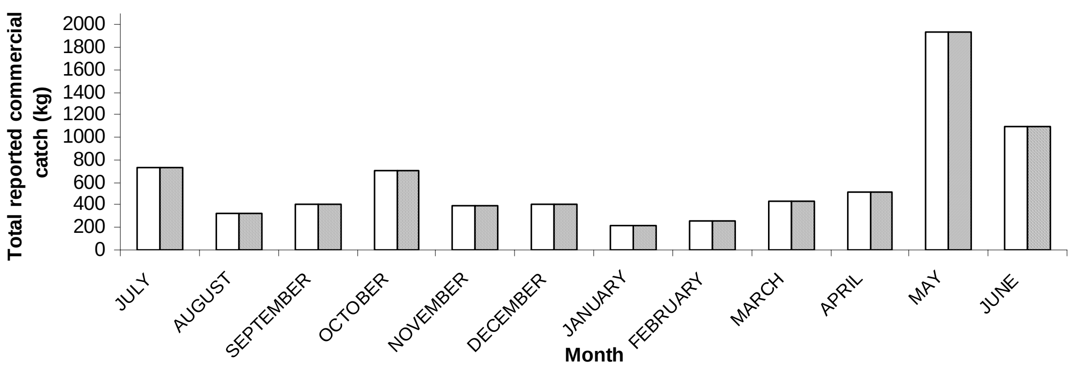


Figure 47 Reported commercial catch per month of bass groper in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

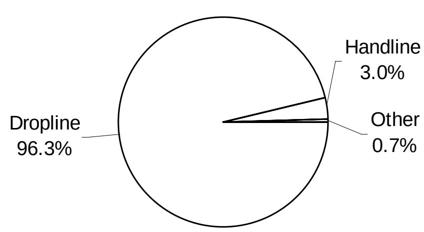


Figure 48 Percent contribution of each method type used in the OTLF to the harvest of bass groper.

Dolphinfish (*Coryphaena hippurus*)

Oxenford 1999, Hutchins & Swainston 2001, Dempster 2004.

Dolphinfish is a circum-tropical oceanic pelagic species found in the Atlantic, Indian and Pacific oceans. In Australian waters they can be found in Western Australia, Northern Territory, and from Queensland to Montague Island in NSW.

This species is limited in habitat by sea surface temperatures of 19-20°C and extensions of distribution occur with seasonal variations in water temperature. Dolphinfish are also known to associate strongly with floating objects and are highly sought after by recreational fishers around fish aggregation devices (FAD). In NSW, significantly more dolphinfish were observed around offshore FAD than inshore FAD in summer and autumn. These fish are considered to be highly migratory although detailed information on migration routes and stock structure are not available for the east coast of Australia.

Dolphinfish studies elsewhere suggest the species grows rapidly with fish reaching 1 kg after 6 months and 10 kg after 1 year, with an estimated maximum size of 200 cm (TL) and 25 kg. They also mature at about 6 months of age and females are believed to reach maturity at a smaller size than males. Dolphinfish are highly fecund, producing 58000 – 1.5 million eggs per female, with an exponential increase in egg number with an increase in fish size. They can also spawn frequently once mature. There is general agreement in the literature that this species is short lived (< 4 years old), with most dying before they reach 2 years of age.

A study on the diets of dolphinfish caught in NSW waters showed that they predominantly feed on larval or small juvenile fish and invertebrates. Many of these prey species are associated with drifting clumps of algae off Sydney and Port Stephens. Dolphinfish also serve as the prey items of large tuna, sharks, marlin, sailfish and swordfish.

All of the dolphinfish harvested by commercial fishers in NSW is taken in the Ocean Trap and Line Fishery (Fig. 49) however the recreational catch of this species is greater than the commercial catch. Since 1990/91 the commercial catch of dolphinfish has fluctuated between 1.2 tonnes and over 25 tonnes, with the 2003/04 catch estimated at around 3.7 tonnes (Fig. 50). November to April are the months of primary commercial harvest of dolphinfish (Fig. 51) with the highest abundance of this species found during this period around offshore FAD which are targeted by recreational anglers. This summer/autumn peak period is most likely due to their strong association with water temperature as indicated above. In the 2003/04 period, the method of handline was the main means by which dolphinfish were caught (> 84%) in the Ocean Trap and Line Fishery (Fig. 52).

Dolphinfish (*Coryphaena hippurus*)

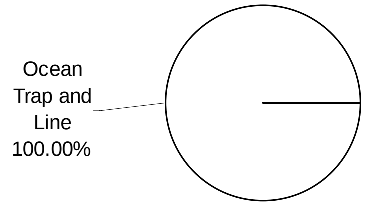


Figure 49 Percent contribution of each NSW commercial fishery to the harvest of dolphinfish.

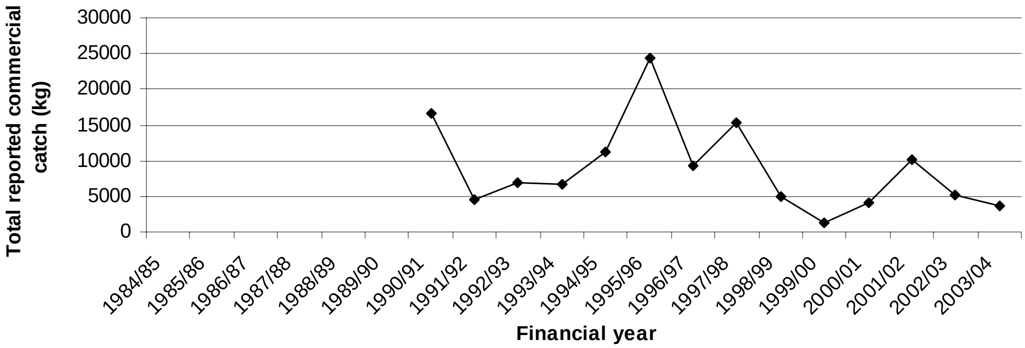


Figure 50 Total reported commercial catch for dolphinfish 1984/85 – 2003/04.

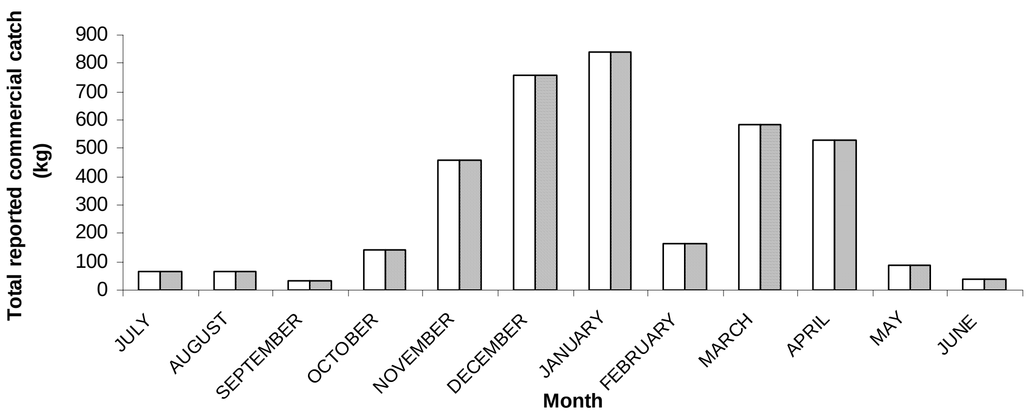


Figure 51 Reported commercial catch per month of dolphinfish in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

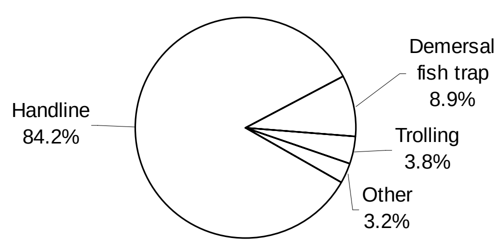


Figure 52 Percent contribution of each method type used in the OTLF to the harvest of dolphinfish.

Gemfish (*Rexea solandri*)

Rowling 1999, Rowling 2001, Caton & McLoughlin 2004.

There are two recognised stocks of gemfish, as indicated by genetic research, in Australian waters. The eastern stock is distributed from Cape Moreton in southern Queensland to the west coast of Tasmania. The western stock extends from western Bass Strait to Geraldton in Western Australia.

Females mature between 4 and 6 years of age while males mature between the ages of 3 to 5. Females can live up to around 17 years and attain a maximum length of around 116 cm. Males are less long lived with a maximum age of about 13 years and maximum length of around 106 cm.

Mature fish in the eastern stock migrate up the east coast to spawn off central and northern NSW during a short period in early to mid-August. The biology of the western stock of gemfish is thought to be similar to that of the eastern stock except that they are thought to spawn in summer instead of winter.

The fishery for eastern gemfish used to target the well-defined winter migration of mature fish at depths of 350 - 450 m between latitudes 40°S and 33°S on the continental slope off southeastern Australia. The major harvest of gemfish occurs in the Commonwealth, mainly by the method of demersal trawl. The Ocean Trap and line fishery accounted for over 86% of the gemfish caught and reported on NSW catch reporting forms (Fig. 53). The commercial harvest of this species has been in severe decline since the mid-1980s (Fig. 54) and it is recognised that eastern gemfish have been overfished for around 20 years. Note that large catches of gemfish in Fig. 54 from the 1980s were made by trawlers now operating under Commonwealth jurisdiction. The Commonwealth manages this stock by a catch allocation for bycatch. Thus, there is theoretically no targeted eastern gemfish fishery. In NSW, fishers must adhere to a 50 kg/day trip limit for all fishing methods. The majority of gemfish recorded on NSW returns indicates that late autumn-winter is the peak time of capture (Fig. 55) with droplining, as part of the Ocean Trap and Line Fishery, accounting for 98% of the catch (Fig. 56).

Gemfish (*Rexea solandri*)

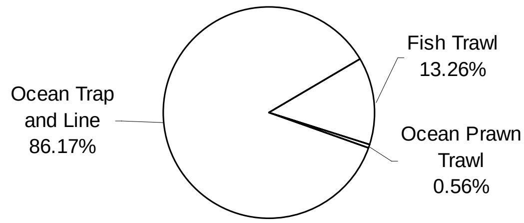


Figure 53 Percent contribution of each NSW commercial fishery to the harvest of gemfish.

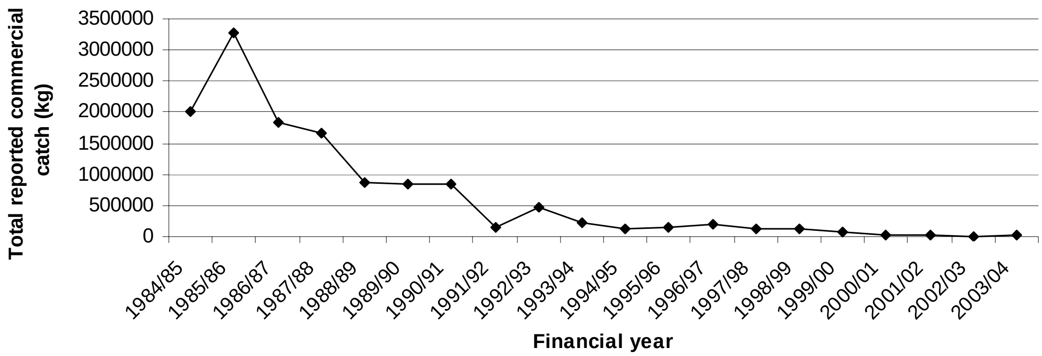


Figure 54 Total reported commercial catch for gemfish 1984/85 – 2003/04.

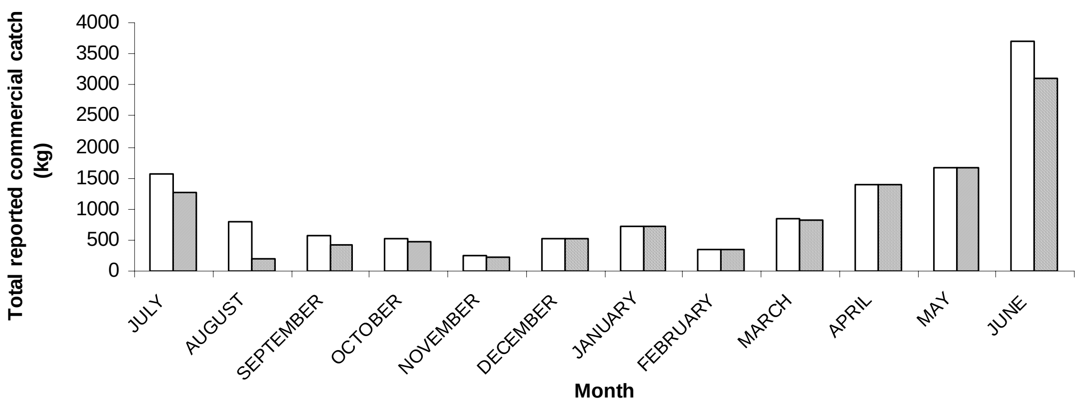


Figure 55 Reported commercial catch per month of gemfish in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

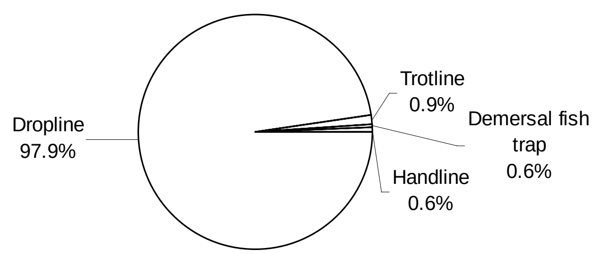


Figure 56 Percent contribution of each method type used in the OTLF to the harvest of gemfish.

Hapuku (***Polyprion oxygeneios***)

Francis *et al.* 1999, Hutchins & Swainston 2001.

Hapuku inhabit the temperate and subtropical waters of the southern Indian and Pacific oceans. Very little information is known for this species in Australia however they are known to inhabit deep offshore waters of Australia's southern half.

Small juvenile hapuku exhibit a pelagic stage where they are associated with flotsam in surface waters and are rarely captured. After this pelagic stage, they become demersal at about 50 cm (TL) in depths of 50-600 m, although fish as small as 40 cm have been caught in bottom trawls. Best age estimates show that this transition occurs at about 3-4 years of age.

A New Zealand study estimated that the oldest fish in their samples was 63 years with few fish being greater than 20 years old. A previous study indicated that 50% of female and male hapuku matured at 88 cm and 85 cm respectively and this corresponds to 10 and 13 years for each sex.

Almost all of the hapuku harvested in NSW managed fisheries is in the Ocean Trap and Line Fishery (Fig. 57). Due to historical reporting circumstances, hapuku and bass groper were reported together from 1984/85 to 1996/97. Also, pre-1997/98 catch data may be confounded because fishers in the South East Trawl Fishery were able to report catch on their State rather than Commonwealth return form. After this period, each species was reported separately, and from 1997/98 to 2003/04 catches of hapuku have remained fairly stable at around 10 tonnes (Fig. 58). The highest reported catch of this species in 2003/04 was in May (Fig. 59) and hapuku, along with bass groper, are often caught with blue-eye. The period of October-December also shows increased catches of this species. As with bass groper and blue-eye, hapuku is mainly caught by droplining (Fig. 60).

Hapuku (*Polyprion oxygeneios*)

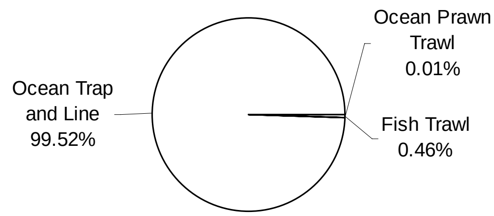


Figure 57 Percent contribution of each NSW commercial fishery to the harvest of hapuku.

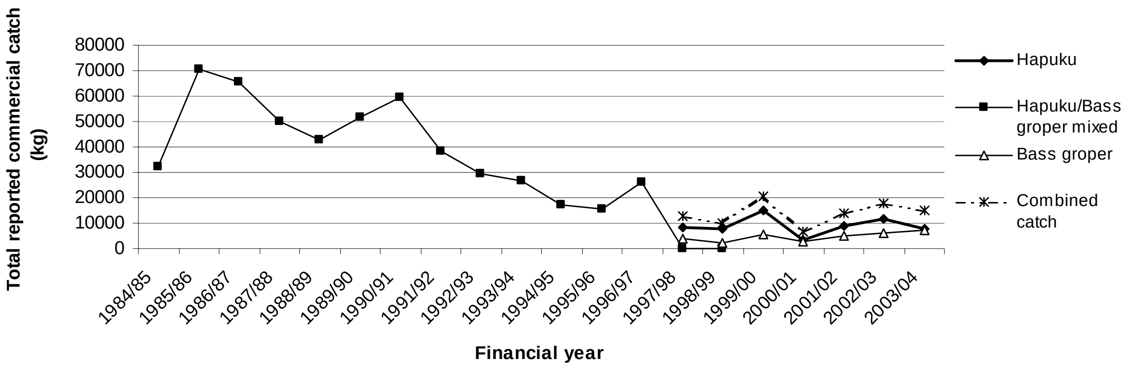


Figure 58 Total reported commercial catch for hapuku 1984/85 – 2003/04.

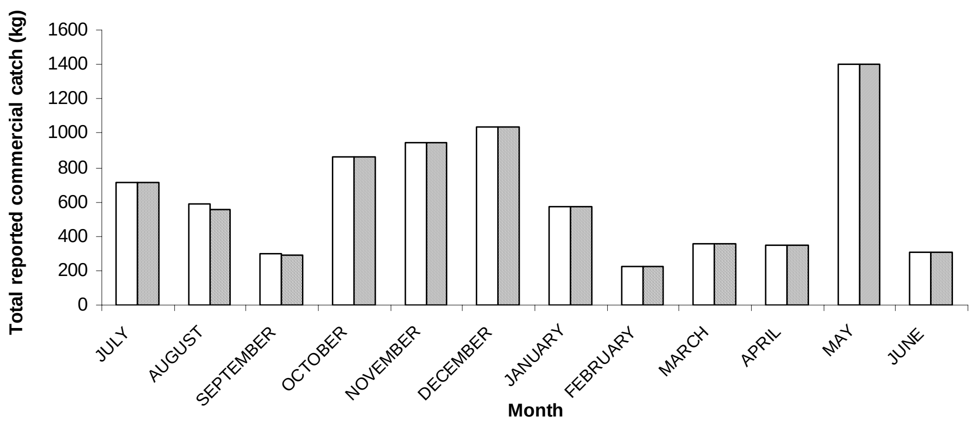


Figure 59 Reported commercial catch per month of hapuku in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

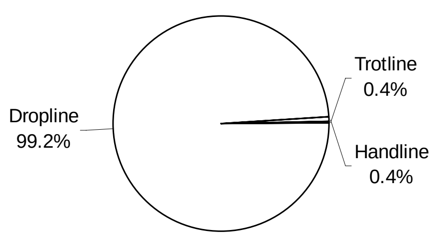


Figure 60 Percent contribution of each method type used in the OTLF to the harvest of hapuku.

Jackass morwong (*Nemadactylus macropterus*)

Kailola *et al.* 1993, Jordan 2001, Smith and Wayte 2002, Burridge & Smolenski 2003.

The worldwide distribution of jackass morwong includes waters of New Zealand, southern South America, southern Africa and some islands in the Atlantic and Indian oceans. Jackass morwong are distributed in Australian waters from Moreton Bay in Queensland to Perth in Western Australia. They occur in depths to 450 m and, in Australian waters, are most abundant between 100 and 200 m.

Jackass morwong have a summer-autumn spawning period with larger, older females being more fecund. Juveniles have an extended pelagic postlarval stage and larvae can be distributed up to 250 km offshore. They are demersal fish with juveniles inhabiting the shallow reefs of Bass Strait and Tasmania.

Sampling of jackass morwong along the southern and eastern shelf region of Tasmania showed that the size distribution for males was 13 - 43 cm (FL) and 13 – 46 cm (FL) for females, with no significant difference in growth between males and females. Growth of juveniles is rapid with fish attaining a size of about 26 cm at 3 years of age, when fish are thought to reach sexual maturity, after which time growth slows. A maximum age of 30 years for females and 41 years for males was recorded in this Tasmanian study, however only few fish were older than 25 years.

Allozyme, mitochondrial DNA (mtDNA) and microsatellite studies found that there is no population structuring for Australian jackass morwong. However, allozyme and mtDNA studies did find significant genetic differences between Australian and New Zealand samples although microsatellite analysis did not. Further work is needed in this regard to resolve this issue.

About 90% of the commercial harvest of jackass morwong in 2003/04 was taken by the Ocean Trap and Line Fishery (Fig. 61). In NSW, steep declines in the total commercial catch of this species has occurred in the last 25 years with 1046 tonnes reported in 1984/85 compared to only 80 tonnes in 1995/96, however data prior to 1991/92 probably includes catches from the Commonwealth South East Trawl Fishery (Fig. 62). There has been a further decline in commercial catches in more recent times with only 13 tonnes reported for the 2003/04 financial year, of which 12 tonnes was caught in the Ocean Trap and Line Fishery. The southern port of Eden remains the main landing port for this species with 8 tonnes of the Ocean Trap and Line catch landed there in 2003/04. The peak catches of jackass morwong are taken in winter (Fig. 63) with the majority of fish in the Ocean Trap and line Fishery caught by demersal fish traps (Fig. 64).

Jackass morwong (*Nemadactylus macropterus*)

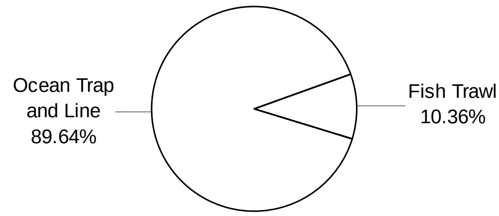


Figure 61 Percent contribution of each NSW commercial fishery to the harvest of jackass morwong.

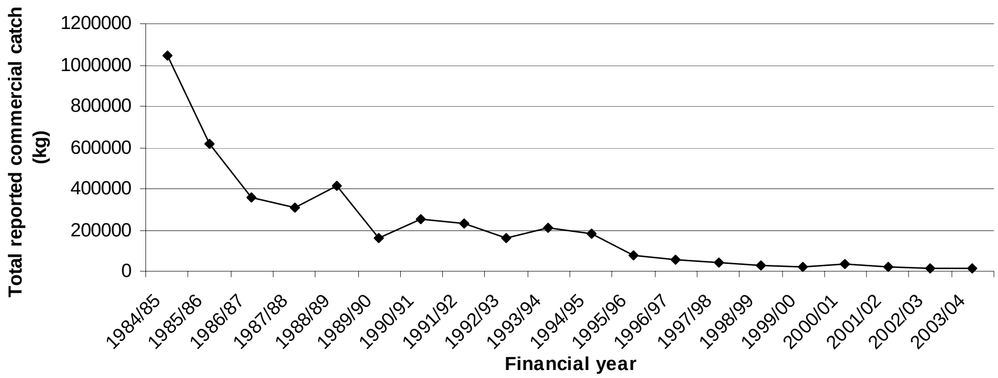


Figure 62 Total reported commercial catch for jackass morwong 1984/85 – 2003/04.

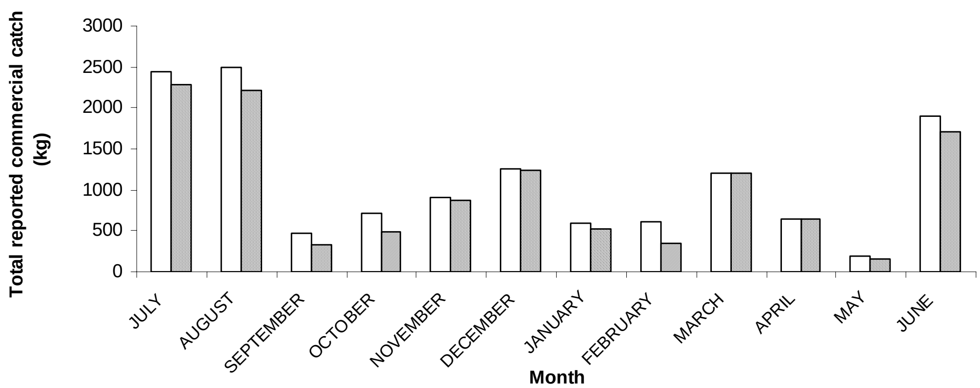


Figure 63 Reported commercial catch per month of jackass morwong in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

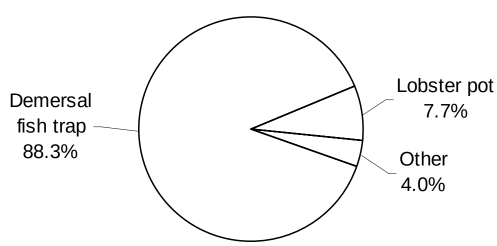


Figure 64 Percent contribution of each method type used in the OTLF to the harvest of jackass morwong.

Mulloway (*Argyrosomus japonicus*)

Marais 1984, Hall 1986, Lenanton & Potter 1987, Black & Dixon 1992, Gray & McDonall 1993, Kailola *et al.* 1993, Griffiths & Heemstra 1995, Griffiths & Hecht 1995a, Griffiths 1996, Griffiths 1997a, b, Fielder *et al.* 1999, Silberschneider & Gray 2005.

Mulloway is a nearshore coastal (< 100 m depth) species that also occurs in estuaries and is found in Pacific and Indian Ocean waters surrounding Australia, Africa, India, Pakistan, China, Korea and Japan. In Australia, it is distributed along the eastern, southern and western seaboards from the Burnett River in Queensland (Qld) to North West Cape in Western Australia (WA).

There is limited information available on the stock structure of mulloway. Genetic-based studies have been done only in Australia and the conclusions from these studies are limited as they were based on samples comprising very few individual fish from only a few locations. Some electrophoresis-based evidence showed that a separate sub-population of mulloway occurs in WA compared to the southern (South Australia and Victoria) and eastern (NSW and Qld) seaboards, and that there may be additional population sub-structuring between fish in South Australia and NSW. However, preliminary data based on mitochondrial DNA (mtDNA) analysis did not appear to support this. No other genetic studies have been reported for the species and therefore the degree of genetic division among populations along different seaboards and oceans is not known.

Small (<30 cm TL) juveniles are found in estuaries and nearshore coastal environments. Sub-adult and adult mulloway occur in estuarine and ocean waters. In estuaries, larger juveniles and sub-adult fish (>40 cm TL) appear to be more abundant in the lower reaches where salinities are nearer to seawater. Large individuals are caught around the mouths of estuaries, in surf zones and around rocky reefs and ridges in offshore waters.

Crustaceans accounted for between 14% and 81% of the reported diet of juveniles. The importance of crustaceans in the diet of mulloway appears to decrease with increasing fish size, with fish and squid being the prey of greater relative importance in larger mulloway.

Mulloway grow to a large size and are relatively long lived. In South African waters the maximum length was recorded at 181 cm TL, weight of 75 kg and age of 42 years. In South Africa, 50% of male and female mulloway mature at 92 and 107 cm TL respectively, which corresponds to 5 years of age for males and 6 years for females. In NSW, 50% size at maturity for males was estimated at 51 cm (2+ years of age) and for females at 68 cm (3+ years of age). Mulloway are known to spawn in summer in Australian waters.

In 2003/04, most of the NSW commercial harvest of mulloway was taken in the Estuary General Fishery (67%). However, mulloway is an important species in the Ocean Trap and Line Fishery and a large portion of the total mulloway catch was also taken in this fishery (25%, Fig. 65). There has been a decline in the commercial catch of mulloway since the mid-1980s (Fig. 66). The current size limit of 45 cm was imposed in the early 1990s and CPUE for this species has remained fairly stable during this period. The commercial catch of mulloway is greatest during winter by estuary fishers (Fig. 67) and is characteristically greatest in summer/autumn by ocean fishers, although larger catches were also recorded for these fishers in late winter during 2003/04. Within the Ocean Trap and Line Fishery, mulloway is predominantly caught by handlining (Fig. 68).

Mulloway (*Argyrosomus japonicus*)

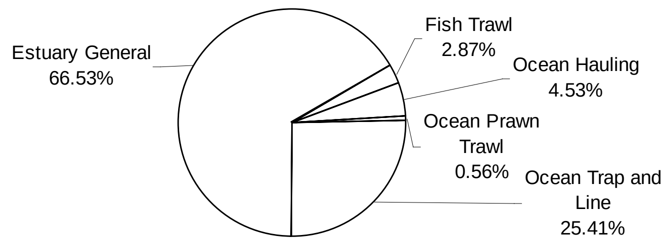


Figure 65 Percent contribution of each NSW commercial fishery to the harvest of mulloway.

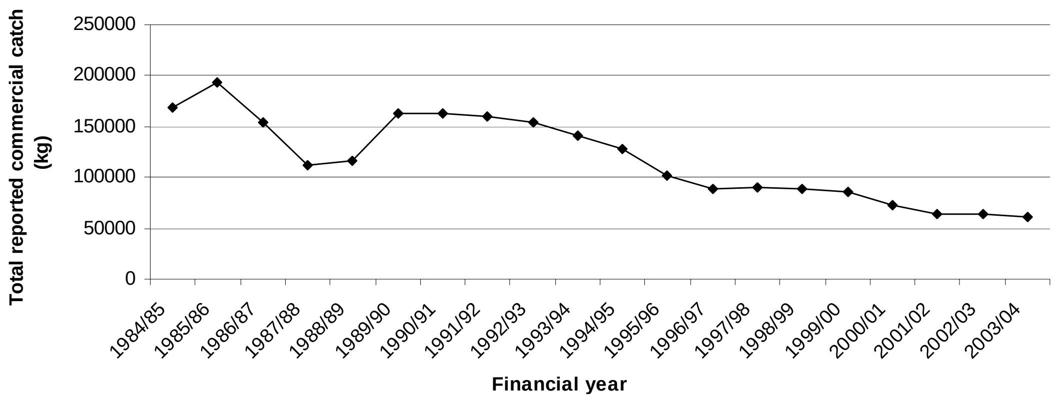


Figure 66 Total reported commercial catch for mulloway 1984/85 – 2003/04.

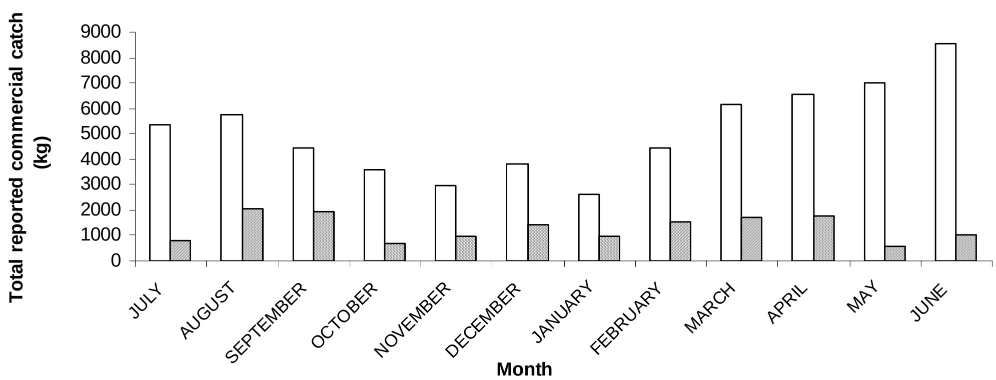


Figure 67 Reported commercial catch per month of mulloway in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

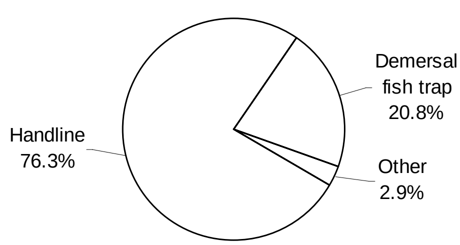


Figure 68 Percent contribution of each method type used in the OTLF to the harvest of mulloway.

Pearl perch (*Glaucosoma scapulare*)

McKay 1997.

Pearl perch have a restricted distribution from Rockhampton in Queensland to Port Jackson in NSW only. They occur in coastal waters in moderate depths to 90 m on the continental shelf particularly close to submerged reefs, rock ledges or rough bottom. Pearl perch are reported to move into coastal waters during the day, usually adjacent to rock faces, gutters and terraces of bomboras and islands. They seem to prefer places of high water movement in shallow water, yet seek the protection of isolated reefs in gutters and channels in deeper waters. Pearl perch tend to stay in one area for up to six months, and although individuals are observed, most are seen in small groups or schools. This species is stated to be a midwater feeder moving well up from the bottom to take bait during the night, however most pearl perch are harvested on the bottom during the day.

Pearl perch have a maximum total length about 70 cm but sizes of up to 30-50 cm are more common. The largest reported weight for this species is 7.3 kg taken from the 35 fathom reefs east of Moreton Bay in July 1991. No other published biological information is available for this species.

Within the NSW managed commercial fisheries, Ocean Trap and Line landed over 97% of the estimated reported harvest in 2003/04 (Fig. 69). Species specific reporting of this pearl perch began in 1990/91 and since that time, estimated reported landings have fluctuated between 6 tonnes (1990/91) and over 17 tonnes (1995/96, Fig. 70). The last 7-8 years have seen the commercial catch of pearl perch remain fairly stable. In 2003/04, June was the month recording the highest catch of this species, however catches in winter and summer are similar (Fig. 71). Within the Ocean Trap and Line Fishery, demersal fish traps and handlining are the main methods by which this species is taken (Fig. 72).

Pearl perch (*Glaucosoma scapulare*)

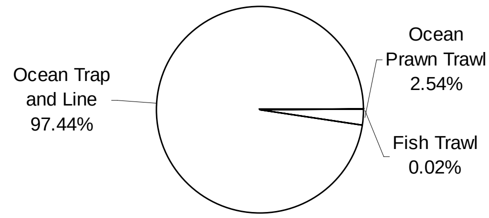


Figure 69 Percent contribution of each NSW commercial fishery to the harvest of pearl perch.

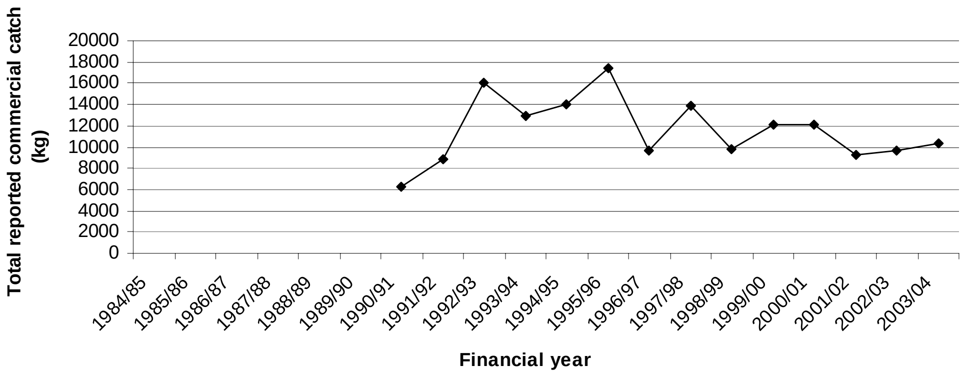


Figure 70 Total reported commercial catch for pearl perch 1984/85 – 2003/04.

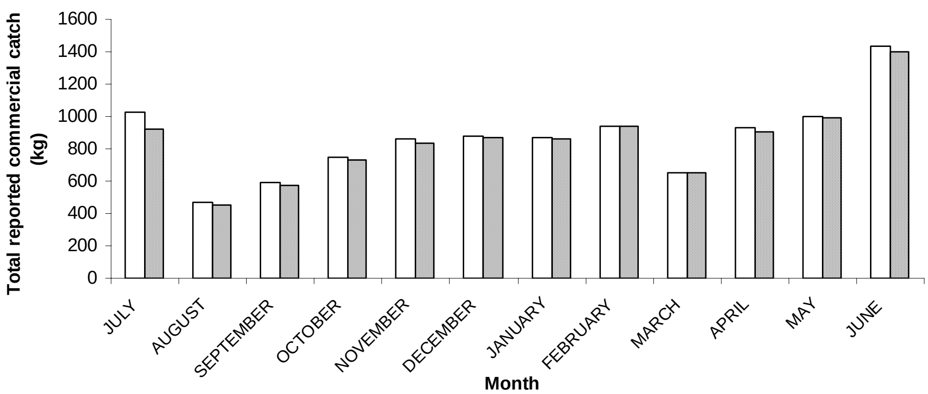


Figure 71 Reported commercial catch per month of pearl perch in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

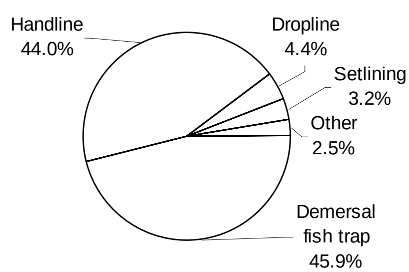


Figure 72 Percent contribution of each method type used in the OTLF to the harvest of pearl perch.

Eastern Blackspot Pigfish (*Bodianus unimaculatus*)

Kuiter 1993, Anderson & Millar 2004, Denny & Babcock 2004.

Pigfish are distributed in the south-west Pacific from southern Queensland to Victoria, including Lord Howe and Norfolk islands, and the Kermadec Islands. It was previously confused with the Western Australia species, *Bodianus vulpinus*. There is no available information on the biology of pigfish in Australia or elsewhere, however fish of the genus Bodianus are protogynous hermaphrodites i.e. juveniles first developing female reproductive organs that may possibly change into male reproductive organs in select circumstances.

Information on habitat types in which they reside is scarce. Pigfish have been shown to be associated with kelp forests in New Zealand. They have also been found to be significantly more abundant in NZ marine parks than in adjacent areas however this could be due to the quality of habitat within the reserve rather than a reserve effect. In Australia, pigfish have been caught in depths of > 50 m.

Over 99% of pigfish caught in NSW is from the Ocean Trap and Line Fishery (Fig. 73). Reporting of this species on catch returns began in 1990/91 and the NSW estimated commercial harvest is small (< 10 tonnes, Fig. 74). The late 1990s saw a downturn in the commercial harvest of pigfish. Catches of pigfish in 2003/04 were highest in winter, and catches ranged from 165 kg to 400 kg per month (Fig. 75). The main method by which this species is taken in the Ocean Trap and Line Fishery is by demersal fish traps (Fig. 76).

Eastern Blackspot Pigfish (*Bodianus unimaculatus*)

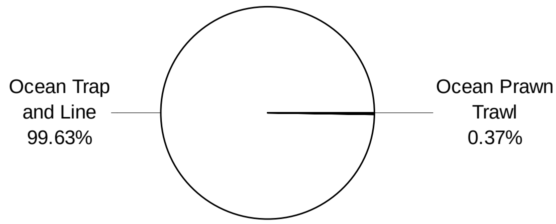


Figure 73 Percent contribution of each NSW commercial fishery to the harvest of pigfish.

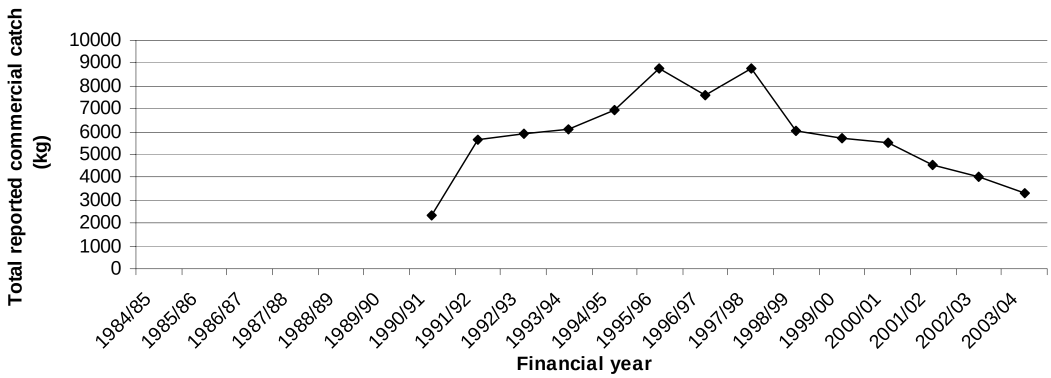


Figure 74 Total reported commercial catch for pigfish 1984/85 – 2003/04.

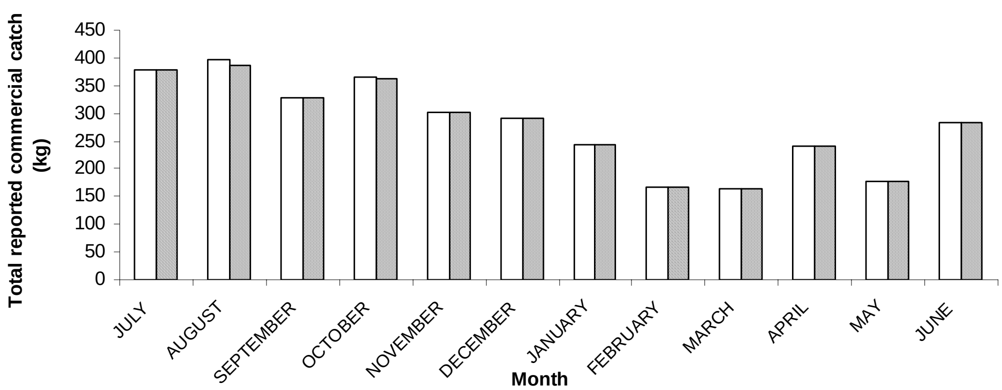


Figure 75 Reported commercial catch per month of pigfish in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

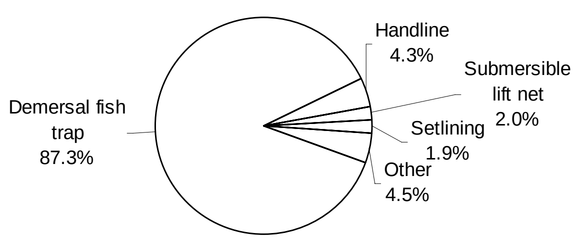


Figure 76 Percent contribution of each method type used in the OTLF to the harvest of pigfish.

Sharks (mixed species)

Ocean Trap and Line fishers catch a variety of shark species. Due to the difficulties in identification, the species of most sharks caught are "unspecified" when reported. When species is reported, the catch can consist of black-tip shark, Endeavour dogfish, greeneye dogfish, dogfish unspecified, fiddler shark, ghost shark, hammerhead shark, mako, Port Jackson shark, saw shark, school shark and tiger shark. Catches of all these species, as well as the "unspecified" categories have been amalgamated to produce the "Sharks (mixed species)" category that is reported on here.

Due to the variety of sharks captured, and the uncertainty surrounding which species are more common in the retained catch, the reporting of the distribution of each species is difficult. However, most of the dogfish species are distributed in the continental slope waters of NSW and adjoining Australian states. The black-tip, tiger, hammerhead, and mako sharks, as well as the greeneye and Endeavour dogfish have widespread distributions while ghost sharks are broadly distributed in Australian continental shelf and upper slope waters. The saw shark, *Pristiophorus* species A, is the only one of four *Pristiophorus* to occur off NSW and it appears to be endemic to continental shelf and upper slope waters off NSW, from Coffs Harbour to Lakes Entrance in Victoria.

In 2003/04, sharks (mixed) were mainly taken by the Fish Trawl Fishery (55%) with the Ocean Trap and Line Fishery accounting for around 23% of the harvest of this group of species (Fig. 77). Since 1984/85, retained catches of sharks have decreased from 1100 tonnes to around 300 tonnes however data presented here regarding the harvest of sharks prior to 1997/98 probably includes catches from the South East Fishery (Fig. 78). Since 1997/98, catches have remained stable. Sharks in this category are mainly caught from winter through summer (Fig. 79) however catches in the Ocean Trap and Line Fishery remain fairly consistent throughout the year, ranging from 3 t – 8 t per month. Line methods account for almost all the sharks (mixed) that are retained in this fishery (Fig. 80).

Sharks (mixed species)

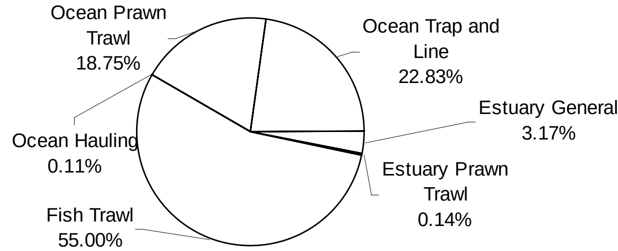


Figure 77 Percent contribution of each NSW commercial fishery to the harvest of sharks.

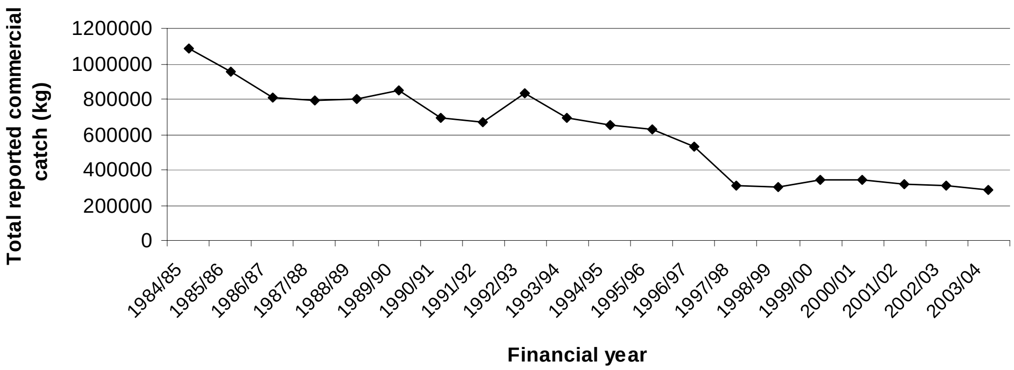


Figure 78 Total reported commercial catch for sharks 1984/85 – 2003/04.

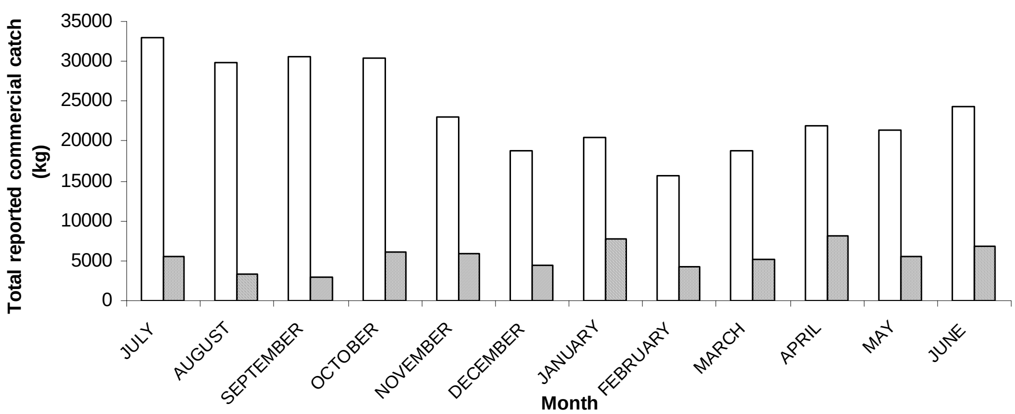


Figure 79 Reported commercial catch per month of sharks in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

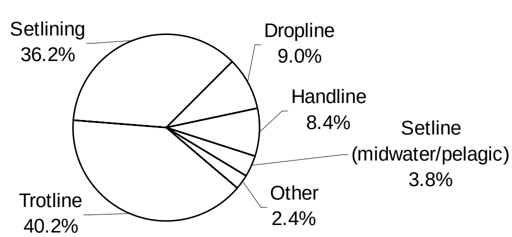


Figure 80 Percent contribution of each method type used in the OTLF to the harvest of sharks.

Spanish mackerel (*Scomberomorus commerson*)

McPherson 1992, Kailola *et al.* 1993, Lester *et al.* 2001, Moore *et al.* 2003, Grandcourt *et al.* 2005, Mackie *et al.* 2005.

Spanish mackerel are distributed in the waters of the Indo-Pacific from the Red Sea and South Africa to southeast Asia, north to China and Japan, and south to Australia. They are also found in the eastern Mediterranean Sea. In Australian waters, they are distributed from Geographe Bay in Western Australia (WA) northwards to St Helens in Tasmania. Within this geographical distribution, Spanish mackerel can be found from the edge of the continental shelf to shallow coastal waters. Adults are associated with coral reefs, rocky shoals and current lines on outer reef areas and offshore, while juveniles form schools. Small juveniles up to 10 cm (FL) live in creeks, estuaries and sheltered mud flats during the early wet season of north Queensland.

Spanish mackerel sampled in WA showed that 50% of females reached sexual maturity at about 79 cm, while 50% of males reached sexual maturity at 63 cm. Females can be categorised as serial or partial spawners with fish caught in WA showing a peak in reproductive activity from August to January depending on the region, and in the spring/summer months in Queensland. In WA, females may spawn every 3 days and females caught in Qld may spawn every 2-6 days. They are highly fecund with 1.2 million eggs not uncommon. In Queensland waters, Spanish mackerel can reach 240 cm (FL) and a maximum weight of 70 kg with females growing to a larger size than males. Initial growth is rapid with fish reaching 100 cm in the first few years of life. The oldest males and females studied in the eastern Queensland commercial fishery were 10 (127 cm FL, 19 kg) and 14 years (155 cm FL, 35 kg) respectively, with few older fish sampled during a separate study.

Migrations of Spanish mackerel extend along the entire east coast of Queensland although permanently resident populations also seem to exist. Resident fish disperse from reefs after spawning whilst migrating fish move up to 1000 nautical miles to the south. The use of parasites to distinguish between stocks showed that there may be six separate stocks of Spanish mackerel across northern Australia, however, the use of isozyme, allozyme and mitochondrial DNA genetic analysis failed to find any such differences. The diet of Spanish mackerel consists of small fish like anchovies, clupeids and carangids, as well as squid and shrimp.

All Spanish mackerel caught by NSW managed fisheries were landed by the Ocean Trap and Line Fishery (Fig. 81). In 1988/89 the estimated harvest of NSW caught Spanish mackerel peaked at 51 tonnes and large fluctuations in the estimated catch continued to occur until the mid 1990s (Fig. 82). In recent years, there has been a decline in the harvest of this species with 2003/04 recording a total NSW catch of around 4.5 tonnes. Spanish mackerel catches in NSW are highly seasonal with the main period of capture being in March and April (Fig. 83) which also corresponds to peak catches of Spotted mackerel. Spanish mackerel are caught by line methods with handlining contributing 50% of the catch (Fig. 84).

Spanish mackerel (*Scomberomorus commerson*)

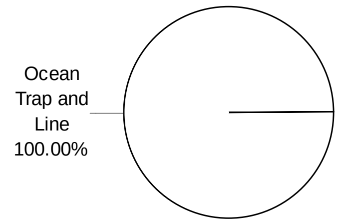


Figure 81 Percent contribution of each NSW commercial fishery to the harvest of Spanish mackerel.

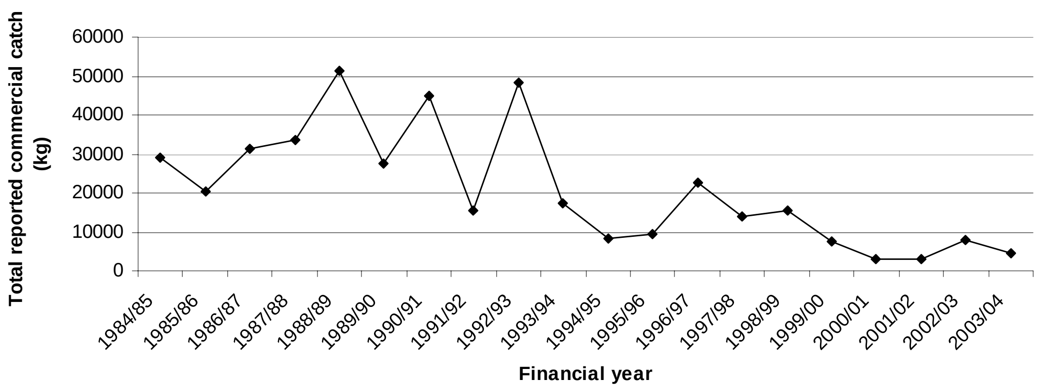


Figure 82 Total reported commercial catch for Spanish mackerel 1984/85 – 2003/04.

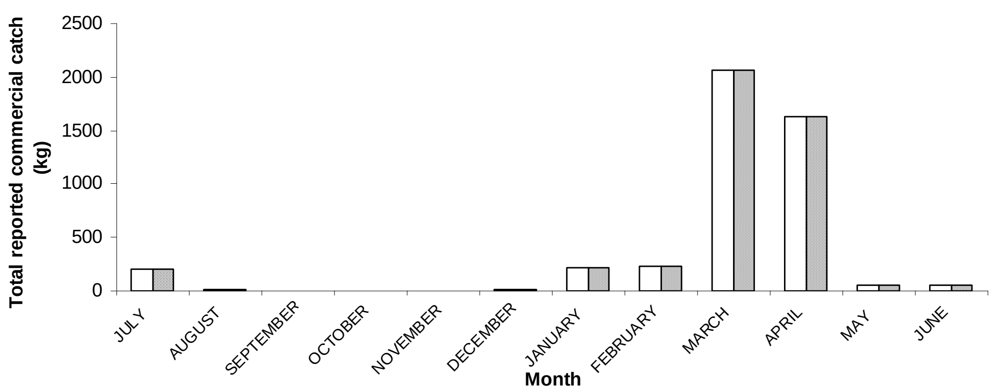


Figure 83 Reported commercial catch per month of Spanish mackerel in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

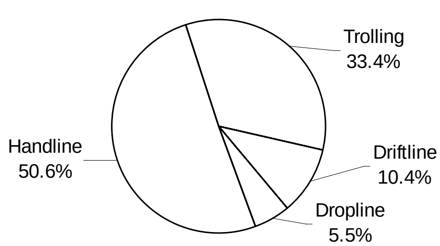


Figure 84 Percent contribution of each method type used in the OTLF to the harvest of Spanish mackerel.

Spotted mackerel (*Scomberomorus munroi*)

Kailola *et al.* 1993, Begg *et al.* 1997, Begg & Hopper 1997, Begg 1998, Begg & Sellin 1998.

Spotted mackerel is endemic to the Australasian region and, in Australian waters, is distributed from Wollongong in NSW to Rottnest Island in Western Australia.

A tagging study on spotted mackerel released in NSW and Queensland showed that approximately 39% of fish moved over 100 km with the greatest movement being 1100 km (fish at liberty for 228 days). Of those fish that moved over 100 km, more were recaptured in northern Queensland during winter and early spring while more were recaptured in southern Queensland in summer. Due to the seasonality and direction of movements, it is suggested that the east coast spotted mackerel comprise of a single stock undertaking seasonal migrations.

Female spotted mackerel sampled in northern Queensland were in spawning condition from August to October while males were in advanced stages of maturity for most of the year. Spawning occurs in offshore waters in an area believed to be between Mackay and waters south of Townsville. The size at which 50% of spotted mackerel reach sexual maturity is 45-50 cm (FL) for females and 40-45 cm (FL) for males. The smallest mature female sampled was 46.5 cm (FL) while the smallest mature male was 36 cm (FL). After spawning, pelagic eggs and larvae may then be dispersed southward by the East Australian Current (EAC).

Samples of spotted mackerel taken from Queensland waters show that males were aged up to 7 years and females were aged up to 5 years. However, the maximum sizes of fish measured from that study were 75.1 cm (FL) for males and 86 cm (FL) for females, and the results indicated that females were significantly larger than males for any given age. Spotted mackerel grow quickly for the first three years of life, after which growth slows.

Spotted mackerel feed almost exclusively on pelagic species such as anchovies, pilchards and herring. Samples taken from fish in Queensland waters suggest that feeding followed a seasonal cycle that was coupled with maturity. Spotted mackerel are in northern Queensland waters from late winter to early spring for spawning and this coincided with reduced feeding activity. Prior to this, feeding levels increased in July to prepare for spawning. Spotted mackerel then migrate to southern Queensland after spawning (late spring) and this migration is associated with feeding.

Greater than 99% of spotted mackerel harvested commercially in NSW in the 2003/04 period was taken in the Ocean Trap and line Fishery (Fig. 85). There have been large fluctuations in the reported commercial catch of this species since 1990/91 with a peak in catch of around 53 tonnes estimated for 1997/98 and only 2.5 tonnes in 1991/92 (Fig. 86). More recent catches have ranged from around 10 tonnes to 25 tonnes. In the 2003/04 period, the greatest harvest of spotted mackerel was taken in April and to a lesser extent in March (Fig. 87). This also corresponds to the timing of peak catches of Spanish mackerel. Within the Ocean Trap and Line Fishery, the method of handline dominates the way in which this species is caught, with other line methods contributing to the remainder of the catch (Fig. 88).

Spotted mackerel (*Scomberomorus munroi*)

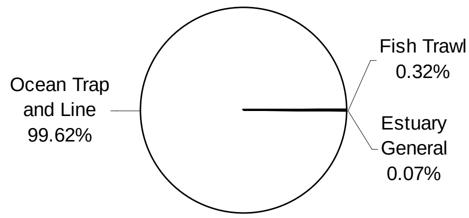


Figure 85 Percent contribution of each NSW commercial fishery to the harvest of spotted mackerel.

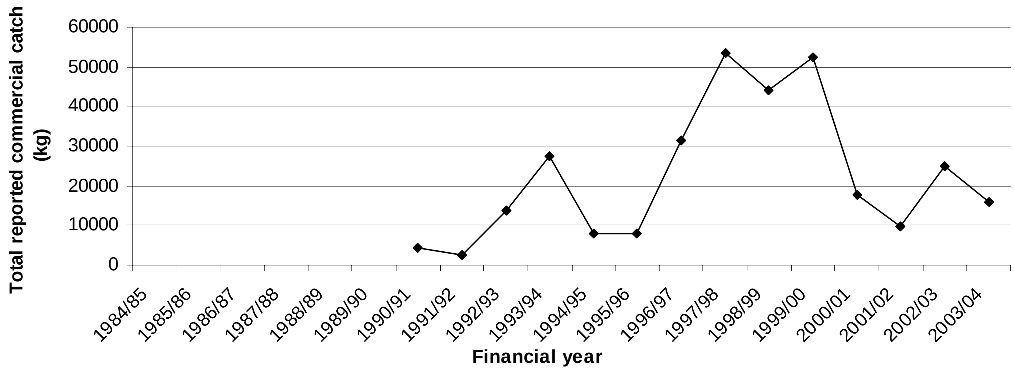


Figure 86 Total reported commercial catch for spotted mackerel 1984/85 – 2003/04.

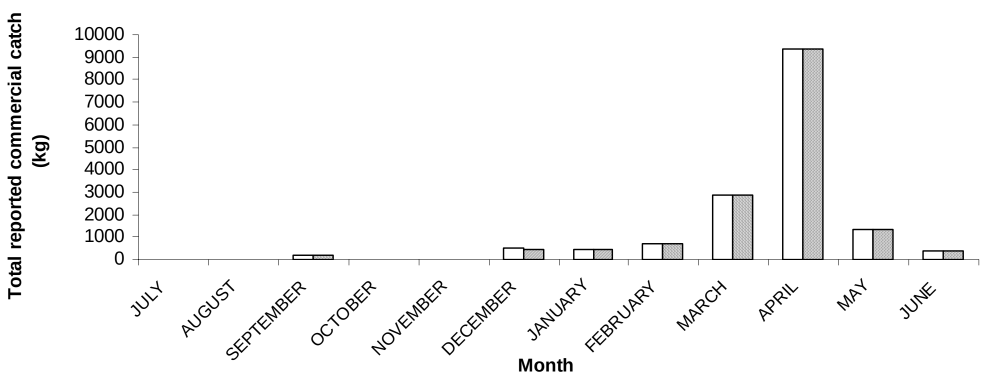


Figure 87 Reported commercial catch per month of spotted mackerel in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

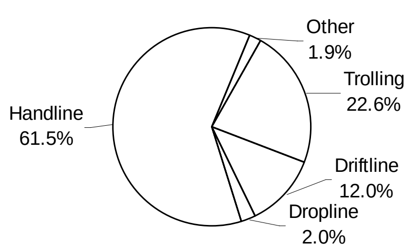


Figure 88 Percent contribution of each method type used in the OTLF to the harvest of spotted mackerel.

Sweep (*Scorpis lineolatus*)

Kailola *et al.* 1993, Stewart & Hughes 2005

Silver sweep is a member of rocky reef fish communities along the coasts of southeastern Australia (from southern Queensland to South Australia, including Tasmania and Lord Howe Island) and the North Island of New Zealand. They are a schooling planktivorous fish that are often observed in mid-water schools feeding above rocky reefs.

The biology, ecology and fisheries of sweep are still poorly understood with recent work done on this species in NSW accounting for much of the information currently known. Sweep grow to a maximum size of approximately 37 cm total length (TL), occur to a depth of about 30 m but are commonly encountered in much shallower waters. The larvae have been reported in waters off central NSW between May and December with peak abundances occurring in August and September. Newly settled juveniles have been found in estuaries, rockpools and nearshore waters during winter months, with eggs being pelagic but undescribed.

Sweep grow quickly during their early years and the age at which 50% of sweep reach sexual maturity is between 2-3 years old which is equivalent to approximately 17 cm fork length (FL). Off the NSW coast they have a winter spawning season. Sweep are relatively long-lived with the maximum age reported in the commercial fishery being 54 years. Between December 2002 and November 2003, approximately 50% of the fishery was comprised of fish older than 15 years and more than 20% comprised of fish older than 30 years. The longevity and slow growth of this species may make it vulnerable to over harvesting.

Sweep are captured by both commercial and recreational fishers in NSW. The Ocean Trap and Line Fishery harvests about 77% of the total commercial landings of this species while the Ocean Haul Fishery makes up the majority of the remainder (22.5%; Fig. 89). Between 1990/91 and 1992/93, reported commercial landings of sweep increased from about 70 tonnes to 150 tonnes with peak landings of 157 t occurring in 1995/96 (Fig. 90). Shortly after this time reported landings decreased sharply to about 32 t and landings have been around this tonnage in recent years. Peak months of capture are in spring and summer (Fig. 91) with fish trap and handline being the main methods of catching this species in the Ocean Trap and Line Fishery (Fig. 92).

Sweep (*Scorpis lineolatus*)

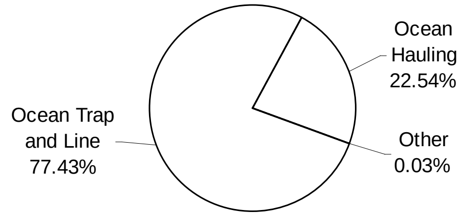


Figure 89 Percent contribution of each NSW commercial fishery to the harvest of sweep.

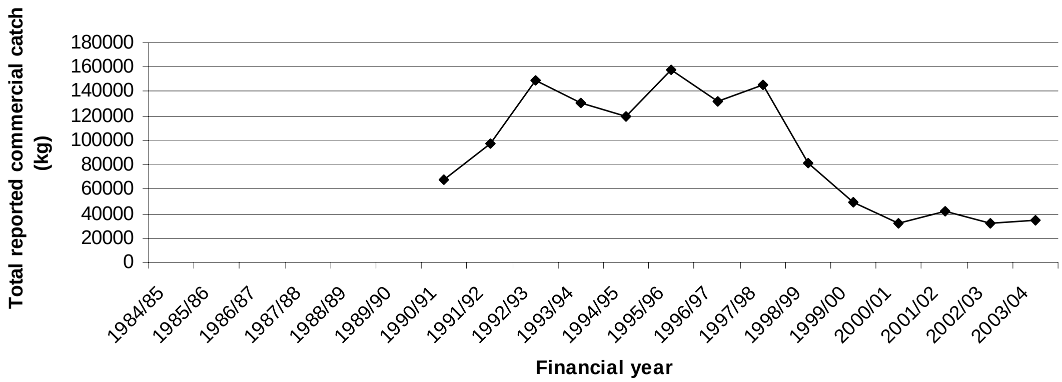


Figure 90 Total reported commercial catch for sweep 1984/85 – 2003/04.

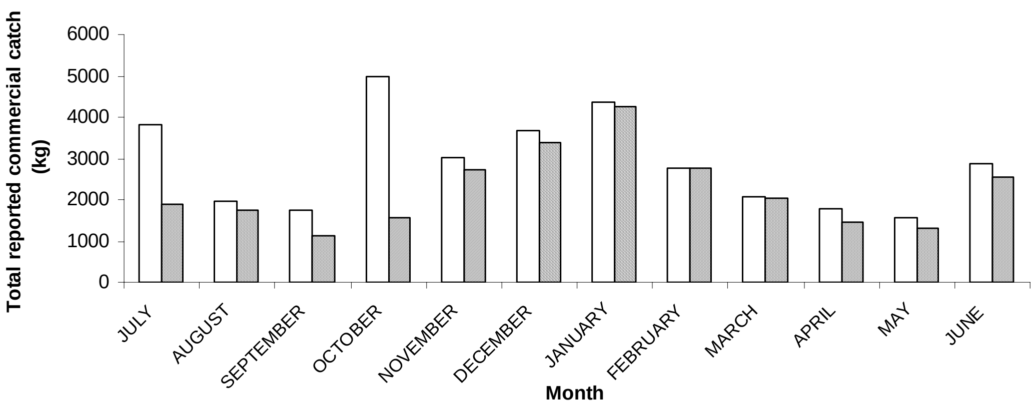


Figure 91 Reported commercial catch per month of sweep in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

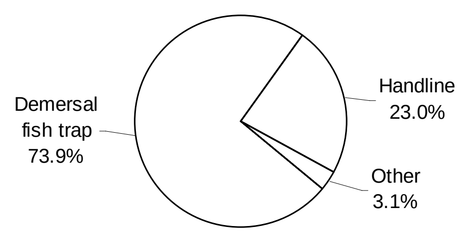


Figure 92 Percent contribution of each method type used in the OTLF to the harvest of sweep.

Teraglin (*Atractoscion aequidens*)

Kailola *et al.* 1993, Griffiths & Hecht 1995b, Hutton *et al.* 2001.

Teraglin occur in all three of the World's major oceans from Angola to South Africa and, in Australia from southern Queensland to Montague Island in NSW. Juvenile fish can be found in inshore waters, including deeper estuaries, while schools of adult fish can be found at depths of 20 – 80 m over gravel or broken reef substrata.

There is virtually no information available on the biology of this species in Australian waters with much of the minimal information gathered for teraglin from South Africa. For teraglin studied in South Africa, there was no difference in the lengths of fish for a given age between males and females. Growth did slow, however, at the onset of sexual maturity. The size at which 50% of teraglin mature in South African waters was reported to be about 90 cm (equivalent to about 5 years of age) while 100% maturity was recorded at around 93 cm (about 6 years of age) with no difference between males and females. In South African waters, teraglin reach a maximum length of around 130 cm and a maximum weight of around 18 kg, spawn during spring and the diet of teraglin mainly consists of pilchards and anchovies.

In 2003/04 over 97% of the harvest by NSW managed commercial fisheries of teraglin was taken by fishers in the Ocean Trap and Line Fishery (Fig. 93). Since 1984/85 reported catches of teraglin have fluctuated from around 49 tonnes in 1992/93 to around 10 tonnes in 2003/04 (Fig. 94). In 2003/04, June recorded the highest catches of teraglin (1700 kg), followed by April (1500 kg) and February (1350 kg) of that year (Fig. 95). Within the Ocean Trap and Line Fishery, teraglin is mainly caught by the method of handlining (Fig. 96).

Teraglin (*Atractoscion aequidens*)

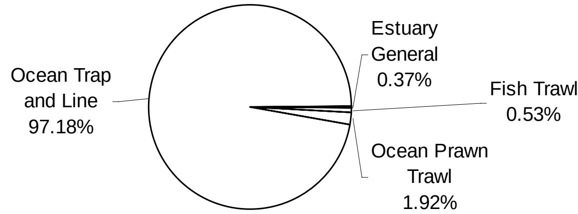


Figure 93 Percent contribution of each NSW commercial fishery to the harvest of teraglin.

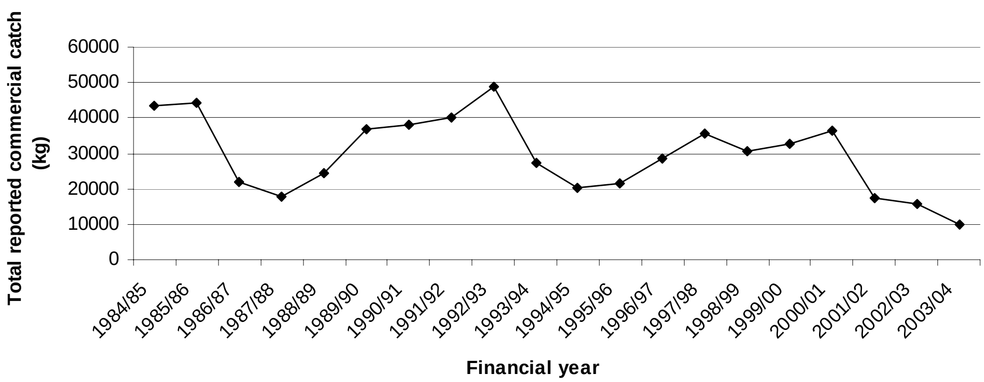


Figure 94 Total reported commercial catch for teraglin 1984/85 – 2003/04.

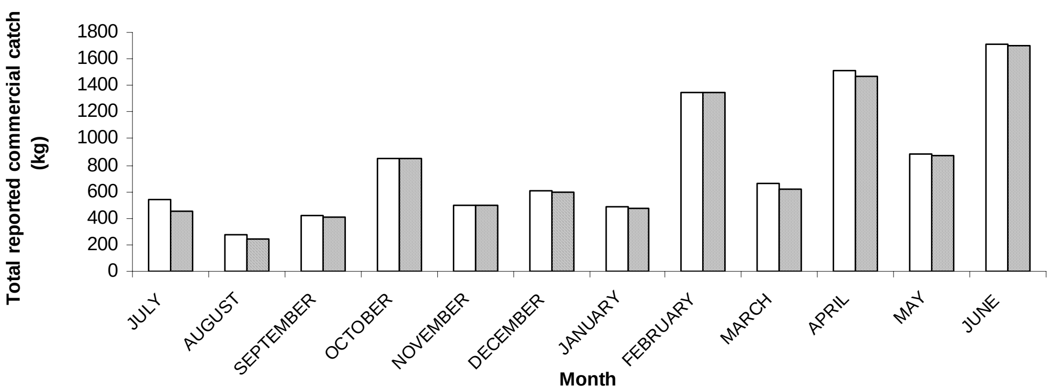


Figure 95 Reported commercial catch per month of teraglin in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

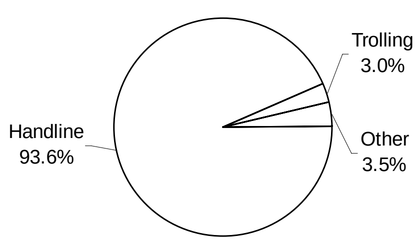


Figure 96 Percent contribution of each method type used in the OTLF to the harvest of teraglin.

Wobbegong sharks

Including: Banded/ornate wobbegong (*Orectolobus ornatus*) and Spotted wobbegong (*O.maculatus*). Possible third species (*O. halei*).

Last & Stevens 1994, Compagno 2001.

The ornate wobbegong (*Orectolobus ornatus*) is distributed in the western Pacific from Indonesia, New Guinea and warm-temperate Australian waters. In Australia, this species can be found off Queensland, NSW, Victoria, South Australia and the south coast of Western Australia. The spotted wobbegong (*O. maculatus*) is distributed in the western Pacific from southern Queensland to NSW, South Australia and southern Western Australia.

The ornate wobbegong is common inshore bottom dwelling shark found in bays, on coral and rocky reefs on the coast and around offshore islands, in lagoons, on reef-flats and in reef channels. It can be found from intertidal areas to waters of at least 100 m in depth. This species apparently prefers clearer water than that of the spotted wobbegong. The spotted wobbegong is a temperate to tropical bottom dwelling shark that can be found in intertidal areas through to waters of at least 110 m in depth. It is commonly found on coral and rocky reefs in caves and under overhangs, in coastal bays and estuaries, on seagrass beds and on sandy substrata.

The diets of the ornate and spotted wobbegong comprise of invertebrates, such as crab, lobster and octopus, as well as fish species (including sharks and rays).

The spotted wobbegong is thought to attain a maximum length of 320 cm but most individuals are between 150 cm and 180 cm in length. The maximum size of the ornate wobbegong has been recorded as 288 cm, however this may be due to confusion between this and a possible third species of wobbegong in this area: *O. halei*. The reproductive strategy of these species is ovoviviparous whereby the young develop in the womb. Wobbegongs have a large number of pups with one spotted wobbegong recorded as having 37 pups. Ornate wobbegongs have litters of at least 12 pups. Available published literature indicates that size at maturity for the ornate wobbegong is about 175 cm but a male was also found to be mature at 63 cm. Again, the existence of a possible third species may account for this result. Also, the spotted wobbegong is thought to mature at around 60 cm. Recent investigations into wobbegongs in NSW waters has indicated that size at maturity for these species differs from the published literature and this research is continuing.

Most records for wobbegongs are reported and recorded as “carpet shark” rather than being species-specific. Therefore, the following data is presented for wobbegongs in total. The Ocean Trap and Line Fishery accounts for 80% of the commercial harvest of wobbegong sharks in NSW (Fig. 97). From 1990/91, wobbegong catches have declined from around 120 tonnes to around 65 tonnes in 2003/04 (Fig. 98). In the 2003/04 period, wobbegongs were predominantly caught between summer and winter (Fig. 99) with line methods accounting for over 80% of the catch within this fishery (Fig. 100)

Wobbegong sharks

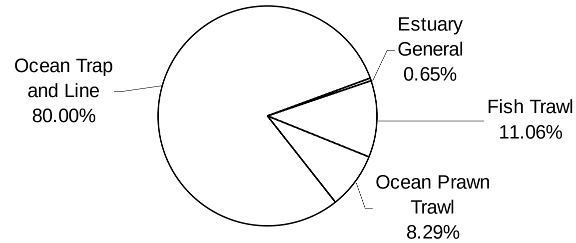


Figure 93 Percent contribution of each NSW commercial fishery to the harvest of wobbegongs.

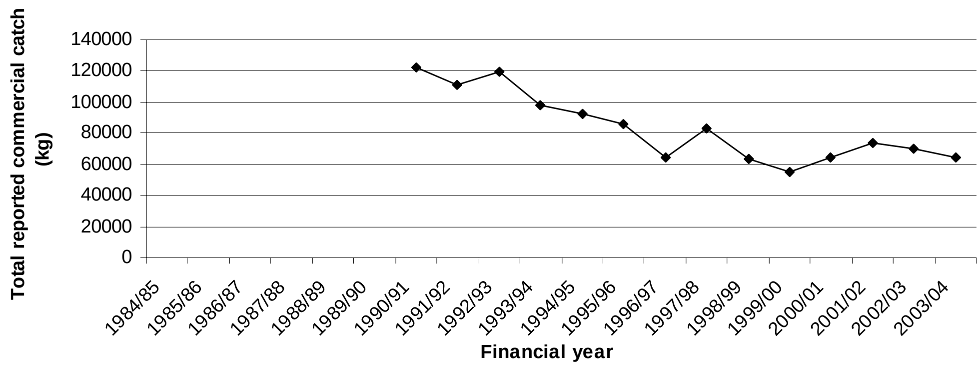


Figure 94 Total reported commercial catch for wobbegongs 1984/85 – 2003/04.

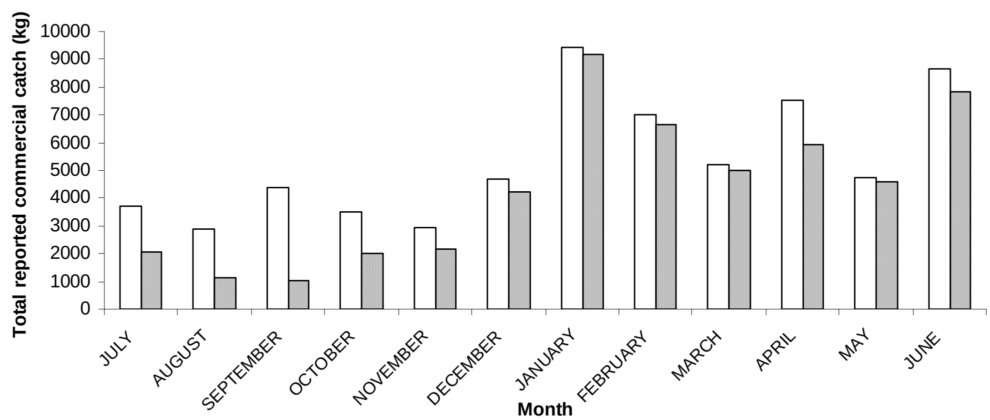


Figure 95 Reported commercial catch per month of wobbegongs in 2003/04. White bars are for all fisheries combined, striped bars are the OTLF contribution.

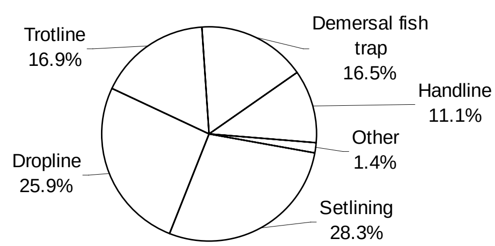


Figure 96 Percent contribution of each method type used in the OTLF to the harvest of wobbegongs.

Appendix B1 cont. - 30 year catch trends for the Primary and Key Secondary species of the OTLF across all NSW commercial fisheries.

	Financial year														
Common name	**1972/73**	**1973/74**	**1974/75**	**1975/76**	**1976/77**	**1977/78**	**1978/79**	**1979/80**	**1980/81**	**1981/82**	**1982/83**	**1983/84**	**1984/85**	**1985/86**	**1986/87**
Primary species															
Yellowtail kingfish	226	279	191	272	264	181	243	174	231	284	341	563	525	591	544
Snapper	685	709	960	700	747	710	849	889	921	950	856	731	763	664	548
Leatherjackets (mixed species)	463	386	250	137	123	88	74	125	156	165	179	161	182	173	128
Silver trevally	179	237	274	268	272	292	244	292	442	594	872	1296	1464	1014	916
Australian bonito	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue-eye trevalla	-	-	-	-	-	-	130	113	107	114	149	168	124	116	172
Rubberlip morwong	-	-	-	-	-	-	497	681	957	596	551	513	535	443	326
Yellowfin bream	257	355	293	289	347	318	304	458	515	549	481	476	457	519	590
Bar Cod	-	-	-	-	-	-	-	-	-	-	-	-	2	7	4
Gummy Shark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spanner crab	-	-	-	-	-	-	-	-	-	-	-	-	149	292	383
Key Secondary species															
Sharks (mixed species)*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wobbegong sharks	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver sweep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mulloway	290	386	167	241	281	246	216	204	257	226	197	162	168	193	154
Gemfish	-	-	-	-	2109	2382	4533	3035	3899	3362	2593	2327	2020	3268	1845
Teraglin	52	73	110	88	110	75	69	76	36	32	44	42	43	44	22
Jackass morwong	-	-	-	-	-	-	540	524	1012	1306	1017	1159	1046	620	360
Dolphin fish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spotted mackerel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pearl perch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hapuku & Bass groper	23	32	47	98	94	136	21	16	45	27	37	34	32	70	66
Hapuku	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bass groper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black-spot pigfish	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Narrow-barred Spanish mackerel	-	-	-	-	-	-	42	21	24	28	31	19	29	21	31

Note: * All sharks excluding Gummy and Wobbegong Sharks: Dash indicates data were not available for that taxon in that financial year.

Appendix B1 cont.

	Financial year														
Common name	**1987/88**	**1988/89**	**1989/90**	**1990/91**	**1991/92**	**1992/93**	**1993/94**	**1994/95**	**1995/96**	**1996/97**	**1997/98**	**1998/99**	**1999/00**	**2000/01**	**2001/02**
Primary species															
Yellowtail kingfish	580	553	500	419	387	418	347	295	194	83	84	98	136	135	257
Snapper	638	561	495	392	516	606	518	412	324	308	288	301	294	290	212
Leatherjackets (mixed species)	145	126	105	102	96	140	166	184	182	163	167	157	159	145	360
Silver trevally	960	1294	1077	1042	652	757	718	615	736	704	445	392	318	282	315
Australian bonito	-	-	-	112	123	141	141	152	173	134	194	274	206	151	102
Blue-eye trevalla	292	282	286	320	252	182	192	211	204	201	112	93	114	68	91
Rubberlip morwong	278	270	261	195	152	146	186	180	215	197	162	123	105	84	68
Yellowfin bream	695	611	538	569	507	628	719	588	550	496	499	383	324	320	331
Bar Cod	7	10	10	29	20	17	15	11	14	15	18	12	23	27	29
Gummy Shark	-	-	-	14	27	30	44	42	70	49	52	39	41	37	52
Spanner crab	488	292	209	259	326	330	351	444	424	373	315	231	212	209	150
Key Secondary species															
Sharks (mixed species)*	-	-	-	694	675	836	707	669	644	549	321	317	365	363	433
Wobbegong sharks	-	-	-	122	111	120	98	92	86	64	83	63	54	64	98
Silver sweep	-	-	-	68	97	150	131	120	157	132	145	82	49	31	42
Mulloway	112	117	163	163	159	154	141	128	102	89	90	89	80	70	69
Gemfish	1653	861	840	832	143	476	214	135	141	195	127	116	78	25	18
Teraglin	18	25	37	38	40	49	27	20	22	29	35	31	32	36	17
Jackass morwong	307	415	160	254	230	159	208	183	80	57	45	31	18	37	19
Dolphin fish	-	-	-	17	5	7	7	11	24	9	15	5	1	4	10
Spotted mackerel	-	-	-	4	3	14	28	8	8	31	53	43	52	18	11
Pearl perch	-	-	-	6	9	16	13	14	17	10	14	10	12	12	10
Hapuku & Bass groper	50	43	52	59	39	30	27	17	16	26	13	10	21	7	14
Hapuku	-	-	-	-	-	-	-	-	-	-	9	8	15	4	9
Bass groper	-	-	-	-	-	-	-	-	-	-	4	2	6	3	5
Black-spot pigfish	-	-	-	2	6	6	6	7	9	8	9	6	6	5	5
Narrow-barred Spanish mackerel	33	51	28	45	15	48	17	8	9	23	14	15	7	3	3

Note: * All sharks excluding Gummy and Wobbegong Sharks: Dash indicates data were not available for that taxon in that financial year.

APPENDIX B2

DETAILED INFORMATION SUPPORTING RISK ASSESSMENTS FOR THREATENED SPECIES

Appendix B2 Detailed Information Supporting Risk Assessments For Threatened Species

This appendix provides the detail behind the risk levels given for threatened and protected species in section B2.

Risks to species listed under the Fisheries Management Act

The following assessments of threatened species include all marine fish whose distributions and/or biology could bring them into contact with the fishery, and whose risk levels due to the fishery were summarised in Table B2.32.

Of the endangered or vulnerable species, only green sawfish, grey nurse shark, black cod and great white shark are considered in detail for the risk assessment. The other endangered species, namely eastern freshwater cod, Murray hardyhead, Oxleyan pygmy perch, river snail and trout cod, and vulnerable species, namely Adams emerald dragonfly, Buchanans fairy shrimp, Macquarie perch, silver perch and southern pygmy perch are all freshwater species and thus do not overlap or interact with the Ocean Trap and Line Fishery.

The currently listed endangered populations and the ecological communities are also not considered as they also occur in, or are in the latter case, freshwater environments. Bennetts seaweed is presumed extinct, but was also a marine algae that was thought to occur along rocky shores of coastal areas. It was only ever collected from Sydney Harbour, beyond the range of this fishery, and so is also not considered further in the following risk assessment.

Members of the families Pegasidae, Solenostomidae and Syngnathidae (i.e. seahorses and their relatives) are protected under section 19 and although they are marine species, have not been considered in detail as there is likely to be very limited to no interaction in terms of diet, behaviour or movement due to the methods used in this fishery, and limited spatial overlap due to the habitat requirements of the animals.

Endangered species

Green sawfish (*Pristis zijsron*)

Conservation status: The green sawfish is listed as endangered under the FM Act.

Distribution and decline: Green sawfish have been recorded in the tropical Indo-West Pacific from eastern Australia and Papua New Guinea through to western India, with a disjunct population off Mozambique and eastern South Africa. In Australia, the species occurs mainly in the tropics from Broome to southern Queensland, with individuals found as far south as Sydney and a single record from Glenelg, South Australia. In NSW, specimens have been collected from Byron Bay in the north to Parramatta River in the south, plus an unofficial record from Jervis Bay. Green sawfish have suffered a serious population decline in NSW, however it remains common in the north of its range (Last and Stevens, 1994). The last, southern-most confirmed record of this species in NSW was from the Clarence River, taken in 1972 (Pogonoski *et al*., 2002). Prior to 1972, the species was regularly found in the shallow waters at the mouths of the Tweed, Clarence and Richmond Rivers and on outside ocean beaches such as Yamba (NSW Fisheries Scientific Committee, 1999). The last specimen from the Sydney region was taken in 1926.

Key Threatening Processes: None of the currently listed KTP apply to the green sawfish.

Other threatening processes: Bycatch in shallow water prawn trawling, and other netting methods in shallow water pose a threat to the species, as they would rarely be returned to the water alive. The species is also targeted harvest for flesh, fins and saws. The fins command a high price in the shark fin trade and the saws are used in traditional medicine and were sold as curios. Habitat degradation may also threaten this species.

Habitat: The green sawfish inhabits muddy bottom habitats and enters estuaries (Allen, 1997), and is frequently found in shallow waters (Last and Stevens, 1994).

Recovery plans: There is no recovery plan for the green sawfish.

Assessment of risk to the green sawfish

Biological characteristics: Little information is available about the reproductive biology of the green sawfish. All sawfishes are ovoviviparous (live bearers), which have long gestation periods and tend to give birth to small numbers of relatively large pups. On the basis of this information, the green sawfish is considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: There is very limited geographical overlap of the fishery with this species, as it has always been more common in the north of its range. There is also likely to be limited interaction within the small area of overlap owing to the techniques and habitats fished in this fishery. If they were caught on set, drop or handlines, individuals are likely to be released alive rather than taken onboard, assuming the line was retrieved soon after capture. Overall, the overlap and interaction with the fishery is likely to be minimal.

Risk: Low. The species is now rare in NSW (last confirmed record from 1972) and prefers nearshore and estuarine waters, and is therefore unlikely to be regularly encountered by the fishery. However, any capture may impede the recovery of the species in NSW waters.

Grey nurse shark (*Carcharius taurus*)

Conservation status: The grey nurse shark is listed as Endangered under the FM Act and as a Critically Endangered Population (East Coast) under the EPBC Act. The eastern population of the grey nurse shark is also protected in Queensland and Victoria.

The listing in NSW was based on declining population trends (Otway and Parker, 2000), life history characteristics, limited knowledge of their ecology and abundance and the continued pressure from commercial (Commonwealth and State) and recreational fishing. It was listed nationally because its migratory behaviour took it outside the bound of NSW.

Distribution and decline: In Australia, the grey nurse shark occurs from Mooloolaba, southern Queensland to Shark Bay, Western Australia, but is less common on the south coast of the continent (Hutchins and Swainston, 2001). In NSW it has recently been predominantly found confined to coastal waters along the entire coast. There are at least sixteen sites in NSW waters where significant numbers of grey nurse sharks are reported to consistently occur, and these sites are generally referred to as known aggregation sites (Table 1). There are also two sites off the NSW coast in Commonwealth waters: Pimpernel Rock, which is a Sanctuary Zone within the Commonwealth Solitary Islands Marine Reserve; and the Cod Grounds, which is currently being assessed by the Commonwealth for establishment as a marine reserve.

At certain times of the year these sharks aggregate according to sex – from July to October males occur together in southern Queensland and females in central NSW (Reid and Krogh, 1992; Otway and Parker, 2000). Grey nurse sharks are reported from other sites along the coast (e.g. Long Reef and South Marley), but these sites do not appear to be used as aggregation sites.

Table 1 Known aggregation sites of grey nurse shark off the NSW coast

Aggregation site	General location	Jurisdiction	Site protection
Julian Rocks	Byron Bay	NSW	Sanctuary/CH*
Pimpernel Rock - Solitary Island	Coffs Harbour	Commonwealth	Sanctuary
Anemone Bay/The Steps – North Solitary Island	Coffs Harbour	NSW	None
Manta Arch – South Solitary Island	Coffs Harbour	NSW	None
North-West Solitary Island	Coffs Harbour	NSW	None
Fish Rock	South West Rocks	NSW	Critical Habitat
Green Island	South West Rocks	NSW	Critical Habitat
Cod Grounds	Laurieton	Commonwealth	None
Mermaid Reef	Laurieton	NSW	None
The Pinnacle	Forster	NSW	Critical Habitat
Sawtooth Rocks	South of Forster	NSW	None
Big and Little Seal Rocks	South of Forster	NSW	Critical Habitat
Edith Breaker	South of Forster	NSW	None
Little Broughton Island	Port Stephens	NSW	Critical Habitat
Magic Point	Maroubra	NSW	Critical Habitat
Bass Point	Shell Harbour	NSW	Critical Habitat
Tollgate Islands	Batemans Bay	NSW	Critical Habitat
Montague Island	Narooma	NSW	Critical Habitat

* denotes Critical Habitat and inclusion as a Sanctuary Zone in the zoning plan for Cape Byron Marine Park, the regulation for which is anticipated to commence in April 2006

Grey nurse sharks have been found to move extensive distances at certain times of the year (Otway and Burke, 2004). Unidirectional distance travelled ranged from 25 to 681 km over a two month period. Furthermore, males and females tended to move north during autumn and winter and females then moved south during spring and summer (Otway and Parker, 2000; Otway and Burke, 2004).

The east coast population of grey nurse sharks has shown a major decline over the last 50-60 years. Data from the beach meshing program (Newcastle to Wollongong) shows the number of grey nurse sharks caught has declined from 36 sharks per year in the 1950s to three or less per year in the 1980s (Reid and Krogh, 1992; Pollard et al., 1996; Otway and Parker, 1999, 2000). More recently, only one or two sharks per year have died in the bather protection nets (DPI, unpublished data).

In the 1960s and 70s, recreational spearfishers used to kill large numbers of grey nurse sharks as they were thought to be man-eaters, and commercial fishers used to also catch them for their livers and oils. These practices have ceased since protection in 1984, but there are still approximately 12 accidental fishing-related deaths reported every year, and owing to the fear of prosecution is likely to be under-reported. Modelling by Otway *et al*. (2004) suggest that these 12 mortalities per year could cause the quasi-extinction (i.e. years elapsed for the population to consist of less than 50 females) of the species at between 6 - 324 years, but is more likely to occur within 45 - 53 years. The latter figure is based on an existing population of 1000 sharks and that only half of accidental deaths are reported.

Otway and Parker (2000) observed substantially fewer pups than expected based on the population size of mature adults (6 - 14 pups compared to 34 - 42 expected, 1998-1999). They suggested that this may be an indication of reproductive failure due to fewer females encountering fewer males to mate.

Key Threatening Processes: Hook and line fishing, shark meshing (FM Act), and harmful marine debris (EPBC Act) pose a threat to the grey nurse shark.

Fishing by hook and line is used in the Ocean Trap and Line Fishery and in recreational fishing. This method of fishing is considered a threat to grey nurse sharks for the following reasons. Grey nurse sharks form aggregations which, when hook and line fishing is used in the area of these aggregations, make them more likely to be hooked. The damage inflicted on grey nurse sharks by hooks include injuries to their mouths potentially affecting feeding behaviour, ingestion of hooks causing perforations to internal organs potentially leading to septicaemia and bacterial infection that could result in death (NSW Fisheries Scientific Committee, 2003). This suggests that even when grey nurse sharks are caught and released by either commercial or recreational fishers, hook damage may be substantial enough to still threaten the survival or well-being of the shark.

Shark meshing is done in NSW on 49 beaches from Newcastle to Wollongong. They are meshed from September to April each year. The shark protection is based on the idea that if populations of dangerous sharks are reduced the probability of attack will be reduced (Eckersley, 1996). Thirty-five percent of sharks (all species) killed in the mesh nets have been on the beach side of the net. It is not known what proportion of these deaths consisted of grey nurse sharks. There has been no work done on the survival of sharks caught in the nets and released. Between the 1950s and 1970s beach meshing was responsible for killing substantial numbers of grey nurse sharks (Environment Australia, 2002a).

Harmful marine debris is land sourced plastic garbage, fishing gear from recreational and commercial fishing and ship sourced solid non-biodegradable floating material discharged at sea (DEH, 2002). Marine debris can be harmful by entanglement and/or ingestion. Entanglement can restrict mobility, inflict wounds leading to infection and inhibit hunting due to impaired swimming. Ingestion of marine debris includes fishing gear (including hooks) attached to species of fish that forms their diet, plastic objects mistaken for food items. The level of entanglement or ingestion of marine debris by grey nurse shark has not been studied. Aquaria experience has found that hook wounds can puncture the stomach, pericardial cavity and oesophagus causing infection and death (Threatened Species Scientific Committee, 2003).

Other threatening processes: Other forms of commercial fishing, shark finning and excessive eco-tourism activity may threaten the grey nurse shark (Pogonoski *et al.*, 2002).

Grey nurse sharks can be caught incidentally by ocean fish and prawn trawlers. Improved navigation technology enables some trawl fishers to fish very close to rocky reefs that grey nurse sharks occupy. Individuals that survive trawling, which is unlikely, must be released, but there has been no work done on their subsequent survival and behaviour. Commercial and recreational fishing may indirectly affect grey nurse sharks via the depletion of their main prey species. Grey nurse sharks feed on many of the same species harvested by fishers, particularly in the Ocean Trap and Line

Fishery (Otway and Parker, 2000). Of the prey species harvested by the OTLF and recreational anglers, kingfish and snapper are overfished, bream is fully fished and bonito, mackerels, mulloway and morwongs have an uncertain exploitation status (see Table B1.4). These levels of exploitation on the prey of grey nurse shark suggest that their food source could potentially be affected by fishing. The extent of the direct and indirect impacts by fishing on grey nurse sharks has not been assessed in terms of their exploitation status.

Whilst shark finning in NSW has been banned there are still some reports of divers seeing grey nurse sharks with their fins cut off. Because shark finning is poorly documented in NSW the level of its impact on grey nurse sharks is unknown.

Ecotourism relevant to grey nurse sharks are diving activities that includes SCUBA and snorkel. A number of dive operators take clients to known aggregating sites for grey nurse sharks for viewing. Provided divers keep their distance it is unlikely that they will affect their behaviour or disturb them. There is currently a code of practice that all dive operators are to adhere to. Whilst ecotourism is not considered a major threat to grey nurse sharks increased pressure on the industry by divers wanting encounters with these sharks over time may require a review of their effects.

Habitat: Warm temperate and subtropical waters from rocky inshore reefs down to 200 m on the continental shelf. In NSW the species is commonly seen in or near sandy-bottomed gutters or rocky caves around inshore islands or reefs between 15 and 40 m (Otway and Parker, 1999, 2000).

Critical Habitats: In NSW, 10 sites where grey nurse sharks are known to aggregate have been gazetted as Critical Habitats under the FM Act, 1994 (Table 1). For most of these sites, fishing and diving restrictions apply throughout the year, but at Julian Rocks and Montague Island the restrictions only apply from May - October and from November - April, respectively. The types of restrictions that apply in Critical Habitat (200 m) and adjacent Buffer Zones (800 m) can be found on the DPI website at http://www.fisheries.nsw.gov.au/thr/species/gns/gns-critical.htm. Small scale movement of grey nurse sharks within these habitats can be greater than 1000 m (Bruce *et al.*, 2004) and the ability to conduct hook and line fishing in these areas, which is their KTP, suggests that they are currently not receiving adequate protection.

Gazettal of other important aggregation sites in NSW waters, particularly those within the Solitary Islands Marine Park and sites at Laurieton and Forster (see Table 1), is currently being discussed as part of ongoing consultation for the NSW draft recovery plan for the species. There is also ongoing consultation between the Commonwealth and fishers about the establishment of a marine reserve at the Cod Grounds.

Recovery plans: A national recovery plan for the grey nurse shark has been adopted by Environment Australia (Environment Australia, 2002a). The national plan calls for reduction of the impacts of commercial fishing, recreational fishing, shark finning and shark control activities, management of eco-tourism impacts, elimination of impacts from aquaria, establishment of conservation areas, development of research and population models to assist recovery, promotion of community education and development of a quantitative framework to assess recovery of the species. A draft recovery plan for the species has been prepared by NSW Fisheries (NSW Fisheries Threatened Species Recovery Planning Program, 2002). A range of recovery actions is proposed in the NSW draft plan, including reducing the impact of commercial fishing (primarily line fishing), declaration of critical habitat, increasing compliance, improved data collection on interactions with fishing, and minimising the effect of shark meshing. Community consultation is ongoing, with a recent discussion paper on further protection for the species (NSW Fisheries, 2003).

Assessment of risk to the grey nurse shark

Biological characteristics: The grey nurse shark is ovoviviparous, bearing one or two pups (rarely four) per litter, but only reproducing every two years (Otway and Parker, 1999), with an estimated population doubling time of more than 14 years. Gestation lasts 9-12 months. Males reach sexual maturity at 190 - 195 cm and four years of age, while females mature at 220 - 230 cm and six years of age. Based on this information, the resilience of the species is considered to be low.

Overlap and interaction with fishery: Although set, drift and droplining are banned in each of the ten critical habitat and buffer zones of grey nurse sharks, handlining and trapping can still be done in these areas, and all methods can be used at other sites where grey nurse occur. The species is also migratory, generally undergoing pole-ward migrations in summer and equatorial migrations in winter (Compagno, 1984). The limited information available suggests that the species may undergo similar migrations in NSW (Otway and Parker, 2000), exposing it to the fishery when they move beyond the critical habitats. Their diet is also thought to comprise many of the species that are targeted in the fishery, particularly snappers, bonito, flatheads and small sharks, thus acting as a source of competition for the shark and providing scope for hooking leading to capture and/or entanglement. Setline fishers targeting wobbegong sharks in the Seal Rocks area used to take the species as bycatch (Pollard *et al*., 1996), and although they would be released under today's regulations, incidental hooking is still likely to occur. The draft recovery plan for the grey nurse shark lists drop lines and other line fishing gear as threats (NSW Fisheries Threatened Species Recovery Planning Program, 2002), and despite the restrictions at critical habitat sites, the above information indicates that there is likely to be a high degree of overlap and interaction with the fishery.

Risk: High. This is due to the combination of extensive spatial overlap with the fishery, use of hook and line methods by the fishery (line fishing is a KTP for the species) and the species' low resilience.

Southern bluefin tuna (*Thunnus maccoyii*)

Conservation status: Southern bluefin tuna is listed as endangered under the FM Act, and as a threatened taxon under the Victorian *Flora and Fauna Guarantee Act 1988*. At the time of writing this report, it was also under consideration for listing as an endangered species under the EPBC Act.

Distribution and decline: Southern bluefin tuna (SBT) are pelagic fish occurring in oceanic waters normally on the seaward side of the continental shelf and worldwide the species is considered a single population. The only spawning ground is between Australia and Java (7^0 S - 20^0 S). In Australia, SBT migrate along the west coast of Australia, across the Great Australian Bight, around Tasmania to 45^0 S and then along the southeast Australian coastline to 30^0 S off northern NSW, which is the eastern boundary of the species' migratory path in Australian waters. Although the species is historically considered rare within the NSW State waters boundary of three nautical miles, the western edge of the migratory path off the NSW coast overlaps State waters. Schools of SBT were observed within State waters during the late 1960s and 1970s, but there have not been any reports within the last 5 years (NSW Fisheries Scientific Committee, 2004).

Well-documented evidence indicates that SBT have declined dramatically in both International and Australian waters. Evidence for the decline in this species is available through both commercial and recreational data, as well as through anecdotal reports, which collectively indicate that the species is now rare to non-existent in catches in NSW waters (NSW Fisheries Scientific Committee, 2004). For example, the Japanese fishery longline catch peaked at 81,605 tonnes in the early 1960s, but was followed by a rapid decline in catch rates in the face of increased fishing effort. The Australian fishery peaked at 21,500 tonnes in 1982 and also rapidly declined. The current Japanese quota as allocated by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is 6,432 tonnes, and Australia and New Zealand's quotas are 5625 and 420 tonnes, respectively. Including non-CCSBT countries, the global quota is now reported to exceed 17,000 tonnes (HSI, 2004).

Southern bluefin tuna has undergone a population reduction of at least 80% over three generations. The parental biomass of SBT in 1995 was estimated to be 5-8% of the 1960 (a time when substantial reductions had already occurred) parental biomass and in the order of 25-53% of the 1980 level. Further, projections over the years 1992 to 1997 are thought to have consistently overestimated the parental biomass in the following two years by about 10-60%. Population analysis by both Australia and Japan since 1984 have optimistically predicted that reversal of ongoing parental biomass decline would occur 2 - 3 years after the year of assessment, but this has never happened. Population estimates and projections by Australian and New Zealand scientists indicate only continued population decline. Predicted downward trends appear to be inconsistent with the actual persistent decline in spawning-fish. There has been no evidence of a reversal of the parental biomass decline (HSI, 2004).

Key Threatening Processes: Hook and Line Fishing could affect SBT.

Other threatening processes: Threats to the species are commercial fishing (particularly purse-seining and longlining) in both International and Australian waters based on the significant demand for SBT in the high priced world sashimi markets and the harvest of wild caught juveniles (primarily in South Australia) for the recently developed highly valuable aquaculture industry, based on grow-out farming. This harvest occurs before SBT migrate to the east Australian coast and before they reach sexual maturity.

Habitat: Pelagic waters usually on the seaward side of the continental shelf.

Recovery plans: A recovery plan for southern bluefin tuna has not yet been prepared.

Assessment of risk to southern bluefin tuna

Biological characteristics: The species is long lived (up to 40 years), slow growing, late maturing (8 - 12 years) and highly migratory. Its estimated minimum population doubling time is 4.5 - 14 years (fishbase.org). The maximum weight is approximately 200 kg at 2.25m length. Southern bluefin tuna is under fishing pressure at all stages of its life cycle. Although reasonably fecund, the single spawning area (off the north-west coast of Australia) and the long maturity period means juveniles are vulnerable to over exploitation. Young fish moving southwards from the spawning grounds in the Java Sea and are taken as juveniles by surface fishing in the continental shelf region of Southern Australia. Elsewhere, in the Western South Pacific Ocean, older juveniles and adult SBT are taken by long-lining. Mature SBT have the tendency to aggregate on the spawning grounds, which makes them vulnerable to longlining, and localised overfishing can easily occur (HSI, 2004). Further, pelagic fish such as SBT aggregate when numbers decline, worsening pre-existing threats, which are all factors that contribute to a low resilience to fishing pressure.

Overlap and interaction with fishery: There is likely to be limited interactions and limited potential geographical overlap with this fishery and SBT. This is due in part to the methods of the fishery, the fact that SBT range only covers about half of the coastline and which represents a small proportion of its range, and also because a section 8 closure was introduced under the FM Act for NSW licensed fishers in 2000 and has been annually renewed.

Risk: Low-moderate

Vulnerable Species

Black cod (*Epinephelus daemelii*)

Conservation status: The black cod is listed as vulnerable under the FM Act.

Distribution and decline: The black cod inhabits warm temperate and subtropical waters of the southwestern Pacific including southeast Australia, Lord Howe Island, Norfolk Island, the Kermadec Islands and the north island of New Zealand (Heemstra and Randall, 1993). In Australia the species occurs from Townsville to Cape Conran, Victoria (Hutchins and Swainston, 2001). A decline in the species around Sydney was noted as early as 1916 (Roughley 1916, cited in Pogonoski *et al*., 2002), and was attributed to overfishing and increased shipping. Increased popularity in spear fishing in the early 1970s also led to noticeable declines, prompting the total protection of the species in NSW in 1983 (Pogonoski *et al*., 2002). Anecdotal reports indicate that marine protected areas, particularly in the north of the State, are providing significant refuges for black cod and that numbers appear to be increasing in some areas, although as yet there has not been a coastwide survey to confirm or refute such reports.

Key Threatening Processes: Hook and line fishing threatens the black cod.

Other threatening processes: Commercial and recreational fishing in Queensland (where the species is not protected) and illegal capture in NSW also threaten the black cod (Pogonoski *et al*., 2002).

Habitat: Coastal reefs, estuaries and deeper offshore reefs. Juveniles are found in rock pools (Hutchins and Swainston, 2001). The species is aggressively territorial, and may occupy a particular cave for life (Heemstra and Randall, 1993).

Recovery plans: A recovery plan for the black cod has not yet been prepared.

Assessment of risk to the black cod

Biological characteristics: There is little information on the biology of this species. Observations suggest that the species is slow growing (Leadbitter, 1992). It is a protogynous hermaphrodite, meaning that small individuals are all females and some become males once they reach a certain size (around 100-110 cm in length) (Francis, 1996). Species with this life history tend to have sex ratios that are naturally biased towards females, but this bias can be artificially increased by selective fishing of the larger fish (males) (Coleman et al., 1996). This feature of the life history makes such species particularly susceptible to overfishing, because the loss of large males through selective fishing may limit the reproductive success of the population, especially where fishers target spawning aggregations (Coleman et al., 1996). This effect may be reduced if the transition of large females to males occurs rapidly enough to compensate for the loss of males (Huntsman et al., 1994). It is not known whether such compensation can occur for black cod, or whether the species has spawning aggregations. Like many large groupers, the species has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, move little as adults, may aggregate to spawn and is protogynous (Huntsman and Schaaf, 1999), which are all factors that contribute to a low-medium resilience to fishing pressure.

Overlap and interaction with fishery: There is significant overlap between the broad geographic range of black cod and the trap and line fishery, as well as significant overlap at the small scale of habitats, as both utilise rocky reefs. Hook and line fishing is also a KTP for this species. In addition, other serranids (e.g. wirrah, Maori cod, and bar cod) are targeted in the fishery, many are reported as 'unspecified cod' and catches of black cod have been reported in the past. Reporting unspecified cod could indicate that there is an identification problem, which could result in numbers of black cod being inadvertently retained. Fish and crustaceans targeted in this fishery are also likely prey for black cod, providing a source of competition for black cod.

Risk: Moderately-high, given the low resilience of the species, line fishing being a KTP for the species and the significant overlap with the fishery.

Great white shark (*Carcharodon carcharias*)

Conservation status: The great white shark is listed as vulnerable and protected (s19) under the FM Act and vulnerable under the EPBC Act.

Distribution and decline: The species occurs in all seas in both hemispheres. It is most commonly found in inshore cool to warm temperate waters. It is most frequently observed in cool to warm temperate continental waters of the Western north Atlantic, Mediterranean Sea, Southern Africa, southern Australia, New Zealand and the Eastern North Pacific. In NSW there has been a decline in the number and size of individuals caught in beach meshing operations and game fishing competitions over the last 50 years, and a similar pattern has been observed in Queensland (Pogonoski *et al*., 2002).

Key Threatening Processes: Hook and line fishing and shark meshing.

Other threatening processes: Commercial fishing, recreational fishing, trade in shark products such as fins and jaws, tourism and possible adverse effects of tagging programs are considered to be threats to the great white shark (Environment Australia, 2002b).

Habitat: The great white shark generally occurs in inshore temperate waters, often around rocky reefs and islands, and in the vicinity of seal colonies (Environment Australia, 2002b).

Recovery plans: A national recovery plan for the great white shark has been adopted under the EPBC Act (Environment Australia, 2002b). The recovery plan calls for monitoring and reduction of the effects of commercial fishing, shark meshing and trade in shark products, investigation into the effects of recreational fishing and tourism, development of research programs towards the conservation of the species, identification and protection of critical habitat, promotion of community awareness and development of a quantitative framework to assess recovery of the species.

Assessment of risk to the great white shark

Biological characteristics: The great white shark is a livebearer, producing litters of 2-11 pups every 2-3 years. Females reach maturity at 4-5 m in length and 12-14 years of age, while males mature between 3.5 and 4.1 m long and 9-10 years of age. Females may reach an age of 23 years (Compagno *et al*., 1997). With a minimum population doubling time of more than 14 years (K=0.06; t_m=8-12; t_{max}=36; Fec=7) (www.fishbase.org), the great white shark is considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: There is considerable spatial overlap between the fishery and great white sharks, however there is no information about the extent of any interactions. They are protected from fishing under s19 of the FM Act and as such are not reported on catch returns and there have not been any studies (observer or fisher recording) to determine the degree of interaction. As line fishing is a KTP for the species, and the fishery targets many species that may otherwise be prey for great whites, there is considered to be moderate overlap with the fishery.

Risk: Moderate.

Protected species (section 19)

The following assessments of protected species include all marine fish whose distribution and/or biology could bring them into contact with the fishery, and whose risk levels due to the fishery were summarised in Table B2.39. The species considered in detail for the risk assessment include Ballina angelfish, eastern blue devil fish, elegant wrasse, estuary cod, giant Queensland groper and Herbsts nurse shark. Protected marine fish that have not been considered further include all members of the families Pegasidae, Solenostomidae and Syngnathidae. They were recently afforded protection under this section of the FM Act owing to concern over their increasing use in aquaria and Traditional Chinese Medicine. Whilst there is no evidence of decline in most of the species that occur in NSW, there is potential for the traditional medicine trade to focus on Australian stocks once they are fully depleted in South East Asia. However, the methods of this fishery are unlikely to result in capture, harm or habitat modification of pegasids, solenostomids or syngnathids such that they would be put at an increased level of risk. The other section 19 species, namely Australian grayling, eastern freshwater cod, trout cod and Macquarie perch are all freshwater species and thus do not overlap or interact with the Ocean Trap and Line Fishery.

Ballina angelfish (*Chaetodontoplus ballinae*)

Conservation status: The Ballina angelfish is protected under section 19 of the FM Act.

Distribution and decline: The Ballina angelfish is known to occur in northern NSW (Coffs Harbour, Ballina and North Solitary Islands) and the Balls Pyramid area of Lord Howe Island. There are also sight records from divers near Kingscliff, Flat Rock and Seal Rocks (Pogonoski *et al*., 2002). This species may be naturally rare and as yet there is no evidence of a decline in distribution or abundance.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect Ballina angelfish.

Other threatening processes: Angelfishes are much sought after in the aquarium trade, which could be a serious potential threat given its difficulty to collect in the wild.

Habitat: Inhabits coral and rocky reefs in depths between 25-123m. Specimens collected by hand from Balls Pyramid were associated with a large rocky pinnacle that rose to within 12m of the surface and was encrusted with hard corals of *Acropora* spp., *Porites* spp., and *Pocillopora damicornis* (Parker, 1994). Three specimens were also caught in a scientific survey off NSW using a trawl in 90 m adjacent to Balls Pyramid (http://www.oceans.gov.au/norfanz/CreatureFeature.htm).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the Ballina angelfish

Biological characteristics: Nothing is known about the biological characteristics or population size of this species, other than that pairs of fish appear to establish large territories (~2500m^2) (Parker, 1994). Its apparent rarity may indicate that it is not highly resilient to fishing pressure, but as yet there is no evidence to support that theory.

Overlap and interaction with the fishery: The limited information about the species suggests that it is restricted to the north coast of NSW, minimising its spatial overlap with this fishery. It is also thought to be rare, further restricting opportunities for interaction. At the smaller scale, however, its apparent preference for deep coral and rocky reefs is likely to bring it into contact with the fishery, as evidenced by the original Australian Museum specimen, which was collected in a deepwater fish trap off Ballina in the late 1950s. Another specimen was collected from a deep trawl by the Research Vessel Kapala off Evans Head in 123m of water in 1978.

Risk: Low-medium. Although rare, given that nothing is known of its resilience and that it is likely to occupy habitats utilised by the fishery, the risk to this species is considered to be low-medium.

Eastern blue devil (*Paraplesiops bleekeri*)

Conservation status: The eastern blue devil is protected under section 19 of the FM Act.

Distribution and decline: The eastern blue devil primarily occurs from southern Queensland to Montague Island, but is most common in NSW from Sydney southwards to Ulladulla (Kuiter, 1993). Museum records include specimens from as far south as Queenscliff, Victoria (Pogonoski et al., 2002). It is a secretive species for which there is no evidence of decline.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect eastern blue devil.

Other threatening processes: The main threat to this species would be collection for the aquarium trade (Pogonoski et al., 2002).

Habitat: Occurs in shallow waters in estuaries, and around Sydney it occurs in the more saline parts of estuaries, along the rocky coastline and around offshore islands (Pogonoski et al., 2002; Kuiter, 1993), usually in caves. Also recorded offshore to depths of up to 40m (Pogonoski et al., 2002).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the eastern blue devil

Biological characteristics: Eastern blue devils grow to about 40 cm. It is a shy, secretive fish that breeds in the warmer months from October to March. Larvae have been taken in the coastal waters off Sydney from November to May (Gray, 1995), and although the eggs of *P. bleekeri* have not been described, those of *P. alisonae* are tightly bound together and deposited onto the substratum and guarded by the male. Males are thought to be solitary and territorial, and like *P. alisonae*, are probably responsible for guarding eggs and rearing juveniles. There is no information on the diet of eastern blue devil.

Overlap and interaction with the fishery: The limited information suggests that there is likely to be significant spatial overlap with the fishery, but its secretive nature and territoriality suggest that it is unlikely to interact with traps or baited lines.

Risk: Low-moderate, given the probably low likelihood of interactions with this fishery and a presumably low-moderate resilience.

Elegant wrasse (*Anampses elegans*)

Conservation status: The elegant wrasse is protected under section 19 of the FM Act.

Distribution and decline: In Australia, the elegant wrasse is known from southern Queensland, NSW, Elizabeth and Middleton Reefs, Lord Howe Island, Norfolk Island and the Kermadec Islands. In NSW, it is thought to occur as far south as Montague Island. It is also occurs in New Zealand, New

Caledonia and Rapa, Mangareva, Pitcairn and Easter Islands (Pogonoski *et al.*, 2002). There is no evidence of a decline in the distribution or abundance of this species.

Key Threatening Processes: No Key Threatening Processes are considered likely to affect elegant wrasse.

Other threatening processes: None identified.

Habitat: Juveniles are found in coastal bays and harbours, and larger juveniles and females in aggregations on coastal rocky reefs down to 10m (Kuiter, 1993; Francis, 1993). Adult males usually occur in deeper water to about 30m, particularly around coral and rocky reefs and over rubble (Francis, 1993).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the elegant wrasse

Biological characteristics: Elegant wrasse grow to approximately 30cm in length. Juveniles and females aggregate in small, fast-moving groups that pause only to browse on the seabed for their food, which consists of crustaceans and worms (Ayling and Cox, 1982; Francis, 1993). Adult males are much less common, are territorial and solitary animals that move from one group of females to another.

Overlap and interaction with the fishery: The limited information suggests that elegant wrasse have significant spatial overlap with the fishery, but that there are unlikely to be any interactions, as elegant wrasse are protected from fishing and thus can't be retained, and the fishery does not target the preferred food of elegant wrasse. Incidental capture is highly unlikely by either traps or hook and line methods.

Risk: Low-moderate, on the basis that the little that is known of the biology and distribution of the species suggests that it probably has a moderate resilience and very low degree of interaction with the fishery.

Estuary cod (*Epinephelus coioides*)

Conservation status: The estuary cod is protected under section 19 of the FM Act.

Distribution and decline: The estuary cod is a widespread tropical Indo-West Pacific species. In Australia, it is most common in Queensland, Northern Territory and Western Australian waters. In NSW, the species is known to occur as far south as Sydney.

Key Threatening Processes: Hook and line fishing may pose a threat to estuary cod.

Other threatening processes: Commercial and recreational line fishing are potential threats to this species (Pogonoski *et al*., 2002).

Habitat: The estuary cod occurs from lower estuaries to offshore reefs. Juveniles are found inshore and adults are usually found along the bases of small drop-offs associated with large caves, or in shipwrecks, but they also occur offshore to depths of 100m (Kuiter, 1996; Heemstra and Randall, 1993).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the estuary cod

Biological characteristics: Like many large groupers, the species has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, moves little in the adult stage, forms spawning aggregations (which may be targeted by fishers) and is protogynous (Huntsman and Schaaf, 1999), which are all factors that contribute to a low-medium resilience to fishing pressure. Juveniles (sexually immature females) occur in estuaries and move out onto offshore reefs at around 40-50 cm in length (Sheaves, 1995). Individuals in estuaries appear to move little, indicating high site fidelity and relatively small home ranges (Sheaves, 1993).

Overlap and interaction with the fishery: Occurring only as far south as Sydney restricts the spatial overlap between estuary cod and this fishery. Overlap is further restricted because estuary cod, as the name implies, prefer estuarine waters, although they are also known from offshore reefs. Hook and line fishing, however, is thought to be a threatening process for this species. In addition, other serranids (e.g. wirrah, Maori cod, and bar cod) are targeted in the fishery and many are reported as 'unspecified cod'. Reporting unspecified cod could indicate that there is an identification problem, which could result in numbers of estuary cod being inadvertently retained. Fish and crustaceans targeted in this fishery are also likely prey for estuary cod, providing a source of competition. Further, it is possible that during flood events, some estuary cod move into nearshore waters where they may come into contact with the fishery. Overall, there is limited potential for interaction with the fishery.

Risk: Low-moderate, given its low-medium resilience and limited interaction.

Giant Queensland groper (*Epinephelus lanceolatus*)

Conservation status: The giant Queensland groper is protected under section 19 of the FM Act.

Distribution and decline: This species occurs throughout the tropical waters of the Indo-Pacific region and extends into some warm temperate waters. In NSW, the species generally occurs in the northern half of the State, from about Hawkesbury River (Heemstra and Randall, 1993). Over its range, the species is naturally rare, and has been extirpated from heavily fished areas. Due to its large size (up to 3m and 600kg) the species was sought after by line and spearfishers before becoming a protected species in NSW in the early 1980s (Pogonoski *et al*., 2002).

Key Threatening Processes: Hook and line fishing may pose a threat to the giant Queensland groper.

Other threatening processes: Commercial and recreational line fishing practices are potential threats to this species (Pogonoski *et al*., 2002).

Habitat: The species occurs at depths down to 100m, but is more common at shallower depths. It is commonly seen on coral reefs, in caves and around wrecks.

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the giant Queensland groper

Biological characteristics: There is little information on the biology or reproduction of this species. Like many large gropers, the species probably has a low natural mortality rate, reaches maturity and maximum size slowly, is inherently rare, moves little during the adult stage, forms spawning aggregations to spawn (may be targeted by fishers) and is protogynous (Huntsman and Schaaf, 1999), which are all factors that contribute to a low-medium resilience to fishing pressure.

Overlap and interaction with the fishery: Occurring only as far south as Sydney restricts the spatial overlap between Queensland groper and this fishery. Overlap is further restricted as the species is thought to be naturally rare, even in areas unexploited by fishing practices (Pogonoski *et al*., 2002). Hook and line fishing, however, is thought to be a threatening process for this species. In addition, other serranids (e.g. wirrah, Maori cod, and bar cod) are targeted in the fishery and many are reported as 'unspecified cod'. Reporting unspecified cod could indicate that there is an identification problem, which could result in Queensland groper being inadvertently retained. Fish and crustaceans targeted in this fishery are also likely prey for Queensland groper, providing a source of competition. Overall, there is limited potential for interaction with the fishery.

Risk: Low-moderate, given its low-medium resilience and limited interaction.

Herbsts nurse shark (*Odontaspis ferox*)

Conservation status: Herbsts nurse shark is listed as protected from fishing under Section 19 of the FM Act.

Distribution and decline: Records show an irregular distribution throughout most of the world's oceans. In Australia it has been recorded off NSW (Pogonoski *et al.*, 2002). Trawl surveys by the NSW Fisheries research vessel Kapala and an observer study of commercial trawling (Liggins, 1996) suggest that numbers have dramatically declined off NSW since the mid 1970s (Fergusson *et al.*, 2003). The decrease in abundance suggests that trawling is having an adverse effect on the population (Fergusson *et al.*, 2003).

Key Threatening Processes: No Key Threatening Processes are considered likely to affect Herbsts nurse shark.

Other threatening processes: Incidental capture by commercial fishing activities is considered a potential threat to this species in NSW (Pogonoski *et al.*, 2002).

Habitat: The species lives on or closely associated with the bottom in deep waters along continental and insular shelves and upper slopes (Last and Stevens, 1994). It has been recorded at depths of depths 150 to 850 m in NSW (Fergusson *et al.*, 2003). It is occasionally found in shallower water (Last and Stevens, 1994).

Recovery plans: No recovery plan is required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to Herbsts nurse shark

Biological characteristics: The size of this species at birth is over 1 m and the species reaches at least 3.6 m (Last and Stevens, 1994). Overseas studies have found that size at maturity is large, around 2.75 m for males (Compagno, 1984). Other aspects of the species' reproductive biology are thought to be similar to those of the grey nurse shark (Pogonoski *et al.*, 2002). Based on this information, the resilience of Herbsts nurse shark is considered to be low.

Overlap and interaction with fishery: Commercial fishing on the outer continental shelf and continental slope is considered to be a potential threat to the Herbsts nurse shark (Pogonoski *et al.*, 2002). Anecdotal reports suggest that trawling is the only fishing method by which the species is likely to be caught (K. Graham, NSW Fisheries, pers. comm., 2003).

Risk: Low-moderate. The very limited overlap with the fishery restricts the potential for impact on the species.

Protected species (section 20)

The following assessments of protected species include all marine fish whose distribution and/or biology could bring them into contact with the fishery, and whose risk levels due to the fishery were summarised in Table B2.39. The species considered in detail for the risk assessment include Australian bass, black marlin, blue groper, blue marlin, estuary perch and striped marlin. The other section 20 species, namely Atlantic salmon, brook trout, brown trout, eel-tailed catfish, freshwater crayfish, golden perch, Murray cod, rainbow trout and silver perch are all freshwater species and thus do not overlap or interact with the Ocean Trap and Line Fishery.

Australian bass (*Macquaria novemaculeata*)

Conservation status: The Australian bass is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: Occurs in coastal rivers from Mary River and Fraser Island in Queensland south to tributaries of Gippsland Lakes in Victoria. They are known to move extensively upstream, reaching altitudes of 600m in the Hawkesbury River system. Is thought to have declined severely as access to about half of its potentially available habitat has been obstructed by dams and weirs blocking important migration paths. River regulation also interferes with spawning cues provided by flooding and with subsequent population recruitment (Harris and Rowland, 1996).

Key Threatening Processes: Five of the six listed KTP pose a threat to Australian bass, including hook and line fishing, especially in areas where local fishing pressure is high; the introduction of fish to fresh waters within a river catchment outside their natural range; the removal of large woody debris; the degradation of native riparian vegetation along New South Wales water courses; and the installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.

Other threatening processes: Recruitment may also be prevented by acidification of streams whose catchments have been affected by artificial drainage schemes in potential acid-sulphate soils (Harris and Rowland, 1996).

Habitat:

Recovery plans: A recovery plan is not required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to Australian bass

Biological characteristics: Australian bass grow to about 600 mm and 3.8 kg, but are more commonly caught at much smaller sizes up to 1 kg. They migrate downstream into estuaries to breed from May to August before their return homing migration, and are highly fecund. Juvenile fish migrate upstream through spring and summer, as do females, whereas most males remain in tidal waters, so that the population is sexually segregated during the non-breeding season. There is marked sexual dimorphism, with males and females maturing at 180 mm (2-4 years) and 280 mm (5-6 years), respectively, and females growing much larger, although this difference is less marked in smaller rivers in the north of its range. Larvae feed on zooplankton and chironomid larvae, whereas older fish are generalised carnivores, eating a wide range of fish, crustaceans and insects (Harris and Rowland, 1996). Although there has not been a formal estimation of its resilience, these features suggest that it has moderate resilience.

Overlap and interaction with fishery: Australian bass prefer fresh and estuarine waters to the coastal nearshore and offshore waters in which the fishery operates. It is possible, however, that during flood events, some Australian bass move into nearshore waters where they may come into contact with the fishery, as evidenced by the capture of Australian bass in a fish trawl following a flood event (Liggins, 1996). Overall, there is very limited potential for interaction with the fishery.

Risk: Low, given its probable moderate resilience and very limited interaction.

Black marlin (*Makaira indica*)

Conservation status: The black marlin is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: An Indo-Pacific species found in tropical and subtropical waters, occasionally entering temperate waters (www.fishbase.org).

Key Threatening Processes: Hook and line fishing could affect this species.

Other threatening processes:

Habitat: Black marlin are a pelagic species, usually found in surface waters above the thermocline, often near shore close to land masses, islands and coral reefs. They occur down to a depth of about 915m, and prefer waters in the range of 15-30^{o}C (www.fishbase.org).

Recovery plans: None is required, as this species is not listed as vulnerable or endangered.

Assessment of risk to striped marlin

Biological characteristics: Black marlin are thought to grow to about 465cm and 750kg. They feed on fishes, squids, cuttlefishes, octopods, large decapod crustaceans and mostly on small tunas when abundant. They are thought to have medium resilience, with an estimated minimum population doubling time of 1.4 - 4.4 years (K=0.47; Fec=67 million; assuming tm>2) (www.fishbase.org).

Overlap and interaction with fishery: Black marlin are very widely distributed, and NSW waters represent a small proportion of their distribution, limiting the overlap between this species and the fishery. They have not been recorded on catch returns in this fishery.

Risk: Low, given the species' resilience, its wide distribution and limited interaction with the fishery.

Blue groper (*Achoerodus viridis*)

Conservation status: The blue groper is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: Occurs from Hervey Bay, Queensland, to Wilsons Promontory in Victoria (Hutchins and Swainston, 2001). Recreational angling is the only method by which the species can be taken, and although there is some evidence that the species is still being overfished in some areas, in others its protected status has allowed it to rebuild numbers to the point where it is commonly seen on rocky reefs throughout its range (Smith *et al*., 1996).

Key Threatening Processes: Hook and line fishing may pose a threat to the blue groper, especially in areas where local fishing pressure is high (Pogonoski *et al.*, 2002).

Other threatening processes: Illegal spearfishing also poses a threat to the blue groper (Pogonoski *et al.*, 2002).

Habitat: Juveniles inhabit seagrass beds until they reach about 10 cm in length, when they move to rocky reefs. Adults may range over large areas of reef in estuaries and offshore to depths of at least 60 m. (Gillanders, 1995a; Kuiter, 1996)

Recovery plans: A recovery plan is not required for this species because it is not listed as vulnerable or endangered.

Assessment of risk to the blue groper

Biological characteristics: The blue groper is a protogynous hermaphrodite, commencing life as a female, with some individuals changing to males after 8-18 years. Females are mature at 1-2 years. The sex ratio is heavily biased toward females (1:6.8 - 1:62 (Gillanders, 1995b)). The reproductive characteristics of the species make it particularly susceptible to overfishing of large males (Gillanders, 1995b), which is partly why it is a s20 protected species and has a low bag limit for recreational anglers. Based on this information, the resilience of the species is considered to be moderate (i.e. it has four risk averse traits and two risk prone traits).

Overlap and interaction with fishery: There is considerable spatial overlap between the fishery and blue groper, however there is no published information about the extent of any interactions. Observer data collected during a mesh selectivity study of this fishery indicates that blue groper were caught infrequently in traps and discarded alive (J. Stewart, NSW Fisheries, unpublished data). There is no information about the incidence of hooking with line gear, although it is likely to occur infrequently, as the diet of eastern blue groper primarily includes crustaceans, molluscs and echinoderms, and lines in the fishery are usually baited with fish flesh.

Risk: Low-medium, given the perceived increase in numbers throughout most of its range, its resilience and limited interaction with the fishery.

Blue marlin (*Makaira mazara*)

Conservation status: The blue marlin is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: An Indo-Pacific species found in tropical, subtropical and sometimes temperate waters. It is the most tropical billfish species and is common in equatorial waters (www.fishbase.org).

Key Threatening Processes: Hook and line fishing could affect this species.

Other threatening processes:

Habitat: Blue marlin are an epipelagic and oceanic species, mostly confined to the waters on the warmer side of the 24°C surface isotherm and known to effect seasonal north-south migrations. Not usually seen close to landmasses or islands, unless there is a deep drop-off of the shelf. They occur down to a depth of about 40m (www.fishbase.org).

Recovery plans: None is required, as this species is not listed as vulnerable or endangered.

Assessment of risk to blue marlin

Biological characteristics: Blue marlin are thought to grow to about 500 cm and 900 kg, with a reported maximum age of 28 years. They are believed to form small-scale schools of at most ten smaller individuals, whereas larger fish tend to be solitary. Blue marlin feed on squids, tuna-like fishes, crustaceans and cephalopods, and are caught with trolled lines (of live baits or lures). They are thought to have low resilience, with an estimated minimum population doubling time of 4.5 - 14 years (r=0.104; K=0.12-0.29; Tm=4; Tmax=28; Fec=31 million) (www.fishbase.org).

Overlap and interaction with fishery: Blue marlin are very widely distributed, and NSW waters represent a small proportion of their distribution, limiting the overlap between this species and the fishery. Prior to their protection under s20 of the FM Act, they were recorded on catch returns in this fishery. Pre-protection catches of less than 1 ton, indicate that very few fish were retained. Catches are also likely to be limited by season.

Risk: Low-moderate. Despite the low resilience of blue marlin, they are considered to be at low-moderate risk from this fishery because of their limited overlap and protected status. Resilience is more important when species are being retained, and thus removed from the population, but that is not the case in this fishery. Further, it is probable that the active methods by which they are caught in this fishery, primarily trolling and live baiting, are unlikely to result in hooking and retrieval mortality.

Estuary perch (*Macquaria colonorum*)

Conservation status: The estuary perch is protected from commercial fishing under section 20 of the FM Act.

Distribution and decline: Estuary perch occurs in coastal rivers and lakes, from the Richmond River in northern NSW south to the mouth of the Murray River in South Australia. It is also found in the Arthur and Ansons Rivers in northern Tasmania. The species has undergone an apparent decline, but no data are available and the species is protected from commercial fishing and conservative bag limits apply to angling catches (Harris and Rowland, 1996).

Key Threatening Processes: Five of the six listed KTP pose a threat to Australian bass, including hook and line fishing, especially in areas where local fishing pressure is high; the introduction of fish to fresh waters within a river catchment outside their natural range; the removal of large woody debris; the degradation of native riparian vegetation along New South Wales water courses; and the installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams..

Other threatening processes: Overfishing is cited as the main reason for the decline of this species (Harris and Rowland, 1996).

Habitat: Occurs in tidal waters in the north, but moves further upstream in the southern part of its range away from the main distribution of the closely related Australian bass. Generally prefers deeper and more saline waters than bass and is commonly found in fresh or slightly brackish reaches of estuaries.

Recovery plans: None is required, as this species is not listed as vulnerable or endangered.

Assessment of risk to estuary perch

Biological characteristics: Breeds in seawater at the mouths of estuaries in winter, and numerous, non-adhesive eggs are deposited into the water and are planktonic. Males and females mature at approximately 220 mm and 280 mm, respectively. Diet primarily includes shrimps, prawns and small fishes, but also includes other crustaceans, bivalve molluscs and worms (Harris and Rowland, 1996). Although there has not been a formal estimation of its resilience, these features suggest that it has moderate resilience.

Overlap and interaction with fishery: As its name suggests, estuary perch prefer estuarine waters to the coastal nearshore and offshore waters in which the fishery operates. It is possible, however, that during flood events, some estuary perch may move into nearshore waters where they may come into contact with the fishery. Overall, there is limited potential for interaction with the fishery.

Risk: Low-moderate, given its limited interaction with the fishery.

Striped marlin (*Tetrapturus audax*)

Conservation status: The striped marlin is protected from commercial fishing under section 20 of the FM Act. There is, however, a defence to a prosecution for an offence under section 20 (3) (b) of the Act (relating to sale of fish protected from commercial fishing) if the striped marlin was taken by a person while lawfully taking or attempting to take tuna for sale, by the method of long line (pelagic), minor line or pole fishing, under the authority of a permit issued under a law of the Commonwealth.

Distribution and decline: An Indo-Pacific species found in tropical, subtropical and temperate waters. Occasionally found on the Atlantic side of the Cape of Good Hope. Their distribution in the Pacific Ocean is unique among billfishes and tunas in that it forms a horseshoe-shaped pattern from the northwest Pacific through the eastern Pacific to the southwest Pacific. In the Indian Ocean, fish are more densely distributed in equatorial regions with higher concentrations off eastern Africa, in the western Arabian Sea, the Bay of Bengal and off northwestern Australia. Most dominant and widely distributed of all billfishes. Their abundance increases with distance from the continental shelf (www.fishbase.org).

Key Threatening Processes: Hook and line fishing could affect this species.

Other threatening processes:

Habitat: Striped marlin are an epipelagic and oceanic species, usually found above the thermocline or about 100m. Generally inhabit cooler water than either black (*Makaira indica*) or blue marlin (*M. mazara*) (www.fishbase.org).

Recovery plans: None is required, as this species is not listed as vulnerable or endangered.

Assessment of risk to striped marlin

Biological characteristics: Striped marlin are thought to grow to about 420 cm and 440 kg. Usually seen close to shore only where deep drop-offs occur, and are mostly solitary, but form small schools by size during the spawning season. They are usually dispersed at considerably wide distances. Spawning sites are between 10°S and 30°S in the southwest Pacific and 10°S and 20°S in northeastern Indian Ocean. There is little information on the distribution of striped marlin eggs and larvae, and juveniles are relatively rare in the southwest Pacific Ocean. Fish of 4-10 kg (80-100 cm FL) are regularly caught on longlines in the region but concentrations of fish this size are mostly restricted to the northcentral Pacific Ocean. They feed on fishes, crustaceans and squids. They are thought to have medium resilience, as their minimum population doubling time is estimated at 1.4 - 4.4 years (r=0.09; K=0.2-0-6; Tm=2-3) (www.fishbase.org).

Overlap and interaction with fishery: Striped marlin are very widely distributed, and NSW waters represent a small proportion of their distribution, limiting the overlap between this species and the fishery. They have been recorded on catch returns in the past, however, indicating that they are targeted or retained as byproduct. Total weights for the last five years have been less than 1ton, indicating that only four or five fish are retained per year. Catches are also likely to be limited by season.

Risk: Low, given the species' medium resilience, its extensive distribution and limited interaction with the fishery.

Risks to species listed under the Threatened Species Conservation Act (TSC Act) and Environment Protection Biodiversity Conservation Act (EPBC Act)

Endangered species

Birds

Gould's petrel

Conservation status: The Gould's petrel, *Pterodroma leucoptera leucoptera,* is listed an Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Cabbage Tree Island, near Port Stephens (NSW), was thought to be the only breeding site for this endemic species, but some nesting birds were also found on nearby Boondelbah Island in 1995 (NSW NPWS, 2000a). The species distribution during its non-breeding season (May – October) is unknown, but it is thought to forage predominantly in the Tasman Sea (NSW NPWS, 2000a). Beach washed specimens and sightings at sea extend from the Queensland border to Eyre on the south coast of Western Australia (NSW NPWS, 2000a). Between 1970 and 1993, a decline in the population on Cabbage Tree Island has been documented, estimated numbers decreased from 2,000 to between 1,150 and 1,500 birds (Priddel and Carlile, 1997). The lowest number of breeding pairs recorded on Cabbage Tree Island was 122 in 1990, this increased to 425 pairs in 1995 and has increased each year since (Priddel and Carlile, 1997; NSW NPWS, 2000a).

Key Threatening Processes: This species is listed as being under threat from the activity of feral rabbits (Environment Australia, 1999). Recovery planning for this species under state legislation has successfully implemented the objectives of the threat abatement plan for feral rabbits prepared by Environment Australia and eliminated the identified threat of rabbits to this isolated endangered species. This species is also particularly affected by the ingestion of or entanglement in harmful marine debris (Threatened Species Scientific Committee, 2003).

Other threatening processes: A successful rabbit eradication program conducted on Cabbage Tree Island has eliminated the previously listed threat of nesting habitat degradation by rabbit grazing activity (NSW NPWS, 2000a). Bird-lime trees have not yet been fully removed from Cabbage Tree Island, and the species is still threatened from entanglement in the sticky fruit of this tree (NSW NPWS, 2000a). The species is also currently threatened by predation from avian predators, such as ravens and currawongs, and noise disturbance from military jet aircraft activity (NSW NPWS, 2000a).

Habitat and ecology: This pelagic species occasionally occurs offshore and is rarely observed less than 10 km from its breeding islands (Marchant and Higgins, 1990). It feeds off squid, but their diet is otherwise unknown (Marchant and Higgins, 1990). Like other members of the gadfly group of petrels, the Gould's petrel is also likely to feed on surface fish and krill (NSW NPWS, 2000a). Adult birds begin arriving on Cabbage Tree Island from mid to late September, and the fledglings depart the island from late March to early May, and are thought to then remain at sea for several years (NSW NPWS, 2000a). Breeding pairs produce one egg per clutch (Marchant and Higgins, 1990).

Recovery plans: The NSW NPWS initially prepared a draft recovery plan for the Gould's Petrel in 1996. The five-year life span of this plan has passed and in 2000 a new draft recovery plan for this species was prepared (NSW NPWS, 2000a). The implementation of the initial draft recovery plan has reduced some of the main threats to this species and a corresponding increase in its population and survival has resulted (NSW NPWS, 2000a). None of the recovery actions listed in the current draft recovery plan relate to fishing activities. An action to study the dietary and energetic requirements of this species should identify its marine food resources. This could have future consequences for the fishing industry if the petrel is found to have a reduced reproductive success from limited food resources that are also landed by fishers. Another recovery action, to recommend the declaration of Cabbage Tree Island as a Critical Habitat under the TSC Act, may also have potential consequences for future fishing activity in the vicinity.

Assessment of risk to Gould's petrel

Biological characteristics: The information provided above shows that the Gould's petrel has a restricted geographic range and the small population is restricted to breeding on two islands. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the Gould's petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, especially closer to Port Stephens during its breeding season (September to May). The OTLF could interact with both breeding and non-breeding individuals of this species only when they are foraging. Breeding birds of this species are thought to forage some distance from their breeding islands, probably greater than 10km away. Although the dietary requirements of this species are not well known, the OTLF may be contributing to a reduced availability of food at the water's surface by harvesting species known to herd small baitfish to the water's surface, rather than directly harvesting the prey of this species (see discussion under section B2.4). There are no records of interactions between this species and the OTLF. The Gould's petrel is not known to actively follow fishing vessels and feed on their discards. As its breeding population is currently increasing and the draft recovery plan does not list fishing related activities as a threat to this species (NSW NPWS, 2000a) it seems that if the species does actively feed on fishing discards, is disturbed by the noise or light emitted from fishing vessels or is caught as bycatch, that these interactions either occur infrequently and/or are having a negligible effect on the species. While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the Gould's petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Little tern

Conservation status: The little tern, *Sterna albifrons*, is listed as Endangered under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: In Australia, this species occurs from Shark Bay (WA), around northern and eastern Australia, to the east coast of Tasmania and around to the Gulf of St Vincent in

South Australia. In NSW, a second population of the subspecies *sinensis* predominantly occurs, which is migratory, breeding in the spring and summer along the entire east coast from Tasmania to northern Queensland. The other population of the subspecies breeds in Asia and migrates to Australia in summer, masking the size of the threatened, eastern Australian population. Little terns have been recorded nesting at 70 sites along the NSW coast, but at only 31 since 1987 and 11 in 1998/99. Since 1995, the largest, most successful colonies have been at Sawtell, Harrington, Botany Bay, Lake Wollumboola and more recently Farquhar Inlet (formerly known as Old Bar) (NSW NPWS, 2000b).

Key Threatening Processes: Entanglement in or ingestion of anthropogenic debris is likely to affect this species (NSW Scientific Committee, 2003).

Other threatening processes: The species is threatened by human disturbance from 4WD and trail-bike use to walking or simply sitting or fishing on the beach, adverse weather conditions, predation by introduced animals and birds, coastal development, reduced food availability, damage to estuarine habitats and pollution (NSW NPWS, 2000b).

Habitat and ecology: The little tern occurs on ocean beaches and in sheltered coastal environments especially those with exposed sandbanks of sandspits, including lagoons, estuaries, lakes, bays and inlets. It rarely occurs on rocky or muddy shores. Little terns are migratory or partly migratory seabirds. Most of its nesting sites are sand-spits, sand islands or beaches within or adjacent to the mouths of rivers, creeks and coastal lakes. Nesting also occurs at some sites on ocean beaches well away from estuaries, but often with a large coastal lake nearby. The species forages in the shallow waters inside or at the mouth of estuaries and up to 50m offshore. Little terns in NSW feed predominantly, perhaps exclusively, on fish less than 10 cm long often generally referred to as whitebait. These include perchlets (*Ambassis* spp.), surfsardines (*Iso rhothophilus*) and sprats (Clupeidae), but may also include juvenile mullet, gudgeons, tailor and whiting.

Recovery plans: No recovery plan has been finalised for this species. A draft recovery plan was prepared by NSW NPWS in 2000, but it has not been finalised.

Assessment of risk to the little tern

Biological characteristics: The little tern uses eggs requiring parental care to reproduce, and has a low reproductive output producing one to three eggs per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: It is only the OTLF activities occurring within 50m of the shore that could potentially interact with this species. The fishery does not harvest the preferred prey of this species and therefore competition for the food resources of this species is not an issue. There are no records of any interactions between this species and the OTLF. This species is not known to forage around or follow fishing vessels and bycatch is not a listed threat for this species. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the little tern and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-mod. The OTLF is largely an offshore fishery, only its activities occurring within 50m of the shore could interact with this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Northern royal albatross

Conservation status: The northern royal albatross, *Diomedea sanfordi*, is listed as Endangered under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The species has a circumpolar distribution over the Southern Ocean from 36°S to at least 52°S (Environment Australia, 2001b), and is most common in New Zealand and South American waters (Marchant and Higgins, 1990). It breeds biennially at Chatham Island and Taiaroa Head on New Zealand’s South Island, from November to September (Gales, 1998). Non-breeders of all age groups of this species appear to wander widely between breeding seasons (Environment Australia, 2001b). In Australia, the species is generally found offshore in southeastern waters from Coffs Harbour in the east to Eyre Peninsula in the west, especially in Tasmanian and South Australian waters (Environment Australia, 1998a). The infrequent records of this species in NSW (Environment Australia, 2001b) are from off Coffs Harbour to Bellambi (Pizzey and Doyle, 1985). The total breeding population of this species is 8,500, and there are possibly 34,000 individuals of this species in total (Environment Australia, 2001b). The breeding populations on the Chatham Islands, the main breeding location for this species, are decreasing (Environment Australia, 2001b).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: When on their breeding islands in New Zealand, northern royal albatrosses are threatened by illegal chick harvesting, nesting habitat degradation and climatic changes which are either drying nests or damaging them through storms (Gales, 1998). When at sea, the species is threatened from fishing activities, the previously mentioned longlining activity and the cables and warps used on trawlers, with which the species can collide (Gales, 1998).

Habitat and ecology: This pelagic species breeds every two years in colonies among grass tussocks and feeds on squid, fish and crustaceans (Marchant and Higgins, 1990; Gales, 1998). It begins breeding after nine years of age and has lived for at least 61 years in the wild (Robertson, 1998). One egg is produced per clutch (Environment Australia, 2001b).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to northern royal albatross

Biological characteristics: The information provided above shows that the northern royal albatross is a long lived species that reaches maturity at greater than nine years of age, uses eggs requiring parental care to reproduce and has a low reproductive output, producing one egg per clutch. Its breeding habitat is restricted and current population is small. Subsequently, the resilience level of the northern royal albatross is low.

Overlap and interaction with fishery: Only the OTLF activities occurring south of Coffs Harbour could potentially interact with this species. As this species has only been recorded infrequently in this area and is known to be more common in other waters around Australia and the world, the OTLF could potentially affect only a small number of individuals. As the foraging distance of breeding individuals at their New Zealand colonies is not known, it will be assumed that the fishery could encounter both breeding and non-breeding individuals. The fishery could only interact with this species when it is foraging. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by the harvesting of species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing northern royal albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels, however given the occurrence of this species in the area, any resulting injury or mortality would be infrequent and only have a negligible impact on the population as a whole. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the northern royal albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only a small number of northern royal albatrosses occur off NSW, south of Coffs Harbour. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Southern giant-petrel

Conservation status: The southern giant-petrel, *Macronectes giganteus*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: The southern giant-petrel has a circumpolar pelagic range from Antarctica to approximately 20^{o}S (Marchant and Higgins, 1990). During the species' breeding season, in summer, it is mostly found in Antarctic waters (Marchant and Higgins, 1990). In winter, its range extends into subtropical waters and it is mostly found north of 50°S (Marchant and Higgins, 1990). The species is a common visitor off the entire NSW coast. The global population of this species reduced approximately 17% between 1985 to 2001 (NSW Scientific Committee, 2001a). The estimated 5,000 breeding pairs in Australian territory represents a reduction of approximately 50% since the middle of the last century (Marchant and Higgins, 1990).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). The species is also affected by predation by cats on breeding islands (Garnett and Crowley, 2000).

Other threatening processes: Other identified threats include human disturbance, the accumulation of chemical contamination, predation from rats, habitat degradation from introduced animals and on some breeding islands, hunting (Marchant and Higgins, 1990; Garnett and Crowley, 2000). Within NSW waters, the species is potentially threatened by the loss of southern cuttlefish populations, illegal longline fishing operations and oil spills (NSW Scientific Committee, 2001a).

Habitat and ecology: Found in Antarctic to subtropical waters, this marine species occurs over both pelagic and inshore waters (Marchant and Higgins, 1990). Over summer, it nests annually on Antarctic and subantarctic islands, including Heard and Macquarie Islands, Antarctica and South America, with about 30% of the potential breeding population not attempting to breed each year (Marchant and Higgins, 1990). Males first breed at 4-6 years of age and females at 7-8 years (Marchant and Higgins, 1990). A single chick is raised (Marchant and Higgins, 1990). Adults are present around Antarctic breeding colonies all year, while immature petrels disperse north during winter (Marchant and Higgins, 1990). The species is an opportunistic scavenger and predator and feeds mostly on smaller seabirds, cephalopods, krill, fish and animal carcasses, from the surface of the sea and sometimes on land (Marchant and Higgins, 1990). Very occasionally, the species will dive to shallow depths to capture their prey (Harper, 1987). The species regularly attends fishing vessels (NSW Scientific Committee, 2001a).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to southern giant-petrel

Biological characteristics: The information provided above shows that the southern giant-petrel generally reaches maturity at greater than five years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its current population is much smaller than it was historically. Subsequently, the resilience level of the southern giant-petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, over both pelagic and inshore waters, mostly during winter. The fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter immature individuals. The reason being that the OTLF operates some distance from the nearest breeding colony at Macquarie Island, and adults tend to remain near their colonies throughout the year. As this species feeds from the waters surface and by shallow diving, its natural prey is likely to comprise only of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing southern giant-petrels on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the southern giant-petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. This fishery would only interact with this species during winter. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Wandering albatross

Conservation status: The wandering albatross, *Diomedea exulans*, is listed as Endangered under the TSC Act and as Vulnerable under the EPBC Act.

Distribution and decline: The wandering albatross has a southern circumpolar distribution over the Antarctic, subantarctic and subtropical waters of the Atlantic, Pacific and Indian Oceans (Marchant and Higgins, 1990). The species can be found in southern Australian waters throughout the year (Marchant and Higgins, 1990). It has been recorded along the entire coast of NSW (NSW Scientific Committee, 1996) and is most abundant here from mid-June to mid-September (Marchant and Higgins, 1990). All populations of this species that have been monitored have decreased over the past 20 years (NSW Scientific Committee, 1996). The most recent global population estimate of this species is 55,000 individuals, with around 8,500 pairs breeding annually (Gales, 1998). At last report, fewer than ten pairs breed annually on Macquarie Island (Gales, 1998), a maximum of 44 annual breeding pairs have recorded on this island (Environment Australia, 2001b).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: The species is shot for bait or to prevent them from scavenging bait from drop line fishing gear (Garnett and Crowley, 2000). On Macquarie Island, it is affected by an elevated number of Antarctic skuas and human disturbance (Garnett and Crowley, 2000). The accumulation of chemical contaminants and human disturbance may also pose risks to this species (Garnett and Crowley, 2000).

Habitat: In the Australasian region, this highly dispersive marine species occurs inshore, offshore and in pelagic waters, regularly feeding in sheltered harbours and straits, and has been recorded as gathering at sewage outfalls (Marchant and Higgins, 1990). The species breeds every two years on about nine subantarctic and Antarctic islands, including Macquarie Island, during summer (Marchant and Higgins, 1990). Birds first breed at 7-16 years of age (Environment Australia, 2001b). One egg is produced per clutch (Marchant and Higgins, 1990). They feed mostly on cephalopods and fish by scavenging, seizing food from the surface, shallow plunging or pursuit plunging, and do most of their hunting at night (Marchant and Higgins, 1990). The species frequently attends fishing vessels for food (Brothers, 1991).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to wandering albatross

Biological characteristics: The information provided above shows that the wandering albatross generally reaches maturity at 7-16 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. The breeding habitat of this currently small population is restricted to around nine islands. Subsequently, the resilience level of the southern giant-petrel is low.

Overlap and interaction with fishery: This species can occur throughout the whole area of operation of the OTLF, including inshore, offshore and deeper water, throughout the year but mostly from mid-June to mid-September. As the species is highly dispersive, the fishery may encounter both breeding birds from distant breeding colonies and non-breeding birds. The fishery can only interact with this species while it is foraging. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised moderate likelihood of capturing wandering albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be moderate. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Illegal shooting to protect bait is a listed threat to this species, it is not known if this occurs in the OTLF, guns are allowed to be used by this fishery for OH&S purposes. In all, any interactions between the wandering albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. The fishery could mostly interact with this species between mid-June to mid-September. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Mammals

Unless otherwise specifically referenced, the following information on mammals was obtained from *The Action Plan for Australian Cetaceans* (Bannister *et al.*, 1996).

Blue whale

Conservation status: The blue whale, *Balaenoptera musculus*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Occurring throughout the world's oceans, blue whales migrate between warm water breeding grounds in tropical and subtropical waters and cold water feeding grounds in polar and subpolar waters. There are three subspecies of blue whale, the spatially disjunct northern and southern 'true' blue whale and the pygmy blue whale (Clapham *et al.*, 1999). In the southern hemisphere, 'true' blue whales occur between 20^{o}S and 60-70^{o}S. Pygmy blue whales only occur in the southern hemisphere, particularly in the Indian Ocean, and migrate to north of 50^{o}S in summer. Blue whales have been recorded from all Australian states. Recent strandings in Australia have mostly been pygmy blue whales. Their migration paths are widespread and do not obviously follow coastlines or oceanographic features.

The waters off the far south coast of NSW, and the adjacent waters off Victoria, are one of only three recognised aggregation areas for blue whales in Australia (Environment Australia, 2001c). Blue whales have been sighted in NSW waters on a number of occasions mostly between Bermagui and Green Cape, mostly in October and November (Smith, 2001). While there are no confirmed records of pygmy blue whales in NSW waters, it is likely that some NSW sightings of blue whales may have been this species as it is the more common subspecies in adjacent Victorian waters (NSW Scientific Committee, 2002a).

The population of ‘true’ blue whales dramatically declined during historical whaling operations that fully ceased in the early 1970s. The current southern hemisphere population of ‘true’ blue whales has been estimated at 610 and pygmy blue whales at 4,300 (Butterworth *et al.*, 1995). This is only a small proportion of the original population.

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003). Human induced climate change also threatens this species (NSW Scientific Committee, 2002a).

Other threatening processes: The numbers of blue whales have been so severely depleted that the species vulnerability to other threats is exacerbated (NSW Scientific Committee, 2002a). The species is threatened by seismic operations, collision with large vessels, entanglement in fishing gear, defence operations, and pollution leading to the accumulation of toxic substances in body tissues (NSW Scientific Committee, 2002a).

Habitat and ecology: Blue whales mostly occur along the edges of continental shelves and along ice fronts, and also in both deep oceanic waters and shallow inshore zones (Leatherwood and Reeves, 1983). ‘True’ blue whales reach a maximum age of 80-90 years and a maximum length of 30.5 m. ‘True’ blue males reach sexual maturity at 22 m and females at 23-24 m (5-10 years of age). They give birth to a single calf every two to three years in the tropical open ocean in winter after a 10-11 month gestation period (Rafic, 1999). They mate in winter. Pygmy blue whales reach a maximum age of less than 50 years and a maximum length of 24.4 m. Pygmy blue whales calve every two to three years in tropical open oceans in winter after a 10-11 month gestation period. They mate in winter. ‘True’ blue whales feed almost exclusively on one species of krill in Antarctic waters. Pygmy blue whales feed further north on smaller krill, and have been reported feeding off southern Australia. They exhibit both shallow and deep diving behaviour, and can dive for up to 30 minutes. In one day they may consume two to four tonnes of food.

Recovery plans: A draft recovery plan for blue whales in Australian waters, prepared by Environment Australia, recommends the protection of identified critical habitat, programs to reduce human-induced mortality, maintenance of the stranding and sightings database, continued cooperation with international conservation programs and research to achieve these management goals and increase knowledge of this population (Rafic, 1999).

Assessment of risk to blue whale

Biological characteristics: The information provided above shows that both the ‘true’ and pygmy blue whales have a small population size, live a long time, reach maturity at greater than five years of age and produce a single offspring every two to three years that, like all other mammals, requires some parental care. Consequently, the resilience level of ‘true’ and pygmy blue whales is low.

Overlap and interaction with fishery: It is the OTLF activities south of Bermagui, especially those occurring well offshore, that could interact with this species mostly during October and November. Blue whales could interact with the fishery by colliding with the vessel or entangling in fishing gear or debris. Competition with the OTLF for food is unlikely because the species feeds on krill in Antarctic waters. The collision of blue whales with vessels is rare, the small number of mortalities that may result from this interaction may be significant for this species if it is not recovering (Rafic, 1999). Up to 1999, there were no records of blue whales colliding with whales in Australian waters (Rafic, 1999). The collision of the species with the small vessels used in the OTLF is likely to be extremely rare because of the oceanic distribution of this species, these vessels are far less likely to affect the species than the large container ships that are main listed threat. Entanglement in passive line fishing gear, trap ropes and debris is possible however it is likely to be extremely rare because of the oceanic distribution of this species (Rafic, 1999). In the DEC Marine Fauna Management Database, no blue whales were amongst the seven mammals reported entangled in trap ropes off NSW over the last ten years. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Given the low probability of OTLF activities coming into contact with blue whales, the risk is considered to be low-medium.

Dugong

Conservation status: The dugong, *Dugong dugon,* is listed as Endangered under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The dugong occurs in the Indian and western Pacific Oceans, between about 27^{o}N and 27^{o}S (Smith, 2001). It is now found in small relict populations separated by large areas where it is close to extinction (Smith, 2001). The resident populations around the northern shoreline of Australia from Shark Bay (WA) to Moreton Bay (Qld) support most of the current world population of the species (Smith, 2001). Dugongs usually only occur in NSW as occasional stragglers usually in waters north of Jervis Bay, although they have been reported as far south as Twofold Bay (Smith, 2001). In 1992-93, there was an influx of dugongs (many of them dying) from Hervey Bay into NSW waters. This was due to a large loss of habitat following floods and a cyclone (Smith, 2001). NSW waters act as a refuge area for Queensland’s dugongs (NSW Scientific Committee, 2002b). The minimum size of the Australian population of dugongs was estimated to be 85,000 (Smith, 2001). Populations in the southern Barrier Reef and Hervey Bay area have declined in recent years (Smith, 2001).

Key Threatening Processes: This species could be affected by human induced climate change (Threatened Species Scientific Committee, 2001).

Other threatening processes: Dugongs are threatened by coastal development, poor catchment management leading to siltation and the loss of seagrass beds, traditional hunting, collision with boats, and incidental mortality in gillnets and shark protection nets. Isolated dugong populations are vulnerable to local extinction following stochastic events such as floods or cyclones (NSW Scientific Committee, 2002b).

Habitat and ecology: Dugongs are found in the shallow coastal parts of tropical and subtropical waters. They feed on a wide variety of seagrass species and algae, although usually only in very small amounts if seagrasses are abundant. They live for up to 70 years, reach sexual maturity after ten years and produce a single calf every three to five years (Marsh *et al.*, 1984).

Recovery plans: A recovery plan for the dugong in NSW has not been prepared, but there is a conservation plan for Queensland (Queensland Environmental Protection Agency, 1999).

Assessment of risk to dugong

Biological characteristics: The information provided above shows that the dugong is long lived, reaches sexual maturity after ten years and produces a single calf (twins are rare) every three to five years that, like all other mammals, requires some parental care. Its global population is much smaller than it was historically. Subsequently, the resilience level of the dugong is low.

Overlap and interaction with fishery: Dugongs generally only occur as rare vagrants in NSW, with the exception of the influx in 1993 described above. It is the OTLF activities occurring north of Jervis Bay in shallow inshore waters only that overlap with the distribution of this species. The capture of dugongs on line and trap fishing gear is not listed as a threat in the dugong conservation plan (Queensland Environmental Protection Agency, 1999) and will probably not occur in the OTLF as this species is mainly herbivorous and is not likely to place itself at risk of being captured by feeding on the bait or discards associated with the fishery. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Given the very small probability of a dugong coming into contact with OTLF fishing gear in NSW, the risk is considered to be low-medium.

Southern right whale

Conservation status: The southern right whale, *Eubalaena australis*, is listed as Endangered under the EPBC Act and as Vulnerable under the TSC Act.

Distribution and decline: Southern right whales occur across the southern hemisphere between around 30^{o} and 60^{o}S. They feed in summer in the higher latitudes of their range (between about 45^{o}S and 55^{o}S) and generally move to the lower latitudes for breeding in winter. They approach coasts in winter. In Australia, the species is a winter-spring visitor, occurring around the southern coastline from Perth (WA) to Sydney (NSW), including Tasmania. Their Australian range is possibly extending further north as sightings have been reported from Shark Bay and North West Cape (WA) and Byron Bay (NSW).

The species is regularly observed close to shore along the NSW coast between May and November, and there are a couple of January records (Smith, 2001). The species has mostly been sighted in southern and central NSW (south of Newcastle), although there are some records further north, the furthest from Byron Bay (Smith, 2001). New-born calves are regularly sighted in NSW waters (Smith, 2001). After calving in NSW waters, the population perhaps moves offshore before migrating to more southerly waters in summer (Smith, 2001).

The population of southern right whales dramatically declined during historical whaling operations that ceased in the 1960s. Population estimates are difficult for this species, given its irregular movement and calving cycle. The numbers of southern right whales off southern Western Australia have increased since 1977 at around 10% per year. The Australian population remains small compared with its likely size before exploitation (Smith, 2001). The numbers of southern right whales that visit NSW in any one year is probably less than ten (Warneke, 1996).

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Southern right whales are threatened by direct disturbance, especially when they are close to the coast. The disturbance can result from whale watching activities, recreational and research related boating activities, collision with large vessels, swimmers, divers, low-flying aircraft, coastal industrial activity, defence operations, entanglement in fishing gear and pollution leading to the accumulation of toxic substances in body tissues.

Habitat and ecology: In summer, southern right whales are pelagic and feed in the open Southern Ocean. In winter, they occur close to the coast, particularly calving females. Consistent calving locations in Australia in recent years have been at Doubtful Island Bay and east of Israelite

Bay (WA), the head of the Great Australian Bight (SA), and off the South Australian gulfs and Warrnambool (Victoria). They live to a maximum of 50+ years and reach a maximum length of 17.5 m. Sexual maturity is reached around nine to ten years / 12-13 m. They generally calve every three years in preferred onshore localities during June-August after an 11-12 month gestation period. They mate from July-August. The data implies that there is no feeding near the coast in winter, calving females effectively fast for a little over four months. These baleen whales feed mainly on smaller plankton and copepods, taken primarily in the open ocean, presumably south of 40^{o}S, in summer at or near the surface. Near shore, their swimming speeds are generally slow, however they are capable of reaching 15+ km / hr over short distances.

Recovery plans: The draft recovery plan for southern right whales in Australian waters, prepared by the Commonwealth, recommends minimising human induced threats, the identification and protection of critical and/or preferred habitats, continued cooperation with international conservation programs and research (Burnell and McCulloch, 2001).

Assessment of risk to southern right whale

Biological characteristics: The information provided above shows that the southern right whale is long lived, reaches sexual maturity after nine to ten years and produces a single calf at a time that like all other mammals require some parental care. Its population is much smaller than it was historically. Subsequently, the resilience level of the southern right whale is low.

Overlap and interaction with fishery: The species is frequently seen in inshore areas along the New South Wales coast from May to November (Smith, 2001). The draft recovery plan for the species identifies Twofold Bay and coastal waters 5 km north and south as an area of frequent use by the species, however the plan acknowledges that other areas may become important as the population recovers (Burnell and McCulloch, 2001). Data from South Africa indicates that over the winter, females with calves generally occur in shallow waters, sometimes less than 5 m deep, and that all whales generally occur within 1.85 km of the shore (Best, 1990). Given this distribution, interaction with the OTLF seems likely to occur. Such interactions may include acoustic disturbance, collision with vessels and entanglement in fishing gear. Competition with the OTLF is unlikely because the species feeds on krill in Southern Ocean feeding grounds. Collision with vessels rarely occurs and is considered not to pose a threat to this species (Burnell and McCulloch, 2001). Entanglement in passive line fishing gear, trap ropes and debris is possible however it is likely to be rare. In the DEC Marine Fauna Management Database, no southern right whales were amongst the seven mammals reported entangled in trap ropes off NSW over the last ten years. Acoustic disturbance from fishing boats is possible, and would constitute the greatest risks in near shore aggregation areas (Burnell and McCulloch, 2001). Short-term effects of disturbance from boats may vary from apparently little change to avoidance of rapidly moving vessels (Richardson *et al.* 1995). The long-term impacts of repeated disturbance may include the abandonment of critical habitats, which could have a long-term negative impact on the population (Burnell and McCulloch, 2001), however there is no evidence of this occurring in NSW. The recovery plan calls for the exclusion of commercial fishing from preferred and/or critical habitats of the species between May and October, but it is not clear whether this refers to the Twofold Bay area (Burnell and McCulloch, 2001). Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. There is a small probability of negative interactions with the OTLF between May to November. More data on interactions between this species and the fishery is needed to ensure no impediments to ongoing recovery of the species, particularly in the event of new areas being used by an increasing population of southern right whales.

Reptiles

Unless otherwise specifically referenced, the following information on turtles was obtained from the *Draft Recovery Plan for Marine Turtles in Australia* (Environment Australia, 1998b).

Loggerhead turtle

Conservation status: The loggerhead turtle, *Caretta caretta*, is listed as Endangered under the TSC Act and the EPBC Act.

Distribution and decline: Loggerhead turtles are found worldwide, inhabiting tropical and warmer temperate waters, often straying into higher latitudes (Cogger, 2000). In Australia, loggerhead turtles live year round in coastal waters from southern Western Australia, through the Northern Territory and Queensland to southern New South Wales. Breeding is largely restricted to areas north of 27^{o}S (Cogger, 2000), and they are most abundant within 1000 km of their nesting beaches. In NSW coastal waters, they occur in moderate numbers in the far north and are far less numerous in the southern parts of the State (Cogger, 2000). The eastern Australian population of loggerhead turtles is in severe decline, it has reduced by 86% over the past 23 years to less than 500 breeding females (Limpus, in prep.).

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the loggerhead turtle.

Other threatening processes: The species is threatened by fishing interactions, ingestion of synthetic materials, boat strike, predation of eggs at rookeries, disease, coastal development, tourism, indigenous harvesting. Fishing interactions include incidental capture in trawling, gill netting, pelagic long line and shark meshing gear and entanglement in float lines from traps.

Habitat and ecology: Loggerhead turtles occur within continental shelf waters and forage over coral reef, rocky reef, bay or estuarine habitats. They also forage on the deeper soft-bottomed habitats throughout the coastal waters of the continental shelf. Adult and large immature turtles eat shellfish and crabs, while immature turtles eat sea urchins, jellyfish and sea anemones. They do not form obvious social groups and feed as individuals. They feed off the substrate surface, from within the water column, and at or near the surface on floating prey and discarded trawl bycatch (Limpus, in prep.). They reach sexual maturity at about 30 years or more and grow to an average of one metre in size. On average, 127 eggs per clutch are laid. Loggerhead turtles migrate 2,600 km from feeding grounds in the Northern Territory, New South Wales and Queensland to traditional nesting sites on the eastern and western Australian coastlines. Some nesting turtles also migrate from as far as Indonesia, Papua New Guinea, Solomon Islands and New Caledonia. Australian nesting populations are genetically distinct from those in other countries. The southern Great Barrier Reef and adjacent mainland near Bundaberg is the breeding centre of the eastern Australian population. Successful breeding events have been recorded in far northern NSW (NSW NPWS, 2002b). Mating occurs from late October to early December, followed by nesting from late October to early March. Breeding and nesting occurs on average every 2-5 years.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to loggerhead turtle

Biological characteristics: The information provided above shows that the loggerhead turtle is long lived, reaches sexual maturity at 30 years, uses eggs to produce offspring and lays an average of 127 eggs at a time. Its current population is very small. Subsequently, the resilience level of the loggerhead turtle is low.

Overlap and interaction with fishery: The OTLF activities occurring in coastal NSW waters, especially in the state's far north, could potentially interact with this species. None of the fisheries in NSW are listed as having a significant impact on this species in the 'Recovery Plan for Marine Turtles in Australia' (Environment Australia, 2003), largely because loggerhead turtles are not numerous in NSW. Interactions that are possible with the OTLF include entanglement in the head gear of traps and passive lines, ingestion of or entanglement in discarded material and collision with fishing vessels. Over the past ten years in NSW, only two loggerhead turtles have been recorded entangled in trap ropes from either active traps or debris and one individual was found dead from boat strike injuries (DEC Marine Fauna Management Database, 2003). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Apart from the DEC database, there has been no focus on recording interactions with fishing activities and turtles in NSW waters. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Loggerhead turtles are only found in NSW in small numbers and the low incidence of mortality on this species from the OTLF should not significantly affect the survival of this population. However, the population of this species is in such decline that all accumulated human-induced mortality could impact upon its survival, and more effort should be placed on recording any fishing related mortality of this species in NSW.

Endangered populations

Little penguin population

Unless otherwise specifically referenced, the following information on the endangered little penguin population at Manly was obtained from the recovery plan for this population (NSW NPWS, 2000c).

Conservation status: The little penguin population (*Eudyptula minor*) in the Manly Point area is listed as an Endangered Population under the TSC Act.

Distribution and decline: Little penguins, found only in Australia and New Zealand, once ranged from Swan River in Western Australia through Tasmania and up to Moreton Bay in Queensland, and may still occasionally venture that far. They are relatively common in the waters of southern Australia, breeding mainly on offshore islands. They generally breed from Port Stephens in NSW along the eastern and southern coasts, including around Tasmania, and as far north as Fremantle on the west coast. The little penguin population at Manly represents only a small percentage of the State's population, however it is of importance as it is the only breeding site on mainland NSW. This population was formerly more extensive, covered a greater area in Sydney Harbour and was more numerous. The population contained 75 breeding pairs in the 2001/02 breeding season (NSW NPWS, 2002a).

Key Threatening Processes: Predation by cats and foxes are a threat to this population.

Other threatening processes: Listed threats to this population include loss of suitable habitat, disturbance, predation by dogs, pollution and commercial fishing activities that harvest the penguins food resources and restrict their access to burrows.

Habitat and ecology: The main habitat of this Manly population (including aquatic areas extending 50m out from the high water mark) has been listed as a Critical Habitat under the TSC Act. Little penguin nesting habitat normally consists of burrows built in sand dunes, rockpiles, sea caves, and occasionally under buildings. At Manly, a range of nest types are utilised, including under rocks on the foreshore, rock falls under seaside houses, garages, under stairs, in woodpiles and under overhanging vegetation.

Little penguins at Manly generally breed from July through to February each year, although this can very between seasons. While little penguins lay two eggs per clutch, usually only one chick hatches, although it is not uncommon for two chicks to hatch at Manly. It is also not uncommon for the penguins at Manly to rear two consecutive clutches in a season.

Once fledged young penguins return to the colony annually to moult until they are ready to breed at three to four years of age. It is not known if young birds spend most of this time at sea or disperse to other colonies. Adult little penguins tend to remain centred on their breeding colony throughout the year, although they may leave for 2-3 months during the non-breeding season. When feeding their young, they generally do not disperse far from their colonies and their daily foraging range is usually between 10 – 30 km.

Little penguins appear to be opportunistic feeders, foraging in relatively shallow waters. Their diet consists mainly of small schooling fish, like anchovies (*Engraulis australis*), pilchards (*Sardinops neopilchardus*), squid (Order Teuthida) and to a lesser extent krill. When swimming in search of food, little penguins are unlikely to swim faster than 6 km/h.

Recovery plans: The recovery plan for this population aims to ameliorate current threats, protect the population and maintain it at current levels, increase the limits of potential habitat, continue community education and involvement and better understand the ecology of this population. Specific management actions in the plan related to fishing in offshore waters include the collection of data on commercial fishing effort and baitfish catches in the ocean adjacent to Sydney Harbour.

Assessment of risk to endangered little penguin population

Biological characteristics: The information provided above shows that little penguins use eggs requiring parental care to reproduce and have a low reproductive output producing 1-4 chicks a year. These biological prone characters of the penguins themselves combined with the prone characters of the population itself, i.e. restricted breeding habitat and small population size, results in a low resilience level for the little penguin population at Manly.

Overlap and interaction with fishery: The OTLF is an offshore fishery that does not operate in or adjacent to the critical habitat area declared for this population. Only when the OTLF vessels working off Sydney Harbour do so reasonably close to shore within 30 km of the colony during the breeding period can the fishery encounter foraging breeding adults from this population. Disturbances from commercial fishing, including activities adjacent to the colony, have not been reported to prevent adults from returning to their fledglings at the colony with food. Such disturbance has been noted at a colony offshore from Wollongong. Immature and non-breeding adult birds from the colony disperse more widely when foraging and may overlap with a larger area of the OTLF. While little penguins forage from within the water column, they generally feed in its upper parts. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. This population is not likely to be adapted to feeding on the discards from the OTLF as its members have not been recorded feeding from the discards of any fishing vessels, including those that operate adjacent to the population. The fact that no little penguins have been recorded captured in the line and trap fishing gear used in Sydney Harbour itself, and that little penguins have not been recorded captured on Commonwealth longline fishing gear (Commonwealth of Australia, 2003) indicates that the bycatch of this fast swimming pelagic bird by the OTLF may not be a problem. While disturbance is listed as a threat to this population, this listing largely concerns the disturbances adjacent to the breeding colony. Any disturbance from the noise and light emitted from this fishery to individuals from this population whilst they are foraging at sea is likely to have negligible effects on the population (see section B2.4). In all, it appears that any interactions between the OTLF and the endangered population of little penguins at Manly should only have a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low. The OTLF operates some distance from the listed critical habitat of this population. Any disturbances to individuals of this population from the fishery should only have negligible consequences both for the species and the population.

Vulnerable species

Birds

Unless otherwise specifically referenced, the following information on birds was obtained from the *Handbook of Australian, New Zealand and Antarctic Birds* (Marchant and Higgins, 1990, 1993; Higgins and Davies, 1996).

Antipodean albatross

Conservation status: The antipodean albatross, *Diomedea antipodensis*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The antipodean albatross only breeds in New Zealand, on Antipodes and Campbell Island (Garnett and Crowley, 2000). It occurs across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia (Garnett and Crowley, 2000). This albatross regularly occurs in small numbers off the New South Wales south coast from Green Cape to Newcastle during winter where they feed on cuttlefish (NSW Scientific Committee, 2001b). Population trends of this species could not be determined due to a lack of historical population data (Garnett and Crowley, 2000). The annual breeding population of this species is relatively small and has been estimated at 5,154 pairs (Gales, 1998).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Along with drowning in longline fishing gear this species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Shooting to protect bait also threatens the species (Garnet and Crowley, 2000). Within NSW waters, potential threats to the species are the loss of the southern cuttlefish populations, illegal longline fishing and oil spills (NSW Scientific Committee, 2001b).

Habitat and ecology: This species breeds every two years, mostly on Antipodes Island, with a small number of breeding pairs on Campbell Island. Egg laying begins in January (Antipodes Island) and February (Campbell Island), and chicks usually fledge the following year in January and March (Gales, 1998). This pelagic species feeds on squid, fish and crustaceans (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to antipodean albatross

Biological characteristics: The information provided above shows that the population of the antipodean albatross is small and only breeds on only two islands. The species uses eggs requiring parental care to reproduce, and like all other albatross species produces one egg per clutch. Subsequently, the resilience level of the antipodean albatross is low.

Overlap and interaction with fishery: Only the OTF activities occurring south of Newcastle could potentially interact with this species. As the foraging range of this species when breeding is not known, it will be assumed that the OTF may encounter both breeding and non-breeding individuals. This fishery is only likely to encounter this species when foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing antipodean albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Illegal shooting to protect bait is a listed threat to this species, it is not known if this occurs in the OTLF, guns are allowed to be used by this fishery for OH&S purposes. In all, any interactions between the antipodean albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities occurring south of Newcastle could interact with this species, especially during winter. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Black-browed albatross

Conservation status: The black-browed albatross, *Diomedea melanophris*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The black-browed albatross has a circumpolar distribution over the southern oceans. The species forages around its Antarctic and subantarctic breeding islands during its summer breeding season and moves further north when not breeding. In Australia, it occurs along the southern coast from Brisbane to Perth. The species regularly migrates to waters off the continental shelf from May to November and is regularly recorded off the coast of NSW during this time (NSW NPWS, 1999a). Sub-adults are observed in Australian waters all year round (Environment Australia, 2001b). Decreases in the numbers and/or recruitment rates at many breeding colonies of this species have been recorded (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation by cats at breeding colonies could also affect this species (Garnett and Crowley, 2000).

Other threatening processes: Other threats to the species include predation by skuas at breeding colonies and pollution (Garnett and Crowley, 2000; NSW NPWS, 1999a).

Habitat and ecology: This generally pelagic species inhabits Antarctic, subantarctic and subtropical marine waters. It breeds annually on Antarctic and subantarctic islands between September and December and begins breeding at around 11 years of age. One egg is produced per clutch. It feeds on fish, krill, crustaceans, cephalopods and offal, and often forages in flocks with other seabirds. Prey are usually seized from the surface or just below while swimming or landing, and also by submerging themselves by plunging from heights and by scavenging behind fishing vessels. Feeding usually occurs during the day, and occasionally at night.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to black-browed albatross

Biological characteristics: The information provided above shows that the black-browed albatross first breeds at around 11 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Populations of this species on Antarctic and subantarctic islands are small (Environment Australia, 2001b). Subsequently, the resilience level of the black-browed albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, especially between May to November. The fishery could only interact with individual birds when they are foraging. As the foraging distance of breeding birds is not known, it will be assumed that the fishery could interact with both breeding and non-breeding individuals. This species can feed from the surface and by diving to unknown depths. When diving this species has been recorded staying under water for periods of 20 seconds (Harper, 1987), and like most albatross species it would probably not be able to reach great depths. Subsequently its diet would predominantly be composed of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised high likelihood of capturing black-browed albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be high. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the black-browed albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. The OTLF operations overlap with the distribution of this species mostly during winter. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Black-winged petrel

Conservation status: The black-winged petrel, *Pterodroma nigripennis*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The black-winged petrel occurs in the north Tasman Sea and southwest Pacific Ocean during its summer breeding season, and moves eastwards into the central Pacific Ocean when not breeding. Within Australia, the species has been sighted in scattered areas along the southern Queensland and NSW coastline. In NSW, they have been observed ashore at Muttonbird Island, Byron Bay, Lord Howe Island, Norfolk Island, Newcastle, Cronulla, Batemans Bay, Solitary Island, Wollongong and Eden (NSW NPWS, 1999b). The breeding range of this species appears to be expanding (Garnett and Crowley, 2000).

Key Threatening Processes: This species is mainly threatened from predation by cats, activity from feral pigs and goats could also affect this species.

Other threatening processes: The introduced brown rat could also affect this species.

Habitat and ecology: This pelagic seabird occurs over subtropical and tropical waters and also over warm currents in cool seas. It breeds during summer on tropical and subtropical islands and inlets in the southwestern Pacific Ocean, including Norfolk and Lord Howe Islands, although nesting events on Lord Howe Island have never been successful (Garnet and Crowley, 2000). It lays one egg per clutch. They are thought to mainly feed on squid and prawns, which they catch by seizing from the surface or shallow diving, often in association with a number of other birds.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to black-winged petrel

Biological characteristics: The information provided above shows that the black-winged petrel has a restricted range in Australia. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the black-winged petrel is low.

Overlap and interaction with fishery: This species may be found scattered throughout the area of operation of the OTLF during summer. The fishery could potentially interact with both breeding and non-breeding individuals of this surface feeding species, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the black-winged petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. The fishery could only interact with this species during summer. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Buller's albatross

Conservation status: The Buller's albatross, *Thalassarche bulleri*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The Buller's albatross generally occurs near its breeding sites on Snares and Solander Islands, New Zealand. It may cross the Tasman Sea, even when breeding and also regularly visits Chile and Peru during the non-breeding season. This pelagic species is found off southeastern Australia, between Coffs Harbour and Eyre Peninsula (Gales, 1998). In this area the species was formerly regarded as rare but there have been more frequent sightings recently. The number of breeding pairs on Snares Island increased between 1969-1992 and on Solander Island decreased between 1986-1996 (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: In Australia, this species occurs over inshore, offshore and pelagic waters. Adult birds arrive at the breeding colony in December and chicks fledge the colony during late August (Gales, 1998). One egg per clutch is laid. The species mostly feeds on squid and some fish, krill and tunicates and takes its food from or just below the water's surface. The species has been observed in association with fishing boats in New Zealand.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to Buller's albatross

Biological characteristics: The information provided above shows that the Buller's albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. It is restricted to breeding on two islands and, given that it is listed as threatened, its population is probably small. Subsequently, the resilience level of the Buller's albatross is low.

Overlap and interaction with fishery: Only the OTLF activities occurring south of Coffs Harbour could potentially interact with this species. The fishery could potentially interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing Buller's albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels, however given the occurrence of this species in the area, any resulting injury or mortality would be infrequent and only have a negligible impact on the population as a whole. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the Buller's albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities occurring south of Coffs Harbour could interact with this species. It seems that only a small number of this species occurs off the NSW coast. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Campbell albatross

Conservation status: The Campbell albatross, *Thalassarche impavida*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species only breeds on Campbell Island, New Zealand. It can be found foraging around New Zealand when breeding and over the temperate shelf waters of New Zealand, southern Australia and the central and western Pacific Islands when not breeding (Environment Australia, 2001b; Gales, 1998). In Australia, it occurs from the NSW/Qld border in the east to Ceduna South Australia in the west (Environment Australia, 1998a). This population has significantly decreased in recent decades (Environment Australia, 2001b).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). High capture rates of this species have been recorded from longliners operating off New Zealand and southern Australia (Gales, 1998).

Other threatening processes: This species may suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Predation from other seabirds on the breeding island also threatens this species (Gales, 1998).

Habitat and ecology: This annual breeder returns to its breeding colony in August and successful breeders and chicks depart in April-May (Gales, 1998). One egg is laid per clutch (Environment Australia, 2001b). It feeds pelagically on squid, fish and crustaceans and also follows boats to retrieve offal (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to Campbell albatross

Biological characteristics: The information provided above shows that the Campbell albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its geographic range is restricted and its current population is significantly smaller than it was historically. Subsequently, the resilience level of the Campbell albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF during the winter non-breeding season. As breeding individuals tend to remain near their distant breeding colonies, the OTLF is only likely to encounter non-breeding individuals of this species. The fishery could only interact with these birds when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised high likelihood of capturing Campbell albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be high. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the Campbell albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-Medium. The OTLF operations overlap with the distribution of this species during winter only. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Flesh-footed shearwater

Conservation status: The flesh-footed shearwater, *Puffinus carneipes*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The flesh-footed shearwater is a trans-equatorial migrant, widely distributed across the southern Indian Ocean and southeastern Pacific Ocean in the breeding season. They are a breeding and non-breeding visitor to the coastal and pelagic waters of southern Australia, where they are locally common in all months of the year. In NSW, the species is fairly common from September-May mostly in the north east of the state, with breeding birds foraging around Lord Howe Island from August to May. It is scarce at other times of the year and in the south east of the state.

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation by cats and foxes at breeding colonies also threatens this species.

Other threatening processes: At its breeding colonies, predation by raptors and skinks, human disturbance and destruction of nesting sites also threaten the species.

Habitat and ecology: This pelagic species occurs in subtropical waters mainly over the continental shelves and slopes and occasionally inshore. It breeds from late September to May on islands in the Australasian region and Indian Ocean, including Norfolk and Lord Howe Islands. Their diet is poorly known but probably includes fish and cephalopods. They feed mostly during the day by seizing from the surface or plunging or diving to about five metres below, often from behind fishing vessels.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to flesh-footed shearwater

Biological characteristics: The flesh-footed shearwater uses eggs requiring parental care to reproduce. Its clutch size has not been specified, but like most other species in this family it is likely to be one. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened shearwater will be assumed to be low.

Overlap and interaction with fishery: It is the OTLF activities off north-east NSW that are most likely to interact with this species, mostly from September to May, mainly in shelf and slope waters and occasionally inshore. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised high likelihood of capturing flesh-footed shearwaters on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be high. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The capture of one flesh-footed shearwater every 50-100 hours (or 8-12 fishing days) of trolling off Western Australia, suggests that trolling and the other active pelagic fishing methods used in the OTLF could capture a considerable number of this species. However, the likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). Although not a listed threat for this species, flesh-footed shearwaters are at risk from debris as carcasses of dead chicks found on Lord Howe Island demonstrate (Priddel, 2003). In all, any interactions between the flesh-footed shearwater and the OTLF should only be having little impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. The OTLF fishing off north-east NSW is most likely to interact with this species, mostly from September to May, mainly in shelf and slope waters and occasionally inshore.

Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Gibson's albatross

Conservation status: The Gibson's albatross, *Diomedea gibsoni*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The Gibson's albatross breeds on three islands around New Zealand and in the subantarctic Auckland Island group. Non-breeding birds are usually found between 30° and 50°S. Males and females of this species forage in different areas, females in the Tasman Sea around 40°S and males further south or in the mid-Pacific Ocean. This species regularly occurs off the NSW coast usually between Green Cape and Newcastle (NSW Scientific Committee, 2001c). About 6,200 pairs of this species breed annually (Environment Australia, 2001b).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). This species could potentially be affected from predation by cats and the activity of pigs if they were introduced to its breeding islands (NSW Scientific Committee, 2001c).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998). Within NSW waters, the species is potentially threatened from the loss of southern cuttlefish populations, illegal longline fishing and oil spills (NSW Scientific Committee, 2001c).

Habitat and ecology: This species breeds every two years, with most eggs laid between December and January and chicks fledging the following year in January to February (Gales, 1998). One egg is laid per clutch (Environment Australia, 2001b). It feeds pelagically on squid, fish and crustaceans (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to Gibson's albatross

Biological characteristics: The information provided above shows that the Gibson's albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This small population only breeds on three islands. Subsequently, the resilience level of the Gibson's albatross is low.

Overlap and interaction with fishery: This species regularly occurs throughout the area of operation of the OTF, especially south of Newcastle. The fishery may interact with breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing Gibson's albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the Gibson's albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities occurring south of Newcastle could interact with this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Grey ternlet

Conservation status: The grey ternlet, *Procelsterna cerulea*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The grey ternlet occurs through much of the tropical Pacific Ocean from Australia east to Hawaii and San Felix and San Ambrosio Islands off the east coast of Chile. In Australia, the species occurs off the east coast between the Tropic of Capricorn and Bass Strait and is occasionally beachcast during stormy weather. Individuals are usually recorded off the east coast between December and March soon after the breeding season, and it is thought that some individuals may disperse to the east coast of Australia from breeding grounds on Lord Howe and Norfolk Islands. There is no information on the population trends of this species (Garnett and Crowley, 2000).

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act and the TSC Act would affect this species.

Other threatening processes: Threats to the species include intensive fishing operations in feeding grounds, cyclonic weather and development of roosting and breeding islands. This species is also vulnerable to predation from rats and birds on breeding islands (Garnett and Crowley, 2000).

Habitat and ecology: The grey ternlet mainly occurs on isolated tropical or subtropical islands on which they breed and roost and their surrounding nearshore waters and is occasionally found in the pelagic zone. They produce one egg per clutch. They usually forage from the surface of the sea during the day and feed on small crustaceans, fish and squid.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to grey ternlet

Biological characteristics: The information provided above shows that the grey ternlet has a restricted range in Australian waters. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the grey ternlet is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, usually between December and March. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the grey ternlet and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. It is mostly the OTLF activity between December-March that is most likely to interact with this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Indian yellow-nosed albatross

Conservation status: The Indian yellow-nosed albatross, *Thalassarche carteri*, is listed as vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species occurs over both pelagic and inshore waters between 15°S and 50°S (Environment Australia, 2001b). It breeds on five islands in the Indian Ocean and is mostly found in the southern Indian Ocean where it is particularly abundant off Western Australia (Garnett and Crowley, 2000). It is the most common albatross in the Great Australian Bight and central Bass Strait and also occurs east off Tasmania and along the east coast of the mainland as far north as Coffs Harbour (Environment Australia, 2001b). The main breeding colony of this species has reduced by about 30% since the early 1980s, with the decline continuing (Garnett and Crowley, 2000).

Key threatening processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Garnett and Crowley, 2000).

Habitat and ecology: This species breeds annually over an eight month period, beginning in mid-August (Environment Australia, 2001b). Pairs travel to distant, subtropical feeding sites while rearing chicks (Environment Australia, 2001b). It feeds on fish and squid (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to Indian yellow-nosed albatross

Biological characteristics: The information provided above shows that the Indian yellow-nosed albatross uses eggs requiring parental care to reproduce, and like other albatross species, it probably has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to five islands. Its current population is much smaller than it was historically. Subsequently, the resilience level of the Indian yellow-nosed albatross is low.

Overlap and interaction with fishery: Only the OTLF activities occurring south of Coffs Harbour could interact with this species, especially during winter. As the distribution of foraging breeding adults can be some distance away, it will be assumed that this fishery could interact with both breeding and non-breeding individuals of this species, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised moderate likelihood of capturing Indian yellow-nosed albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be moderate. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. The rate of capture of yellow-nosed albatrosses in trolling operations off Western Australia was observed to be low (i.e. one bird per 80-100 fishing days - one fishing season). This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the Indian yellow-nosed albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Kermadec petrel (western)

Conservation status: The Kermadec petrel (western population), *Pterodroma neglecta neglecta*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The Kermadec petrel occurs in the Pacific Ocean between 20 and 35°S, dispersing to the central North Pacific. Breeding colonies are located in the South Pacific Ocean, between 25-35°S, from off Lord Howe Island to Juan Fernandez Island. Non-breeding petrels migrate trans-equatorially, with individuals recorded as far north as 28°N in the central Pacific Ocean and 21°N in the eastern Pacific Ocean. The species is present around Kermadec Island throughout the year and is a vagrant to the east coast of Australia. Breeding birds from the small colony off Lord Howe Island can be found in the waters off eastern Australia. Only three single beachcasts of the species have been recorded from the NSW coastline at Kingscliff, Tuggerah Beach and Jervis Bay in the 1970s. The population trend of this species in Australian territory is not known. The petrel is now extinct on Lord Howe Island (Garnett and Crowley, 2000).

Key Threatening Processes: The species is threatened by predation from cats and rabbits on breeding islands and its breeding habitat is sensitive to the impacts of introduced rabbits and goats.

Other threatening processes: Harvesting activity egg collecting by humans could also threaten the species.

Habitat and ecology: This marine species is found in tropical and subtropical waters. It breeds during either summer-autumn or spring-summer. Breeding locations include Ball's Pyramid off Lord Howe Island and Phillip Island near Norfolk Island. It produces one egg per clutch. Very little is known about its diet, it probably feeds on squid and crustaceans. It forages far from its breeding islands and feeds on or just below the water's surface by seizing or dipping.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to Kermadec petrel

Biological characteristics: The information provided above shows that the Kermadec petrel has a restricted geographic range in Australian waters. There is limited population information on this species, however considering it is listed as threatened it will be assumed to be small. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the Kermadec petrel is low.

Overlap and interaction with fishery: Only the OTLF activities north of around Jervis Bay could potentially interact with this species. The fishery is only likely to encounter a small number of individuals of this surface feeding species, either breeding birds from the small colony on Lord Howe Island or vagrant individuals. It could only interact with this species when it is foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the Kermadec petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only a small number of this species are found off NSW, only north of Jervis Bay. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Little shearwater

Conservation status: The little shearwater, *Puffinus assimilis*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The little shearwater has a circumpolar distribution across the Atlantic, Pacific and southern Indian Oceans, generally north of the Antarctic Convergence and reaching 40^{o}N in the northern hemisphere. As the species tends to remain in seas near breeding colonies throughout the year, it is reasonably common in seas off southwest and southeast Australia, Kermadec Island and far southeast New Zealand and less common elsewhere in the Australasian region. In the Australian region the species breeds on subtropical and subantarctic islands off south western Australia and New Zealand, including near Lord Howe and Norfolk Islands. In NSW, the little shearwater has been recorded along the coast and in breeding colonies on islands off Lord Howe Island and near Norfolk Island (NSW NPWS, 1999c). The breeding distribution of this species in the Tasman Sea has declined, it is now extinct from both Lord Howe and Norfolk Islands, both once breeding localities for this species (Garnett and Crowley, 2000).

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act and the TSC Act currently affect this species.

Other threatening processes: Disturbances on breeding islands by visitors and human habitation and the accidental introduction of feral animals, such as rats, cats and dogs to existing breeding refuges threaten the species. The species is also vulnerable to the loss of nesting habitat from development and erosion.

Habitat and ecology: This pelagic species frequently occurs on continental shelf waters in subantarctic, subtropical and occasionally tropical seas. It produces one egg per clutch. It forages far out to sea and feeds on cephalopods, krill and small fish both from the surface and by plunge diving.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to little shearwater

Biological characteristics: The little shearwater uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened shearwater will be assumed to be low.

Overlap and interaction with fishery: This species is reasonably common throughout the area of operation of the OTLF. While the species will tend to remain near its breeding colonies around Lord Howe and Norfolk Islands throughout the year, the fishery could still interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the little shearwater and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Interactions that may occur between this species and the OTF that could negatively affect the species have a very low chance of occurring.

Northern giant-petrel

Conservation status: The northern giant-petrel, *Macronectes halli*, is listed as vulnerable under the EPBC Act and the TSC Act.

Distribution and decline: The northern giant-petrel is found over the southern oceans generally north of the Antarctic convergence between 30 and 64^{o}S. In summer, the species is usually found south of 40-45^{o}S. Breeding occurs on subantarctic islands, including Macquarie Island in summer. Juveniles disperse widely and adults are present at colonies and adjacent seas throughout winter. It is a regular winter visitor to Australian waters, and occurs offshore in southern waters from Fraser Island in the east to Shark Bay in the west (Environment Australia, 1998a). The population of this species on nearly all of its breeding islands, including Macquarie Island, has increased, while a decrease in this population at sea has been observed (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003). Predation by cats at breeding islands also affects this species (Garnett and Crowley, 2000).

Other threatening processes: This species is threatened from predation by rats and skuas on breeding islands and the accumulation of chemical contaminants (Garnett and Crowley, 2000).

Habitat and ecology: This species occurs mainly in subantarctic, Antarctic and also subtropical waters in winter-spring. Predominantly pelagic, it can also occur on inshore waters. Breeding pairs raise a single chick, and each year only around 70% of the population breed (Voisin, 1988). The species begins breeding at 9-11 years of age (Voisin, 1988). They are an opportunistic scavenger and predator, and commonly follow ships. Males generally feed on the carcasses of penguins, seals and cetaceans, while females obtain live prey at sea including cephalopods, small seabirds and fish. They feed on or near the surface of the sea and dive to depths of 2 m.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to northern giant-petrel

Biological characteristics: The information provided above shows that the northern giant-petrel first breeds at 9-11 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Considering this species is listed as threatened, its population can be assumed to be small. Subsequently, the resilience level of the northern giant-petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, over both pelagic and inshore waters, during winter. As breeding birds tend to remain near their distant breeding colonies throughout the year, the fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter immature individuals. The fishery could only interact with this species when it is foraging. As this species feeds from the waters surface and by shallow diving, its natural prey is likely to comprise only of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing northern giant-petrels on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the northern giant-petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. This fishery could only interact with this species during winter. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Osprey

Conservation status: The osprey, *Pandion haliaetus*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The osprey has a cosmopolitan distribution around the world. Around the Australian coastline its distribution is disjunct, occurring in the north from Broome in WA to the south coast of NSW, in the south from Kangaroo Island to the Great Australian Bight, and from

Esperance to Cape Keraudren in the west. In NSW, the osprey occurs primarily along the coast, south to about Womboyn Lake and is found in greater numbers in the north of the State.

Key Threatening Processes: Entanglement in or ingestion of anthropogenic debris is likely to affect this species (NSW Scientific Committee, 2003).

Other threatening processes: Over clearing and degradation of water quality are likely to have an adverse impact on the nesting and feeding habitat of ospreys. The species can also be disturbed by tourism activities.

Habitat and ecology: Ospreys are found in littoral habitats, offshore islands, terrestrial wetlands and coastal lands of tropical and temperate Australia. They are predominantly coastal using bays, estuaries, mangroves, beaches, dunes, cliffs, inshore waters, and coral and rocky reefs. They are not usually observed far from shore at sea. They require extensive areas of clear, open water for fishing, often ranging up into freshwaters of larger rivers. Breeding occurs mainly on the coast or islands. They nest in prominent positions near the ocean or large waterbodies, on rocky headlands, stacks, cliffs, palm trees, in tall dead trees, and on artificial platforms. They feed mostly on fish, clutching them from the surface of the water or diving to less than one metre, and are able to eat toxic (Diodontidae, Tetraodontidae) and spiny fishes (Balistidae and Acanthuridae). They usually scavenge fish from ashore or take them from the shallows nearby. Offshore fishing is unusual. They also feed on terrestrial vertebrates, seabirds and crustaceans. They are generally seen singly or in pairs, and occasionally in family groups. They are tolerant of human activity, often nesting within or adjacent to urban areas.

Recovery plans: No recovery plan has been prepared for this species.

Assessment of risk to the osprey

Biological characteristics: The osprey uses eggs requiring parental care to reproduce, and has a low reproductive output producing two to three eggs per clutch, rarely four. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened bird will be assumed to be low.

Overlap and interaction with fishery: It is only the OTLF activities occurring in inshore waters that could potentially interact with this species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. This species is not known to forage around or follow fishing vessels and bycatch is not a listed threat for this species. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the osprey and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. The OTLF is largely an offshore fishery, only its activities occurring in inshore waters could interact with this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Providence petrel

Conservation status: The providence petrel, *Pterodroma solandri*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The species is mainly subtropical in the southwest Pacific Ocean, including the Tasman Sea, however some birds migrate to the north Pacific and Bering Seas. The species can be observed in moderate numbers in the waters off the eastern Australian coast between Fraser Island and southeast Tasmania during its breeding season, from March to November. It may also be observed in this area during December to February, although it is generally rare or absent. In NSW, the species occurs along the entire coast, however, it has been recorded most often off the north coast. The species currently breeds at only two locations, Lord Howe Island and Phillip Island (near Norfolk Island). It also historically bred on Norfolk Island.

Key Threatening Processes: The species is threatened from predation by cats and it may be sensitive to the impact of feral pigs and goats.

Other threatening processes: None.

Habitat and ecology: This pelagic species occurs on subtropical and tropical waters of the southwest Pacific and in colder waters in the North Pacific. Breeding occurs during winter in burrows or rock crevices. It produces one egg per clutch. It feeds on fish, cephalopods, crustaceans and offal, and favoured feeding grounds are located within the Tasman Sea and along the edge of the continental shelf off the east coast of Australia. Like other members of the gadfly family, this species probably feeds from the water's surface. It has been observed feeding at night and near fishing boats.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to providence petrel

Biological characteristics: The information provided above shows that the providence petrel has a restricted geographic range in Australian waters. It is restricted to breeding on two islands. It uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Subsequently, the resilience level of the providence petrel is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTLF, mostly off the northern NSW coast, mostly from March to November. The fishery is likely to interact with breeding individuals from nearby colonies and perhaps also non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species, known to forage near fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the providence petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. It is the OTLF activities occurring off northern NSW from March-November that are most likely to interact with this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Red-tailed tropicbird

Conservation status: The red-tailed tropicbird, *Phaethon rubicauda*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The red-tailed tropicbird occurs in the tropical parts of the Indian and Pacific Oceans between 40°N and 40°S. It nests on numerous islands throughout its range, including Norfolk and Lord Howe Islands off NSW. In Australia, the species is found between November-March along the western and northern coasts and in the Coral Sea area, with scattered records along the east and south coasts to around Yorke Peninsula (SA). In NSW, the species has been recorded along the whole coast as far south as Montague Island and occasionally inland.

Key Threatening Processes: Predation by cats on breeding islands threatens this species.

Other threatening processes: Predation by rats, dogs and other birds, human interference (including harvesting outside of the Australian Territory), urban development and mining activity on breeding islands affect this species. On Christmas Island the yellow crazy ant also threatens this species.

Habitat and ecology: This pelagic, tropical and subtropical species breeds on islands between October and April. It produces one egg per clutch. When foraging it ventures hundreds of kilometres away from breeding sites. It mostly feeds on fish and cephalopods by deep plunging vertically into the water from a height of 6-10 m. When diving, they remain underwater for an average of 26.6 seconds. They follow ships from the air at an average height of around 40 m.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to red-tailed tropicbird

Biological characteristics: The red-tailed tropicbird uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened bird will be assumed to be low.

Overlap and interaction with fishery: It is the OTLF activities that occur north of Montague Island that could potentially encounter scattered numbers of this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels, however given the occurrence of this species in the area, any resulting injury or mortality would be infrequent and only have a negligible impact on the population as a whole. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the red-tailed tropicbird and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only OTLF activities north of Montague Island could encounter scattered individuals of this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Salvin's albatross

Conservation status: The Salvin's albatross, *Thalassarche salvini*, is listed as vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species breeds on three islands south of New Zealand and one island in the Indian Ocean (Garnett and Crowley, 2000). It forages over most of the southern Pacific Ocean, especially off South America, in the Indian Ocean (in small numbers) and sometimes in the South Atlantic Ocean (Garnett and Crowley, 2000). It is abundant throughout the year on all continental shelf areas around New Zealand and roams widely in winter (Environment Australia, 2001b). Small numbers of non-breeding adults regularly fly across to southeast Australian waters (Environment Australia, 2001b).

Key threatening processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: This species breeds annually, eggs are laid in October and chicks fledge in March-April (Environment Australia, 2001b). Breeding adults forage over shelf waters around colonies (Environment Australia, 2001b). They probably feed on fish and squid and commonly follow fishing boats (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to Salvin's albatross

Biological characteristics: The information provided above shows that the Salvin's albatross uses eggs requiring parental care to reproduce, and like other albatross species, it probably has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to four islands. As it is listed as a threatened species, its population is assumed to be small. Subsequently, the resilience level of the Salvin's albatross is low.

Overlap and interaction with fishery: As the distribution of this species in the Tasman Sea is poorly known, it will be assumed that all of the OTLF fishing off NSW could interact with this species. The fishery is not likely to impact upon breeding individuals of this species as they tend to forage in waters some distance from the OTLF. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing Salvin's albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels, however given the occurrence of this species in the area, any resulting injury or mortality would be infrequent and only have a negligible impact on the population as a whole. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the Salvin's albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only small numbers of this species occurs off the NSW coast. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Shy albatross

Conservation status: The shy albatross, *Thalassarche cauta*, is listed as vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The shy albatross is endemic to Australia (Environment Australia, 2001b). Information on its at-sea distribution is confounded by its recent separation from other closely related taxa. It appears to occur in Australian waters below 25°S from southwest Western Australia to Queensland, mostly around Tasmania and southeastern Australia, where it can be found year round (Environment Australia, 2001b). Although uncommon north of Sydney, the species is commonly recorded off southeast NSW, particularly between July and November. Some juvenile and immature individuals can be found in most sub-Antarctic to subtropical waters and have also been recorded in the northern hemisphere (Environment Australia, 2001b). It breeds on three islands in Australian territory (Environment Australia, 2001b). The population of this species was greatly reduced in the late 18th Century, and it has been increasing through the 20th Century (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species is shot off Tasmania to reduce bait stealing and for bait and food in South African waters (Garnett and Crowley, 2000). Trawl fisheries could also threaten the species if collides with cables or gets trapped in nets (Garnett and Crowley, 2000). Disturbance by introduced predators at breeding colonies, pollution from plastics, oils and chemicals and avian pox virus also threaten the species (Garnett and Crowley, 2000; NSW NPWS, 1999d). Commercial overexploitation of food reserves near breeding colonies in Bass Strait could threaten this species in the future (Gales, 1998).

Habitat and ecology: Found mainly in subantarctic and subtropical waters, this species feeds over continental shelf waters, including in bays and harbours. Adults seldom venture more than 600 km from their breeding colonies (Environment Australia, 2001b). It breeds annually between September and December. It first breeds at five to six years of age. One egg is produced per clutch. It feeds on fish, squid, crustaceans and offal using a variety of techniques, including seizing prey from the surface, diving and scavenging behind fishing vessels.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to shy albatross

Biological characteristics: The information provided above shows that the shy albatross first breeds at five to six years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. The breeding activity of this species is restricted to only three islands. Subsequently, the resilience level of the shy albatross is low.

Overlap and interaction with fishery: This species may be found throughout the area of operation of the OTF, in shelf and inshore waters, mostly off southeast NSW especially between July and November and uncommonly north of Sydney. As breeding birds tend to remain near their distant breeding colonies throughout the year, the fishery is not likely to have a significant impact upon this species' breeding success as it is only likely to encounter juvenile and immature individuals. The fishery could only interact with this species when it is foraging. As this species feeds from the surface and by plunge diving to depths of about 3m, its natural prey is probably composed of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised moderate likelihood of capturing shy albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be moderate. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). Illegal shooting to protect bait is a listed threat to this species, it is not known if this occurs in the OTLF, guns are allowed to be used by this fishery for OH&S purposes. In all, any interactions between the shy albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. It is the OTLF activities south of Sydney between July and November that are most likely to encounter this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Sooty albatross

Conservation status: The sooty albatross, *Phoebetria fusca*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: This species breeds on islands in the southern Indian and Atlantic Oceans and forages south of 30°S, between southern NSW and Argentina. The species has not been recorded in the Pacific Ocean. In Australian waters the sooty albatross occurs off the south coast from Tasmania to Western Australia. Occasionally, the species is recorded off the NSW coast, north to Grafton (NSW NPWS, 1999e). Individuals are generally recorded in Australian waters in winter (NSW NPWS, 1999e). A decrease of 50% in the population size of one breeding site has been recorded, but not at the other sites (Garnett and Crowley, 2000).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a).

Other threatening processes: This species may also suffer from colliding with the warps and cables used on fishing trawlers (Garnett and Crowley, 2000). Disturbance on breeding islands from frequent fires and predation by rats and pollution from plastics, oils and chemicals also threaten the species (NSW NPWS, 1999e).

Habitat and ecology: This pelagic species inhabits subantarctic and subtropical marine waters, and is occasionally observed over inshore waters. It breeds every two years on small, isolated, subantarctic islands between August and December. The species first breeds at 12 years of age, on average (Environment Australia, 2001b). One egg is laid per clutch. The species feeds on fish, crustaceans, offal and squid by seizing prey from the surface while swimming or by landing on top of prey. It possibly feeds at night and may follow fishing vessels for short periods.

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to sooty albatross

Biological characteristics: The information provided above shows that the sooty albatross first breeds at an average of 12 years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Considering this species is listed as threatened, its population is assumed to be small. Subsequently, the resilience level of the sooty albatross is low.

Overlap and interaction with fishery: This species may occasionally be found off the NSW coast as far north as off Grafton, generally during winter. Considering this species' breeding islands are some distance away, and the species generally occurs off NSW during the non-breeding season, it will be assumed that the OTLF will be only likely to encounter juvenile or immature individuals. The fishery could only interact with this species when it is foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing sooty albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels, however given the occurrence of this species in the area, any resulting injury or mortality would be infrequent and only have a negligible impact on the population as a whole. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). In all, any interactions between the sooty albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities south of Grafton are most likely to encounter this species. It seems that only a small number of this species occurs off the NSW coast. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Sooty tern

Conservation status: The sooty tern, *Sterna fuscata,* is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The sooty tern is found within the tropical and subtropical waters and islands of the Indian, Pacific and Atlantic Oceans. In Australia, individuals are widespread in the tropics and occasional sightings occur along the west and east coasts, from Perth in Western Australia to Bermagui on the south coast of NSW, although in NSW they are more common off the north coast. There are breeding colonies of this species on Lord Howe and Norfolk Islands and their offshore islets.

Key Threatening Processes: Predation by cats on breeding islands threatens this species (NSW NPWS, 1999f)

Other threatening processes: Threats to the species include disturbance to breeding colonies, egg collecting, ticks and predation of eggs and chicks by rats and other birds, particularly silver gulls (NSW NPWS, 1999f).

Habitat and ecology: This species occurs in offshore and pelagic zones and is almost never found inshore. Usually one and occasionally two eggs are laid per clutch. They are active during day and night, mainly feeding on fish, squid, crustaceans and hydrozoans taken from or just below the water's surface and occasionally by diving through the crests of waves. Food may also be scavenged from the aerial pursuits of other birds and by hawking for cicadas over forests.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to sooty tern

Biological characteristics: The sooty tern uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg and occasionally two eggs per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: As the sooty tern is almost never found in inshore waters and is more common off northern NSW, it is the OTLF activities north of Bermagui that work further offshore that are more likely to potentially interact with this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the sooty tern and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities in offshore waters north of Bermagui are most likely to encounter this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

Southern royal albatross

Conservation status: The southern royal albatross, *Diomedea epomophora*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: This species is found across the Southern Oceans, from 36°S to 55°S (Environment Australia, 2001b). It breeds on four islands around New Zealand (Gales, 1998). It is found off southern Australia at all times of the year, especially between July and October, from Byron Bay to southwestern Western Australia (Environment Australia, 2001b). In NSW, the species has mostly been recorded around the central coast from Coffs Harbour to Bellambi (Pizzey and Doyle, 1985). There are around 13,000 breeding pairs of this species, and 50,000 individuals in total (Environment Australia, 2001b).

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Ingestion of or entanglement in harmful marine debris also affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: The species may also suffer from colliding with the warps and cables used on fishing trawlers (Gales, 1998).

Habitat and ecology: Around Australia, this species has mostly been recorded over the continental slope areas (Environment Australia, 2001b). The species breeds every two years and lays its eggs in November-December and chicks fledge October-November (Gales, 1998). It begins to breed at nine years of age (Environment Australia, 1998a). One egg is produced per clutch (Environment Australia, 1998a). It feeds pelagically, primarily on squid and fish (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to southern royal albatross

Biological characteristics: The information provided above shows that the southern royal albatross first breeds at nine years of age, uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its breeding habitat is restricted to four islands. Subsequently, the resilience level of the southern royal albatross is low.

Overlap and interaction with fishery: OTLF activities south of Byron Bay that operate over the continental slope could potentially interact with this species, especially between July to October. As the foraging distance of breeding individuals of this species is not known, it will be assumed that the fishery could interact with both breeding and non-breeding individuals. As the larger albatrosses are generally surface feeders (Commonwealth of Australia, 2003), their natural prey is probably composed of pelagic species. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised low likelihood of capturing southern royal albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be low. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species, known to follow fishing vessels, may become entangled or ingest discarded hooks in unspent bait when foraging around OTLF fishing vessels. The rate of any resulting injury or mortality from such interactions with the OTLF is not known. The species could also feed on the fishery's discards and be indirectly disturbed from the noise and light emitted from a vessel. Such encounters are not likely to reduce the survival of an individual, especially as discards from the fishery are available to the species throughout the year and the various stages of its breeding cycle (see discussion under section B2.4). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). In all, any interactions between the southern royal albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities occurring over the continental shelf south of Byron Bay could encounter this species, especially between July to October. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

White tern

Conservation status: The white tern, *Gygis alba*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The white tern occurs transglobally throughout tropical and sub-tropical oceans. It breeds on numerous islands across the Indian and southwest Pacific Oceans, including Norfolk and Lord Howe Islands. Individuals may occasionally visit the east coast of Australia between Cape York Peninsula and Sydney and generally only come ashore as a result of stormy weather. Within NSW, they are regularly recorded off the coast at Ballina and occasionally off Sydney and Wollongong. They are present on Lord Howe Island from September to June, dispersing when the winter gale arrives.

Key Threatening Processes: Predation by cats on breeding islands threatens this species.

Other threatening processes: Threats to the species include stochastic events impacting upon small colonies, strong winds dislodging their eggs that are laid singly on horizontal branches, predation by kestrels, owls and currawongs, and the introduced black ant.

Habitat and ecology: The white tern is found on isolated tropical islands and their nearshore waters. They are also recorded in the pelagic zone, especially off Australia. The species feeds both inshore and offshore from the surface of the water on fish, squid and less frequently crustaceans and insects. Dawn and dusk are probably important feeding times for the species.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to white tern

Biological characteristics: The white tern uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. This species' longevity, age at maturity and population size is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: It is the OTLF activities north of Sydney, especially those off the state's far north, which could potentially interact with this species. The fishery could only interact with this species when it is foraging, and while it is not known if breeding birds on nearby Lord Howe and Norfolk Islands forage off NSW, it will be assumed that the fishery could encounter both breeding and non-breeding birds. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the white tern and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities north of Sydney could encounter this species. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

White-bellied storm petrel

Conservation status: The white-bellied storm petrel, *Fregatta grallaria grallaria*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: The distribution of the white-bellied storm petrel is poorly understood. The species is found in the subtropical and highly saline tropical Pacific, Atlantic and Indian Oceans, to 42^{o}S. It breeds on islands and stacks close to the Subtropical Convergence in the southern Atlantic and Pacific Oceans, including the Lord Howe Island group. This is the only area where the species breeds around Australia. In Australia, the species is thought to occur in the Tasman and Coral Seas between May-October. The continental margin of north and central NSW may be a favoured feeding area of birds breeding on islands adjacent to Lord Howe Island. In NSW, the species has been recorded on continental shelf waters between Wolli and Nambucca Heads, off Coffs Harbour and off Wollongong. The species has been extinct from Lord Howe Islands since 1913, but continues to breed on nearby islands (Garnett and Crowley, 2000).

Key Threatening Processes: Predation by cats on breeding islands threatens this species (NSW NPWS, 1999g).

Other threatening processes: It is also vulnerable to the accidental introduction of rats to their breeding colonies (Garnett and Crowley, 2000).

Habitat and ecology: This pelagic species breeds from December to February and migrates to the tropics during the non-breeding season. It produces one egg per clutch. During the non-breeding season it is found near the edge of Australia's continental shelf 10 km to 25 km offshore. It feeds on cephalopods and crustaceans from or just below the surface, by dipping.

Recovery plans: There is no recovery plan for this species.

Assessment of risk to white-bellied storm petrel

Biological characteristics: The white-bellied storm petrel uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. It has a restricted geographic range in Australia. This species' longevity and age at maturity is unknown. Considering this uncertainty and the risk prone characteristics previously mentioned, a precautionary approach will be taken and the resilience level to this threatened tern will be assumed to be low.

Overlap and interaction with fishery: It is the OTLF activities north of Wollongong, especially those occurring over the continental margins, which are most likely to potentially interact with this species. The fishery could interact with both breeding and non-breeding individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The likelihood of capturing this species in line fishing gear used by the OTLF is probably very low as it has never been recorded captured on Commonwealth longline gear, a gear-type renowned for its seabird bycatch problem that is used in the Lord Howe Island vicinity (Commonwealth of Australia, 2003). This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the white-bellied storm-petrel and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Only the OTLF activities north of Wollongong, especially those occurring over the continental margins could encounter this species, especially from May to October. Interactions that may occur between this species and the OTLF that could negatively affect the species have a very low chance of occurring.

White-capped albatross

Conservation status: The white-capped albatross, *Thalassarche steadi*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: The white-capped albatross breeds on five islands in the Auckland and Antipodes Island groups off New Zealand and generally forages in nearby waters (Gales, 1998). Adults are found in New Zealand and southeast Australian waters throughout the year whilst immature birds commonly occur off southeast Australia and South Africa (Environment Australia, 2001b). In Australia, the species is especially found in waters around Tasmania (Environment Australia, 1998a). There is little information on the occurrence of this species in waters off NSW.

Key Threatening Processes: This species is incidentally caught by longline fishing operations in Commonwealth waters (Environment Australia, 1998a). Predation of chicks by pigs on one of its breeding islands also threatens this species (Croxall and Gales, 1998).

Other threatening processes: The species can be affected by colliding with the cables and warps used on fishing trawlers (Gales, 1998).

Habitat and ecology: The species breeds annually, egg laying starts mid November and young fledglings leave their nests in mid August (Gales, 1998). Off Australia, it is found in offshore pelagic waters (Garnett and Crowley, 2000). The diet of this species has never been studied, but it is probably composed of squid and fish (Garnett and Crowley, 2000).

Recovery plans: A recovery plan for albatrosses and giant-petrels, prepared by Environment Australia, seeks to quantify and reduce threats to these species survival, reproductive success and foraging habitat, monitor populations breeding within Australian waters, educate fishers and the public about the threats to these species, and to achieve substantial progress towards the global conservation of these species (Environment Australia, 2001b).

Assessment of risk to white-capped albatross

Biological characteristics: The information provided above shows that the white-capped albatross uses eggs requiring parental care to reproduce, and has a low reproductive output producing one egg per clutch. Its geographic range seems somewhat restricted and its breeding habitat is restricted to five islands. Subsequently, the resilience level of the white-capped albatross is low.

Overlap and interaction with fishery: While the distribution of this species off NSW is poorly known, it will be assumed that all OTLF activities occurring in offshore waters could potentially interact with this species. The fishery could interact with both adult and immature individuals, only when they are foraging. As mentioned under section B2.4, the OTLF may mainly be contributing to a reduced availability of seabird prey by harvesting species known to herd small baitfish to the water's surface, as any direct affects of the OTLF harvesting bird prey would only be low to minor. There are no records of any interactions between this species and the OTLF. The recognised moderate likelihood of capturing white-capped albatrosses on longline gear (Commonwealth of Australia, 2003) is probably not occurring in the OTLF as pelagic longlining is a Commonwealth method that is rarely used for OTLF purposes alone and the bycatch of birds on demersal longline gear in Australian waters is generally not considered a problem (see discussion under section B2.4). This likelihood, however, may indicate that the chance of capturing this species on other OTLF line gear types would also be moderate. As discussed under section B2.4, seabirds may be killed or injured on the following OTLF fishing methods only when used at a pelagic level: driftlines, trolling, jigging and poling. Any bycatch of this species on driftlines used by the OTLF should not significantly reduce the survival of this species especially as this gear type is generally used on a rare to occasional basis by this fishery and there are only a small number of driftlines that can be used at any one time. The likelihood of birds being killed and severely injured from trolling, jigging and poling gear would probably be reduced by the rapid release of any captures or entanglements from these active fishing methods. This species is not known to forage around or follow fishing vessels. It could be indirectly disturbed from the noise and light emitted from a vessel, however this is not likely to reduce the survival of an individual (see discussion under section B2.4). In all, any interactions between the white-capped albatross and the OTLF should only be having a negligible impact on the population as a whole, resulting in a low level of interaction with the fishery.

Risk: Low-medium. Interactions that may occur between this species and the OTLF that could negatively affect the species have a low chance of occurring.

Mammals

Unless otherwise specifically referenced, the following information on fur-seals was obtained from *The Action Plan for Australian Seals* (Shaughnessy, 1999) and that on whales from *The Action Plan for Australian Cetaceans* (Bannister *et al.*, 1996).

Australian fur-seal

Conservation status: The Australian fur-seal, *Arctocephalus pusillus*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: The Australian fur-seal breeds on five Bass Strait islands, and a small breeding colony is becoming established at Wright Rock. Their range extends to South Australia, south Tasmania and New South Wales and several haul-out sites are known in each state. The species once bred more widely with breeding colonies at Seal Rocks in NSW and southern Tasmania. In NSW, Montague Island is the main site for the species. The species hauls-out on the northern side of the island, throughout the year, but mostly during winter (July to October) when the highest numbers are found (Shaughnessy *et al.*, 2001). A maximum of 540 Australian fur-seals were recorded on Montague Island in October 1998 (Shaughnessy *et al.*, 2001). Although it is generally thought that only male fur-seals haul-out on Montague Island, there are indications that the island is also used by female fur-seals (Shaughnessy *et al.*, 2001). The colonies of Australian fur-seals on the island are non-breeding, although there are records of odd unsuccessful breeding events, the vicinity lacks important features of other breeding colonies, and any fur-seal pups born on the island would probably not survive the weaning period (Shaughnessy *et al.*, 2001). Steamers Beach and Green Cape are other sites in NSW where Australian fur-seals regularly haul-out. Seals also come ashore irregularly at other sites all along the coast from Nadgee Nature Reserve to Tweed Heads. This occurs throughout the year, but most frequently between July and November (Smith, 2001).

The Australian fur-seal population was dramatically reduced from commercial sealing activities. In 1991, the total population size for Australian waters was estimated at between 47,000 and 60,000, with pup production estimated at 13,335. Despite some recent increases, the overall population level in Australia is likely to be much lower now than it was historically.

Key Threatening Processes: The entanglement in and ingestion of plastic debris is a threat to this species (NSW Scientific Committee, 2002c).

Other threatening processes: The species is threatened by reduced prey item availability from fishing operations, illegal shooting of seals that compete with fishing activities and entanglement in fishing gear debris (NSW Scientific Committee, 2002c).

Habitat and ecology: Australian fur-seals prefer rocky parts of islands with flat, open terrain. At sea, they remain mainly within continental shelf waters (Smith, 2001). On average, females reach a maximum length of 157 cm and males 216 cm. The maximum age for females is >21 years and males >19 years. After females reach sexual maturity at three to six years (males reach sexual maturity at around five years) they breed annually between October to December, producing a single pup after an eight to nine month gestation period. They principally feed on fish and cephalopods, and also seabirds. In Tasmanian waters, they predominantly feed on adult fish, such as redbait, leatherjackets and jack mackerel, in winter and adult squid, primarily Gould’s squid, in summer. Australian fur-seals also feed at fishing boats.

Recovery plans: A recovery plan for the Australian fur-seal has not been prepared.

Assessment of risk to Australian fur-seal

Biological characteristics: The information provided above shows that the Australian fur-seal is long lived, reaches sexual maturity at three to six years and produces a single calf that, like all other mammals, requires some parental care. Its breeding habitat is restricted. Although its Australian population is increasing, it is much smaller than it was historically. Subsequently, the resilience level of the Australian fur-seal is low.

Overlap and interaction with fishery: The Australian fur-seal is likely to interact with the OTLF fishing activities, especially those occurring south of Jervis Bay. Potential interactions that could have negative consequences for seals include capture or entanglement in fishing gear, entanglement in lost fishing gear or discarded material, competition with fishers for food resources and illegal shooting by fishers. South coast fishers in NSW have identified fur-seals as a problem; dropliners, handliners and trappers were amongst the fishers that claimed to be the most hindered by seals, especially around Montague Island (Hickman, 1999). Interactions between fur-seals and trollers have also been reported in Tasmanian waters (Kirkwood *et al.*, 1992). Seals hinder fishers by feeding on their catch and bait and scaring their targeted catch. It is such operational interactions that can result in the incidental capture, entanglement or illegal shooting of seals. Other than the capture of seals in lobster traps (e.g. Warneke, 1975), little information exists on the incidental capture or entanglement of seals in trap and line gear. The regularity of such interactions occurring with the OTLF is therefore unknown. The two records of Australian fur-seals on NSW beaches with evidence of interaction with line fishing gear over the past ten years only suggest that the species may become entangled or caught on line fishing gear in NSW (DEC Marine Fauna Management Database, 2003). Commercial drop, drift and set line fishing and any anchored or moored method using a wire trace was prohibited within an 800 m zone around Montague Island in 2002, as the area adjacent to the seal colonies on the north side of the island was declared a grey nurse shark critical habitat area. This spatial closure on fishing activity, along with prohibiting the use of anchored or moored fishing using bait within the 200m critical habitat area, may also have local mitigating consequences for seal interactions, however this has not been investigated. Illegal shooting by fishers in NSW probably occurs, especially considering that seals hinder fishers by damaging their gear and catch, but there is no information on mortality rates. Rates of entanglement in debris, including fishing gear, for this species are high in Tasmania and Victoria, and in NSW, Shaughnessy *et al.* (2001) reported seven Australian fur-seal pups around Montague Island with human debris around their necks, including rope, strap and trawl net portions. No information is available to determine the extent to which this species and the OTLF compete for the same prey. Discarding activities may be attracting seals to OTLF fishing vessels, but the consequences of any resulting interactions are not known. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Despite the possible sources of mortality described above, the population of Australian fur-seals is increasing slowly. It is not known whether these sources of mortality would prevent full recovery of the population to pre-harvest levels, therefore ongoing collection of information on interactions of the fishery with seals is needed.

Humpback whale

Conservation status: The humpback whale, *Megaptera novaeangliae*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Humpback whales occur throughout the world's oceans. Northern and southern hemisphere populations are distinct, because of seasonal migration separation.

Humpback whales are found off coastal Australia in winter and spring and are recorded from all states, except the Northern Territory. They migrate annually between warm water breeding grounds in winter, at around 15-20^{o}S, to cold water (Antarctic) feeding grounds in summer, to 60-70^{o}S. Off Australia, wintering animals off the west coast (Group IV population) are shown to be distinct from those off the east coast (Group V population). The latter is more closely related to those wintering off Tonga. Humpback whales may occur close to the coast on migration. Not all animals migrate south each year, there are some summer sightings in the Coral Sea. There is a reported sex ratio bias towards males in the east coast migration, perhaps not all females migrate north each year.

Humpback whales are regularly sighted in NSW waters when migrating (Smith, 2001). They generally pass close to the coast (rarely venturing >10 km from shore) (Bryden, 1985), mainly between June and November on their northward migration (peaking in June-July) and September and November on the southward migration (Smith, 2001).

The humpback whale population has been greatly reduced by historical whaling activities that ceased in 1963. Recent estimates of the population migrating along the east coast (Group IV) were between 3,000-4,000 and that along the west coast (Group V) were between 14,000-19,000. Australian populations of the species are increasing at a rate of around 10% per year.

Key Threatening Processes: Ingestion of or entanglement in harmful marine debris affects this species (Threatened Species Scientific Committee, 2003).

Other threatening processes: Humpback whales are more likely to be directly disturbed when they are closer to human activities on their migration and in breeding areas. Whale watching, research and pleasure vessels, aircraft, swimmers, divers, coastal seismic activity, defence operations, collision with large vessels, entanglement in fishing gear or shark nets, and pollution leading to the accumulation of toxic substances in body tissues can all directly disturb humpback whales.

Habitat and ecology: Humpback whales are pelagic and are found in Antarctic waters during summer and temperate-subtropical / tropical coastal waters in winter. Key localities for the east coast population are the south coast of New South Wales, off Coffs Harbour, Cape Byron, Stradbroke Island, Hervey Bay, and islands in the Great Barrier Reef, especially the Whitsunday passage area. The exact location of breeding grounds is unknown, although much breeding of the east coast population occurs in central Great Barrier Reef area. However, there is probably a wide range of opportunity for breeding, over several degrees of latitude on each coast. There is evidence that some animals calve in northern NSW waters when migrating north (Smith, 2001). They live to a maximum of 50 years and reach a maximum length of 18 m. Males reach sexual maturity at 11.6 m and females at 13.7 m (4-10 years of age). They calve every two to three years, sometimes twice every three years, or even annually. They calve in tropical coastal waters between June-October after an 11 – 11.5 month gestation period, producing a single calf. Mating occurs between June-October. Feeding areas are concentrated in Antarctic waters, where they almost exclusively feed on Antarctic krill. There is some evidence of them feeding on fish and plankton swarms in warmer waters, for example off Eden in NSW. Feeding behaviour off Eden has been repeatedly observed in recent years during the southward migration (Warneke, 1996). Only negligible amounts of food are taken while in NSW waters (Chittleborough, 1965). Feeding in subtropics off northwest Western Australia and eastern Australia is uncertain, however it is unlikely. The species exhibits both shallow and deep diving behaviour, and can dive for up to 15 minutes.

Recovery plans: A recovery plan for the humpback whale has not been prepared.

Assessment of risk to humpback whale

Biological characteristics: The information provided above shows that the humpback whale is long lived, reaches sexual maturity after 4-10 years and produces a single calf every 1 to 3 years, which like all other mammals, requires some parental care. Its population is much smaller than it was historically. Therefore, the resilience level of the humpback whale is considered to be low.

Overlap and interaction with fishery: Key areas for the species in NSW are the south coast, off Coffs Harbour and Cape Byron. In addition, the entire coast constitutes a migration route for the species, and it may approach close to the coast during migration rarely venturing >10 km from the shore. Given this information, interactions with fishing vessels operating in the OTLF during the species migration (June to November) are likely to occur. Risks from fishing include noise, entanglement and collision with vessels. Competition with the OTLF for food is unlikely because the species mainly feeds on krill in Antarctic waters. Humpback whales may respond to noise from approaching vessels by reducing the proportion of time at the surface, diving for longer, changing direction and moving away. Responses have been measured as far away as several kilometres. Despite these short-term reactions, humpback whales are known to return to areas that experience heavy boat traffic. They seem less responsive to disturbance when feeding than when resting at the surface. The long-term effects of vessel noise on humpback whales are unknown (Richardson *et al.*, 1995). Considering that this species regularly occurs in areas of heavy boat traffic, its collision with vessels including those used in the OTLF is possible. The occurrence of such collisions with the species is not documented. Entanglement in passive line fishing gear, trap ropes and debris is possible. Humpback whales would only become entangled in fishing gear when they accidentally swim into it (Hofman, 1990). Of the seven marine mammals reported entangled in trap ropes off NSW over the last ten years, five were humpback whales four of which were cut free and one that was first sighted in Queensland died (DEC Marine Fauna Management Database, 2003). While such records only indicate the minimal probability of this interaction, especially as there is no direct consistent documentation of such interactions, it appears that any mortality from entanglement is not affecting the species' survival as its Australian population is increasing at 10% per year. Overall the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Interactions are only possible between June to November. Interactions that may occur between this species and the OTLF that could negatively affect the species probably have a low chance of occurring.

New Zealand fur-seal

Conservation status: The New Zealand fur-seal, *Arctocephalus forsteri*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: In Australia, New Zealand fur-seals breed in southern Australia on the south coasts of Western Australia, South Australia and on Maatsuyker Island (Tasmania). They have recently been reported breeding on a couple of islands in northeastern Bass Strait (Arnould *et al.*, 2000). They also breed in New Zealand and Macquarie Island. There are >30 breeding populations in Australian waters. Non-breeding New Zealand fur-seals are occasionally reported from the west coast of Western Australia, Victoria, Bass Strait, New South Wales (mainly Montague Island), Queensland (south of Fraser Island) and New Caledonia. Montague Island is the only known regular haul-out site for New Zealand fur-seals in NSW. Here the species hauls-out on the northern side of the island, where the highest numbers occur between July to October (Shaughnessy *et al.*, 2001). Although considered a non-breeding colony a New Zealand fur-seal pup was born on Montague Island over the summer of 1999/2000, and survived for at least four months (Shaughnessy *et al.*, 2001). It is suspected that both male and female fur-seals haul-out on the island (Shaughnessy *et al.*, 2001). Outside of Montague Island, there are scattered records of New Zealand fur-seals hauling-out along the NSW coast north to Yamba (Smith, 2001). They generally do not stay at such locations for extended periods (Smith, 2001). Animals on the east coast of Australia may have moved there from New Zealand or from South Australia. Seals tagged at Kangaroo Island have been reported at Tathra, Montague Island, Jervis Bay and Sydney.

New Zealand fur-seals in Australian waters suffered a severe decline in numbers from commercial sealing operations in the late 18th and early 19th centuries. Their former range used to extend to the Furneaux Group in eastern Bass Strait where it was quite abundant. New Zealand fur-seals in Australian waters were recently estimated to number 34,700 in the early 1990s. The population of this species in Australian waters is increasing, however it is probably still lower now than it was historically. The recolonisation of Bass Strait breeding sites illustrates the increasing population of this species (Arnould *et al.*, 2000).

Key Threatening Processes: The entanglement in and ingestion of plastic debris is a threat to this species (NSW Scientific Committee, 2002d).

Other threatening processes: This species is threatened by reduced prey item availability from fishing operations, the illegal shooting of seals that interact with commercial and recreational fishing gear, and their entanglement or capture in fishing gear, such as nets used in tuna farming and deep water trawl nets (from the hoki fishery in New Zealand, and perhaps also the Australian south east trawl fishery) (NSW Scientific Committee, 2002d).

Habitat and ecology: New Zealand fur-seals prefer rocky parts of islands with mixed terrain and boulders. At sea, they seem to occur only within continental shelf waters. They reach a maximum length of 100-150 cm (females) or 150-250 cm (males). After females reach sexual maturity at six years, they produce a single pup every year after an eight to nine month gestation period. Their breeding season is from November-January. They principally feed on fish and cephalopods, and also seabirds. They also feed at fishing boats.

Recovery plans: A recovery plan for the New Zealand fur-seal has not been prepared.

Assessment of risk to New Zealand fur-seal

Biological characteristics: The information provided above shows that the New Zealand fur-seal is long lived, reaches sexual maturity at six years and produces a single pup each year that, like all other mammals, require some parental care. Although its Australian population is increasing, it is much smaller than it was historically. Consequently, the resilience level of the New Zealand fur-seal is low.

Overlap and interaction with fishery: New Zealand fur-seals are not abundant in NSW, having major population centres in New Zealand, the south coast of Australia and some Subantarctic islands. It is thought that individuals observed in NSW have migrated from either New Zealand or South Australia. Possible interactions with the OTLF only south of Yamba that could have negative consequences for seals include capture or entanglement in fishing gear, entanglement in lost fishing gear or discarded material, competition with fishers for food resources and illegal shooting by fishers. South coast fishers in NSW have identified fur-seals as a problem, dropliners, handliners and trappers were amongst the fishers that claimed to be the most hindered by seals, especially around Montague Island (Hickman, 1999). Interactions between fur-seals and trollers have also been reported in

Tasmanian waters (Kirkwood *et al.*, 1992). Seals hinder fishers by feeding on their catch and bait and scaring their targeted catch. It is such operational interactions that can result in the incidental capture, entanglement or illegal shooting of seals. Other than the capture of seals in lobster traps (e.g. Warneke, 1975), little information exists on the incidental capture or entanglement of seals in trap and line gear. The regularity of such interactions occurring with the OTLF is therefore unknown. However, as the incidental capture or entanglement of New Zealand fur-seals in trap and line fishing gear has not been listed as a specific threat to this species, the gear types used in the OTLF should not significantly impact upon its survival. Illegal shooting by fishers in NSW may occur, but there is no information on mortality rates. While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem. No information is available to determine the extent to which this species and the OTLF compete for the same prey. While this species is known to feed at fishing boats, the consequences of any interactions resulting from discarding by the OTLF are not known. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. The proportion of the population affected by the operation of the OTLF is very small. The New Zealand fur-seal population is increasing slowly in spite of the fishing pressure. It is not known, whether the population can recover to pre-harvest levels under the existing regime, however it seems unlikely that the OTLF would prevent this.

Sperm whale

Conservation status: The sperm whale, *Physter catodon*, is listed as Vulnerable under the TSC Act and is protected under s.248 of the EPBC Act.

Distribution and decline: Sperm whales are found throughout the world's oceans in deep water off the continental shelf, i.e. in water >200 m deep. Females and young males are restricted to warmer waters north of around 45^{o}S in the southern hemisphere, and adult males travel to and from colder waters. In Albany (WA), the species is concentrated in a narrow area only a few miles wide at the shelf edge and move westward throughout the year. Similar concentrations are known elsewhere. Off the west coast of Western Australia, where the shelf slopes less steeply, sperm whales are less concentrated close to the shelf edge and are more widely dispersed offshore. In the open ocean, sperm whales in the southern hemisphere generally move southwards in summer and northwards in winter. Northern hemisphere sperm whales have a separate migration that consists of similar seasonal movements to those in the south. They occur in all Australian states. Key localities for the species in Australia are near the continental shelf between Cape Leeuwin and Esperance (WA), southwest of Kangaroo Island (SA), off Tasmania's west and south coasts, off New South Wales (including Wollongong), and off Stradbroke Island (Queensland). The sperm whales off eastern Australia (Division 6 stock) are said to be a separate stock than those off western Australia (Division 5 stock) (Smith, 2001).

Sperm whales are commonly sighted off NSW out to the edge of the Australian Exclusive Economic Zone (Smith, 2001). These sightings mostly occurred between August and April (Smith, 2001), however this may represent a bias towards the tuna fishing season as most observations were made on these vessels (Paterson, 1982). The species rarely occurs within the 5 km limit of NSW waters. Small groups of the species have been sighted twice in such waters, off Eden and Broken Bay (Atlas of NSW Wildlife, 02/01/2003). The species has stranded 22 times along most of the coast of NSW, the most recent in March 2000 (Smith, 2001).

The population of sperm whales dramatically declined during historical whaling operations that ceased in 1978. The current number of sperm whales is unknown, however the 'Australian' population of the species is likely to be in the tens of thousands.

Key Threatening Processes: None of the Key Threatening Processes listed under the EPBC Act or the TSC Act would affect this species.

Other threatening processes: The species is currently threatened from direct disturbances such as collision with large vessels on shipping lanes beyond the edge of the continental shelf, seismic operations in this area, net entrapment in deep-sea gill-nets, and pollution leading to accumulation of toxic substances in the body.

Habitat and ecology: Sperm whales are pelagic and are found offshore only in deep water only. Their population is centred in temperate or tropical waters where breeding / nursing schools and groups of young males occur. They concentrate in areas where the seabed rises steeply from great depth, this is probably associated with concentrations of their major food source in areas of upwelling. They reach a maximum age of around 60 years and a maximum length of 18.3 m (males) or 12.5 m (females). Males are sexually mature at 18-21 years / 11.0-12.0 m while females are sexually mature at 7-13 years / 8.3-9.2 m. They calve every four to six years between November – March after a 14-15 month gestation period. They feed mostly on oceanic cephalopods that are taken at depth, and some deep-sea anglerfish and mysid shrimps are also eaten. At the surface, their swimming speed rarely exceeds 7.5 km / hr, however they can swim to 30 km / hr when disturbed. They are deep divers and can do so for over 60 minutes. Maximum diving depths between 1135 m to 3195 m have been recorded, although the mean diving depth is much shallower. They probably use echolocation. Breeding schools of sperm whales include females of all ages and immature and younger pubertal males. Large, socially mature males accompany schools only during the breeding season, and then for short periods of possibly only a few hours. The average school size of such a group is 25 animals, although they have been reported to number up to the low thousands. Bachelor schools of sperm whales consist of older pubertal males and sexually, but not socially, mature males, all of similar size and age. Socially mature males leave such schools to associate with breeding schools, either alone or in small groups of usually less than six animals.

Recovery plans: A recovery plan for the sperm whale has not been prepared.

Assessment of risk to sperm whale

Biological characteristics: The information provided above shows that the sperm whale is long lived, reaches sexual maturity at 7-21 years and produces a single calf every four to six years that, like all other mammals, require some parental care. Its population is much smaller than it was historically. Consequently, the resilience level of the sperm whale is low.

Overlap and interaction with fishery: Given that this species rarely occurs within NSW waters (from coastal baseline to 3 nm), it is only likely to interact with OTLF activities that occur outside of this zone, especially those occurring in water >200 m deep, mostly between August to April. The main potential impact of the OTLF is collision, as collision with large vessels in shipping lanes beyond the continental shelf is a listed threat to this species (Bannister *et al.*, 1996). It is not known how frequently collisions occur, but the relatively small vessels operating in the OTLF are far less likely to have an impact than large container ships. Entanglement of sperm whales in the traps and passive lines used by the OTLF is possible, however it is likely to be rare as such interactions are not listed threats to this species. In the DEC Marine Fauna Management Database, no sperm whales were amongst the seven mammals reported entangled in trap ropes off NSW over the last ten years. The documented regular behaviour of sperm whales around the hauling of demersal longline gear (Nolan and Liddle, 2000) suggests that this species is interested in this fishing method, perhaps to feed. Competition with the OTLF for food is unlikely because the sperm whale consumes deep-sea cephalopods, which are not generally targeted by OTLF operations. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Given the limited potential for interactions with the OTLF, the risks to the sperm whale are considered to be low.

Reptiles

Unless otherwise specifically referenced, the following information on turtles was obtained from the *Draft Recovery Plan for Marine Turtles in Australia* (Environment Australia, 1998b).

Green turtle

Conservation status: The green turtle, *Chelonia mydas*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Green turtles occur worldwide and are found in tropical and subtropical waters, with vagrants extending to higher latitudes (Cogger, 2000). In Australia, green turtles live year round in coastal waters from central Western Australia, through Northern Territory and Queensland to central New South Wales. Breeding is largely restricted to areas north of 27^{o}S (Cogger, 2000), and they are most abundant within 1000 km of their nesting beaches. In NSW, they are found in small numbers in coastal waters (Cogger, 2000). The species is the most frequently recorded marine reptile (112 records) on the NPWS Atlas of NSW Wildlife (at 20/02/2003). It is probably relatively common in northern NSW waters, from where there are records of mostly unsuccessful nestings (Cogger, 2000). A nesting record, near Coffs Harbour was successful (NSW NPWS, 2002b).

Green turtles have been hunted intensively in the past, except in Australia where it was, and continues to be hunted in relatively small numbers by indigenous communities (Cogger, 2000). Recent downward trends in nesting rates for the Queensland stock may be the result of intense hunting pressure in non-Australian waters (Cogger, 2000).

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the green turtle.

Other threatening processes: Green turtles are taken as bycatch in trawl fisheries, gill nets, shark meshing operations and can become entangled in trap ropes. Other influences include boat strike, disease, tourism activities, indigenous harvesting and ingestion of fishing line.

Habitat and ecology: Green turtles inhabit subtidal and intertidal seagrass beds and coral reefs with a good cover of seaweed. Adult turtles feed on seaweeds and seagrasses, whereas immature turtles feed on jellyfish, small molluscs, crustaceans and sponges. They do not form obvious social groups and feed as individuals. Green turtles are long-lived species that become sexually mature after 50 years when they are generally between 91.5 – 122.5 cm CCL. Adult females breed about every six years. On average, 115 eggs are laid in a clutch. They may migrate up to 2,600 km from feeding grounds in Indonesia, Papua New Guinea, New Caledonia, Fiji, Queensland, Northern Territory, Western Australia and New South Wales to breed and nest in southern and northern Great Barrier Reef, northwest Northern Territory, Gulf of Carpentaria, Western Australia, Coral Sea and Ashmore

Reef. Nesting generally occurs from late November to January and earlier in the Northern Territory from July to December. The Australian nesting populations are genetically distinct from those in neighbouring countries. Some green turtles that feed in Australia are part of stocks that breed in other countries and vice versa.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to green turtle

Biological characteristics: The information provided above shows that the green turtle is long lived, reaches sexual maturity after 50 years, uses eggs to produce offspring and lays an average of 115 eggs at a time. Its current population is very small. Subsequently, the resilience level of the green turtle is low.

Overlap and interaction with fishery: The OTLF activities occurring in coastal NSW waters, especially from central NSW north, could potentially interact with this species. None of the fisheries in NSW are listed as having a significant impact on this species in the ‘Recovery Plan for Marine Turtles in Australia’ (Environment Australia, 2003), largely because the number of green turtles occurring in NSW is relatively small when compared to other Australian states. Interactions that are possible with the OTLF include entanglement in the head gear of traps and passive lines, ingestion of or entanglement in discarded material or active fishing lines and collision with fishing vessels. Over the past ten years in NSW, three green turtles have been recorded entangled in crab traps, one entangled in synthetic rope, two with ingested hook and line and one individual was found dead from boat strike injuries (DEC Marine Fauna Management Database, 2003). While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Apart from the DEC database, there has been no focus on recording interactions with fishing activities and turtles in NSW waters. Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Green turtles are only found in NSW in small numbers and the low incidence of mortality on this species from the OTLF should not significantly affect the survival of this population. However, as the population of this species is in decline and it is reasonably common in NSW waters, more effort should be placed on recording any fishing-related mortality.

Hawksbill turtle

Conservation status: The hawksbill turtle, *Eretmochelys imbricata*, is listed as Vulnerable under the EPBC Act and is protected under the NPW Act.

Distribution and decline: Hawksbill turtles occur worldwide and are found in tropical and warm temperate waters and often extend to higher latitudes (Cogger, 2000). In Australia, they are most abundant within tropical waters of Western Australia, Northern Territory and Queensland. Breeding areas in Australia are restricted to north of 26^{o}S (Cogger, 2000). They can be found in small numbers in NSW coastal waters (Cogger, 2000). There is possibly one or more resident communities in far northern NSW and no breeding has been recorded in this area (Cogger, 2000). Julian Rocks near Byron Bay is one such location (L. Tarvey, NSW NPWS, pers. comm., 2003). Hawksbill turtles were intensively harvested in the past. Australia may have globally significant stocks of this species, considering the pressures it faces in the Asia / Pacific region. The breeding population on Millman Island (Qld) has declined.

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, effects of feral pigs and imported fire ants pose threats to the hawksbill turtle.

Other threatening processes: The hawksbill turtle is threatened by fishing interactions, boat strike, predation at rookeries and indigenous harvesting. Fishing interactions include incidental capture in trawling and gill netting gear and ghost fishing by lost nets.

Habitat and ecology: Hawksbill turtles inhabit mostly subtidal and intertidal coral and rocky reef habitats of the continental shelf. They use a parrot-like beak to feed on sponges, seagrasses, algae, soft corals, shellfish, sea squirts and molluscs. They do not form obvious social groups and feed as individuals. Their average shell length is 80 cm. They reach sexual maturity after about 40 years. On average, 130 eggs are laid at a time. Breeding females migrate up to 2,400 km from feeding grounds in New South Wales, Northern Territory, Queensland, Western Australia, Indonesia and Papua New Guinea to traditional breeding and nesting sites in tropical Northern Australia. In addition, many migrate to breeding sites in neighbouring countries including Papua New Guinea, Vanuatu, and the Solomon Islands. The Australian nesting populations are genetically distinct from those in other countries. Breeding occurs year round in the Northern Territory population, between January – April in the Torres Strait and the northern Great Barrier Reef populations and between August - November in Western Australia.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to hawksbill turtle

Biological characteristics: The information provided above shows that the hawksbill turtle is long lived, reaches sexual maturity after 40 years, uses eggs to produce offspring and lays an average of 130 eggs at a time. Its current global population is much small. Subsequently, the resilience level of the hawksbill turtle is low.

Overlap and interaction with fishery: The OTLF activities occurring in coastal NSW waters, especially in the state's far north, could potentially interact with this species. None of the fisheries in NSW are listed as having a significant impact on this species in the 'Recovery Plan for Marine Turtles in Australia' (Environment Australia, 2003), largely because only small numbers of hawksbill turtles occur in the state. Interactions that are possible with the OTLF include entanglement in the head gear of traps and passive lines, ingestion of or entanglement in discarded material and collision with fishing vessels. No fishing related interactions with this species have been recorded in NSW. Apart from the Marine Fauna Management Database maintained by DEC, there has been no focus on recording interactions between fishing activities and turtles in NSW waters. While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Overall, the level of interaction with this species would be low.

Risk: Low-medium. Hawksbill turtles are only found in NSW in small numbers and the low incidence of mortality on this species from the OTLF should not significantly affect the survival of this population.

Leatherback turtle

Conservation status: The leatherback turtle, *Dermochelys coriacea*, is listed as Vulnerable under the TSC Act and the EPBC Act.

Distribution and decline: Leatherback turtles occur across the world's tropical waters and adults are frequently recorded from higher latitudes (Cogger, 2000). In Australia, adult and large immature leatherback turtles are most regularly encountered in temperate waters of Queensland and Western Australia and in New South Wales, Victoria and Tasmania. Small numbers are found in coastal NSW waters (Cogger, 2000). There are possibly one or more resident communities in far northern NSW (Cogger, 2000). Breeding events in NSW have been recorded near Ballina in 1993 (Tarvey, 1993) and near Forster in 1995, the latter was unsuccessful (NSW NPWS, 2002b). The population of this species is declining in international waters. In Australia, the species may have always occurred in small numbers.

Key Threatening Processes: Trawling north of 28°S, harmful marine debris, predation by foxes and imported fire ants pose threats to the leatherback turtle.

Other threatening processes: The leatherback turtle has been incidentally caught in trawling, gill netting and offshore long line fishing gear. They are also occasionally entangled in trap buoy-lines. Predation at rookeries and some indigenous harvesting also threaten the species.

Habitat and ecology: Leatherback turtles are the largest of the marine turtles, with shells averaging 1.6 metres in length and with a total weight of up to 500 kg. They may reach sexual maturity at around 10 years of age and produce on average 90 eggs per clutch. They are oceanic and feed on jellyfish and other soft bodied invertebrates within the water column. The major breeding and nesting sites in the Asia / Pacific occur in Indonesia, Malaysia, Papua New Guinea and the Solomon Islands. Animals from these nesting aggregations use the continental waters of Australia to feed and migrate to temperate waters where they feed within the water column. Leatherback turtles rarely nest in Australian waters, there are perhaps fewer than 40 nesting records in total (NSW NPWS, 2002b). Annual nesting attempts in eastern Australia occur near the Bundaberg coastline and sporadic nesting occurs at other widely scattered sites in Queensland, New South Wales and the Northern Territory.

Recovery plans: The recovery plan for marine turtles in Australia, prepared by Environment Australia, recommends specific actions that seek to reduce mortality, monitor populations, manage factors affecting nesting, protect critical habitats, educate stakeholders and support, maintain and develop international conservation programs (Environment Australia, 2003). No NSW fisheries are listed as having an impact upon marine turtles (Environment Australia, 2003).

Assessment of risk to leatherback turtle

Biological characteristics: The information provided above shows that the leatherback turtle is long lived, reaches sexual maturity after 10 years, uses eggs to produce offspring and lays an average of 90 eggs at a time. Only small numbers of this species occur in Australian waters. Its current global population is much smaller than it was historically. Subsequently, the resilience level of the leatherback turtle is low.

Overlap and interaction with fishery: The OTLF activities occurring in coastal NSW waters, especially in the state's far north, could potentially interact with this species. None of the fisheries in NSW are listed as having a significant impact on this species in the 'Recovery Plan for Marine Turtles in Australia' (Environment Australia, 2003), largely because only small numbers of leatherback turtles occur in the state. Interactions that are possible with the OTLF include entanglement in the head gear of traps, incidental capture on offshore longline fishing gear, ingestion of or entanglement in discarded material and collision with fishing vessels. No fishing related interactions with this species have been recorded in NSW. Apart from the Marine Fauna Management Database maintained by DEC, there has been no focus on recording interactions between fishing activities and turtles in NSW waters. While the species is listed as being affected by marine debris, it is not known to what extent the OTLF contributes to this problem (see discussion under sections B2.4). Overall, the level of interaction between this species and the OTLF would be low.

Risk: Low-medium. Leatherback turtles are only found in NSW in small numbers and the low incidence of mortality on this species from the OTLF should not significantly affect the survival of this population.

Fish

Whale shark (*Rhincodon typus*)

Conservation status: The whale shark is listed as vulnerable under the EPBC Act.

Distribution and decline: The species occurs in tropical to warm temperate seas worldwide, in both oceanic and coastal waters. In Australia, occurs mainly off the Northern Territory, Queensland and northern Western Australia, with only isolated records from New South Wales. Individuals are commonly observed feeding close to the surface. Whale sharks undertake very long distance migrations (e.g. trans-Pacific), which are possibly timed to coincide with blooms of the planktonic organisms on which they feed. Catches in the Taiwanese whale shark fishery apparently declined dramatically during the 1980s (Pogonoski *et al.*, 2002).

Key Threatening Processes: None of the listed KTP are thought to affect the whale shark.

Other threatening processes: Targeted fishing of this species in South East Asia is thought to be the main cause of decline (Pogonoski *et al.*, 2002) and is probably the main threat to its future.

Habitat: Whale sharks occur in oceanic and coastal waters from the tropics to warm temperate waters. They are generally encountered near the surface.

Recovery plans: A recovery plan for the whale shark has not yet been prepared.

Assessment of risk to the whale shark

Biological characteristics: Little is known about the biology of this species. It was recently discovered that the species is a livebearer with an ovoviviparous mode of reproduction, when a pregnant female containing 300 embryos in its uteri was caught off Taiwan (Joung *et al.*, 1996). Individuals probably do not reach sexual maturity until they reach nine metres in length. The Taiwanese whale shark fishery has undergone a decline recently, probably due to fishing pressure (Joung *et al.*, 1996). Based on this information the species considered to have low resilience to fishing pressure.

Overlap and interaction with fishery: Based on its preference for feeding in areas of nutrient-rich upwelling events, its infrequent occurrence in NSW, and minimal potential for competition with the fishery, the extent of overlap and interaction is low.

Risk: Low-moderate, given the small probability of interaction with the fishery.

APPENDIX B3

AN ASSESSMENT OF ECONOMIC AND SOCIAL ISSUES IN THE NSW OCEAN TRAP AND LINE FISHERY MANAGEMENT STRATEGY

(DOMINION CONSULTING PTY LTD)

DRAFT

An Assessment of Economic and Social Issues in the NSW Ocean Trap and Line Fishery Management Strategy

A Report to NSW Fisheries

By

Dominion Consulting Pty Ltd

May 2004

Disclaimer

This report has been compiled on the basis of existing literature, information, and targeted surveys some of which was supplied by the client, New South Wales (Fisheries) and compiled under limited time and financial resources. Neither Dominion Consulting Pty. Ltd, nor its employees nor sub-contracting parties undertake responsibility arising in any way to any persons in respect of the data, errors, or omissions arising, through mis-interpretation of information, negligence or otherwise, however caused. This report should not be used as the basis for commercial decisions; those so doing do so at their own risk.

Dominion Consulting Pty Ltd is an independent consulting company undertaking projects in fisheries economics, management and training.

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The normal disclaimer applies.

CONTENTS

SECTION B. REVIEW OF EXISTING SITUATION

(a) Background

The Department of Planning (DP) (formerly PlanningNSW) guidelines require that the impacts of a Fisheries Management Strategy are assessed as part of an Environmental Impact Statement (EIS) (PNSW, 2002). These guidelines have included relevant matters to meet the Commonwealth "Benchmarks and Terms of Reference for Environmental Assessment of Fisheries" and to satisfy the Commonwealth Government "Guidelines for the Ecologically Sustainable Management of Fisheries" for the purposes of *Environmental Protection and Biodiversity Conservation Act 1999* (PNSW, 2002).

Under the principles of Ecologically Sustainable Development (ESD), the DP guidelines include assessment of the economic and social impacts of any proposed fishery management strategies according to prescribed economic and social considerations. This is to make the economic and social aspects of sustainable resource use and management more transparent in the decision-making process. It also enables potential policy impacts to be mitigated in the policy development process, rather than after the event.

The economic and social assessment sections of the DP guidelines require a review of existing fisheries information in section 3 (B) and an evaluation of the likely implications of the Fishery Management Strategy in section 3 (E).

Prior to the EIS process, the management of the ocean fisheries in New South Wales (NSW) did not integrate economic and social information into the planning process in a formal manner. There is a lack of information on basic economic characteristics of fishing operations and secondary seafood industries. There were no state-wide economic surveys prior to the survey for the EIS process in 2001, or little information on the social composition of fishing communities in NSW. The current study is a first attempt to gather and analyse economic and social information so as to appraise the fisheries management strategies proposed for the management of the Ocean Trap and Line Fishery. The current study is not intended as a “valuation” of the fishing industry. The existing economic and social information is a background to the assessment of specific fishery management strategies proposed in the future management of the Ocean Trap and Line Fishery. This economic and social fishery management strategy assessment is a part of a process of more accountable and transparent fisheries management and improved ecological sustainability. Prior to this study, Environmental Impact Statements have been undertaken for other commercial fisheries in NSW such as Ocean Hauling, Estuary General, Estuary Prawn Trawl and Ocean Trawl

(b) Available Information for Review

Initial analysis of available data revealed a deficit of economic and social information, with the available data coming from the licensing and catch record information held by NSW Fisheries. Catch records can be combined with price information available from the Sydney Fish Markets Pty Ltd to impute revenues to fishers and fisheries in order to estimate a value at point of first sale. This may give a minimum estimated value and may underestimate catch value.

The secondary information available on the seafood industry is limited, coming from licensing details of registered premises. There is no publicly available descriptive economic information on the processing, wholesaling and retail sections of the NSW seafood industry. This leaves an information void in which secondary value estimates of the seafood industry in NSW are not available.

To gain up to date economic and social information for the assessment process an economic and a social survey were commissioned by NSW Fisheries in May 2001.

The social assessment of the fisheries management strategies also uses existing administrative information from licence records and has been augmented by a telephone survey of fishers in NSW. This information was gathered to fill the most immediate information shortfalls for assessment purposes and to give a social profile of the state's fishers in relation to the impending need created by the Fisheries Management Strategy. This approach will need to be augmented with further fishing community surveys in the future. There is a lack of independent surveyed community opinion on fishing issues.

Available data for the social assessment was accessed via the Bureau of Rural Science, Social Science unit from the Australian Bureau of Statistics (ABS). Only partial results of the 2001 ABS census are currently available. Aggregate ABS data is of limited use to a specific fishery study being across fishery administrations, thus including Commonwealth and interstate fishing activity. The NSW EIS process and ABS data access is an area for future development.

Separate social and economic surveys were undertaken across all commercial fisheries in NSW in the May-June period of 2001 in order that subsequent environmental impacts assessments could benefit from improved information. The survey was able to address shortages in information on the fishing industry at the primary level of fishing enterprises and fishers. The limitations on data are discussed. As part of the assessment process, recommendations are made on how to improve the data available for future assessments.

There are four main sources of information and data for the economic and social assessment, and some background on each of the data sources used in the assessment is given below:

Existing NSW Fisheries licencing records have some fisher details such as date of birth and postcode. The licencing records can also show endorsement holdings and fisher file and business numbers. Catch and effort information from the NSW Fisheries database can be added to existing licencing information.

The Sydney Fish Market weighted average monthly prices for species, enables the catch data from catch and effort returns estimated an imputed Sydney value at point of first sale - the "Sydney index". This implies that the estimated landed prices of all seafood landed is the monthly average price at first sale in Sydney and may under or over report the revenue associated with individual fishers. As a price at first sale, it does not include market deductions (circa 10%), and it does not account for export sales which may exceed Sydney prices and for product sold regionally through other Registered Fish Receivers (RFR) and Restricted Registered Fish Receivers (RRFR). Data sourced from NSW Fisheries' records will be referred to as "Source: NSWF" or "Sydney index" in the study.

A specially devised social survey was executed by telephone in May 2001 (Roy Morgan, 2001a). A total of 870 fisher responses were recorded from a total of 1,751 fishers contacted state-wide. The survey results have been analysed for the Ocean Trap and Line fishery and will be referred to as "Source: RM-SS"; An economic survey was designed and executed by mail in May/June 2001 by Roy Morgan Research and will be referred to as "Source: RM-ES". A total of 250 fisher responses were recorded from a total of 1640 fishers and businesses contacted state-wide. An overview of the state-wide social survey is reported in Appendix 2.

Australian Bureau of Statistics (ABS) data were obtained from the Bureau of Rural Science (BRS) social science unit, to examine the secondary level information available on the communities and fishers in the NSW fishing industry. The results of this fisher community profiling are presented in Appendix 3.

Other sources of information have been cited, including general literature and available government and industry statistics.

4. Economic Issues

The DP guidelines must be considered by those parties responsible for preparing an EIS to assess the likely significance of impacts of implementing a Fishery Management Strategy. The guidelines for reviewing existing information on economic issues include:

Outline the investment in the fishing fleet on a state-wide and regional scale;

Outline location, age and investment of fishing associated businesses and infrastructure such as processing facilities and slipways, transport (water and road), berthing facilities, maintenance and repairs and cold stores;

Identify direct (e.g. boat owners, skippers and crew) and indirect (e.g. traders and suppliers) employment by regions including the proportion of fishers with income from other commercial fisheries and/or other non-fishing employment, the seasonality of employment and the demographic profile of those directly and indirectly employed in the fishery;

Outline the economic return from the fishery including its contribution to individual, regional and state income; and the value of licences currently held by individual fishers in the fisheries;

Existing economic multiplier effects, economic rents and community contributions;

Outline the markets for fish species (and the marketing forms) harvested in this fishery and the contribution these fisheries make towards supplying seafood to consumers on a State and regional basis; and

Summarise the overall risks to the economic viability of the fishery from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

The guidelines are presented to guide the reader with a response stated below each guideline.

PNSW Guideline (a): **Outline the investment in the fishing fleet on a state-wide and regional scale**

1. Fishing fleet in the OTL fishery

Vessels in the OTL fishery are diverse as businesses and fishers can have several licensed vessels. The NSWF licence data confirms that OTL fishers may have several small vessels in one fishing business. OTL fishing businesses have a total 1,013 boats from a state wide total of 2,950 with a mean length of 7.25m. Newcastle Marine Brokers (2003) note that 85% of fishing vessels range from 4m to 11m in length. These are small outboard powered aluminium or fibreglass vessels, with possibly only a line fishing entitlement. Fishing vessels that are engaged in harvesting spanner crabs normally range from 5.8m to 8.0m in size. Large vessels with demersal fish traps and lines are found south of Moruya and may be endorsed to fish school and gummy shark. Figure E1 reports available details on the vessels held by OTL endorsed fishers. Regional data on the fishing fleet is not available, but vessel ownership is likely to be correlated with location of businesses as indicated in Table E1.

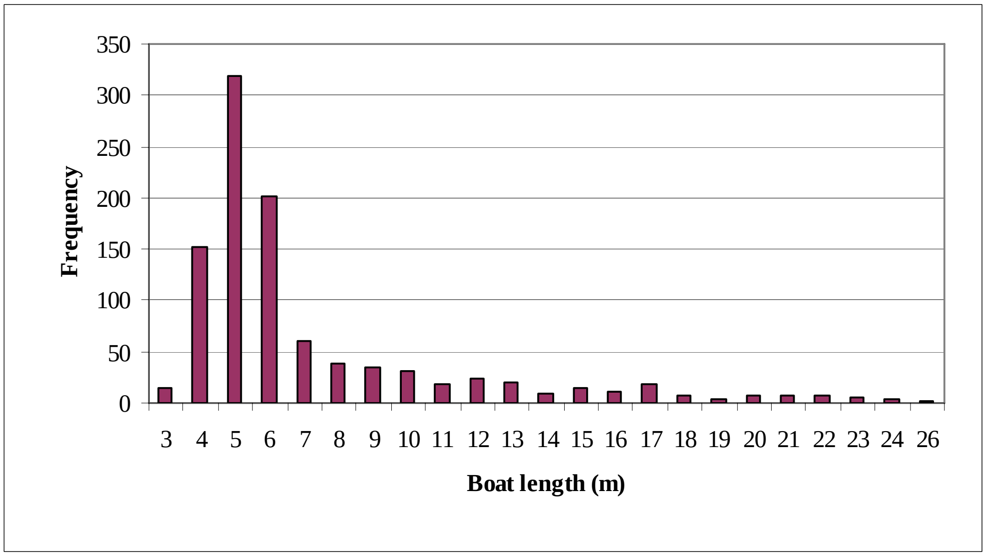

Figure E1: The distribution of vessel lengths in the OTL fishery (Source: NSWF- Licence records).

2. Investment in the Ocean Trap and Line Fishery

Capital investment in the fishery by fishers is in the form of vessels, equipment and licences. The appraisal of a capital value is complicated by restrictions on transferability and the additional items included within business sales, such as boats, nets, sheds and equipment. In addition, investment in the fishery also involves investment in processing and value adding, such as tanks for ice slurry or live fish export.

There is no published data available on ocean trap and line business values. The data used in this study comes from discussions with commercial boat brokers (Newcastle Marine Brokers 2000; 2003). The data indicate that capital investment ranges from approximately $50,000 to $250,000 and the average capital investment is approximately $110,000 in the Ocean Trap and Line Fishery.

In a fishery which has been under management and restructuring, there is an expectation of maintaining and increasing economic viability through time. This profitability should then be reflected in enhanced endorsement and business values. More accurate information is needed on fishery licence and business values. This need will increase, as share values should be monitored as an indicator of viability, when the FMS is implemented.

Based on available information from Newcastle Marine Brokers (2003), the total capital investment in the 443 active ocean trap and line fishing businesses is estimated at approximately $48.7m[9]. These are conservative capital investment estimates and should be treated with caution.

The investment in OTL fishing on a regional scale estimated based on total number of OTL fishing businesses in each zone and presented in Table E1. These estimates are for both active and latent fishing businesses. The estimates indicate that the zone 4 (Manning – Central coast) has 25% of total investment. The other zones with major investment are 3 (Coffs Harbour – Hastings) and 7 (Batemans Bay – Far South Coast) with approximately 20% of total investment.

Table 1: The investment in the OTL fishing businesses in a regional scale (Source: NSWF and Newcastle Marine Brokers 2003),

Zone	Home District	OTL Fishing Businesses	Investment ($)	%
1	Tweed -Richmond	58	6,380,000	10%
2	Clarence	73	8,030,000	13%
3	Coffs Harbour -Hastings	111	12,210,000	19%
4	Manning -Central Coast	141	15,510,000	25%
5	Hawkesbury -Sydney	34	3,740,000	6%
6	Illawarra -Shoalhaven	51	5,610,000	9%
7	Batemans Bay -Far South Coast	105	11,550,000	18%
	Total	**573**	**63,030,000**	100%

PNSW Guideline (b) **Outline location, age and investment of fishing associated businesses and infrastructure such as processing facilities and slipways, transport (water and road), berthing facilities, maintenance and repairs and cold stores.**

This section reviews the available information on processing and other fishing related infrastructure, such as ports and repairs facilities. In NSW, Fishermen's Co-operatives are located at many of the major ports and undertake low levels of fish processing for local markets. More significant processing facilities are located at Iluka, Tuncurry, Newcastle, Wollongong and Eden. Information on investment in these processing facilities is not available. Similarly, information on boat maintenance and repair facilities is not available for this review.

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[9] From available data $110,000 x 443 = $48,730,000 .

Processing infrastructure and cold store facilities

The available data on processing and cold stores is submitted to NSW Fisheries in registering fish receivers. The forms have limited information on the NSW seafood processing sector and are shown in aggregate to preserve confidentiality.

NSW Fisheries has a system of Registered Fish Receivers (RFR) and Restricted Registered Fish Receivers (RRFR) to enable monitoring of the seafood industry. The system has two categories of receivers:

RFR, for large seafood receivers of which there are 92 state-wide, and

RRFR, generally smaller holders of consent forms to sell catch locally and which number 84 state-wide.

The information available on Fish Receivers (Registered Fish Receivers and Restricted Registered Fish Receivers), cold stores and vehicles has been reviewed. Tables E2a and b were compiled from the regulatory forms and can give some indication as to the number of licensed processing facilities associated with OTL fisheries and their location, and report an estimation of the RFR and RRFR holders handling species associated with the OTL fishery – (there is limited data and it should be treated with caution). Information on age and investment is not available for review.

Table E2a: The RFRs associated with the OTL fishery in NSW (Source: NSWF Fish receiver records).

Zone	Area	No. RRFs	With cold stores	No. cold vehicles	No. OTL businesses	No. cold stores - OTL	No. cold vehicles - OTL
North	Tweed - Manning	38	34	39	11	9	7
Central	Wallis - Sydney	29	21	30	18	18	13
South	Illawarra - Far South Coast	25	22	33	7	7	6
Total		**92**	**77**	**102**	**36**	**34**	**26**

Table E2b: The RRFRs associated with the OTL fishery in NSW (Source: NSWF Fish receiver records).

Zone	Area	No. RRFRs	No. OTL businesses	No. cold stores - OTL	Ice box - OTL
North	Tweed - Manning	22	11	4	9
Central	Wallis - Sydney	26	18	6	4
South	Illawarra - Far South Coast	35	7	10	11
Total		**83**	**36**	**20**	**24**

It is estimated that 26 of the 92 RFRs establishments in the state (28.2%) may work with OTL species, but the proportion and volume of business is unknown. There are 13 of 26 RFRs (50%) associated with OTL species in the central area (Wallis-Sydney), and less in the north and south of the state. Approximately 73% of processing firms (by number) are north of

Sydney as per fisher numbers and the value of fishery revenue. Cold storage and retail sales follow this pattern also.

The RRFR data indicates that of 83 RRFRs state-wide, 36 (27%) may have involvement with OTL species. Of these 36, 20 have access to a cold store and 24 have ice box arrangements in place to maintain quality (Table E2). Due to previous co-operative system there are more RRFRs, formerly consent holders, in the southern area of the state with cold storage capacity.

Transport facilities

Road transport in the OTL fishery is required to take the catch from the landing point to market via processors or cooperatives. From state-wide seafood industry records there are 26 seafood transport vehicles capable of holding fish at temperatures below 5 degrees C, associated with establishments which handle ocean trap and line species amongst other seafood. An unknown proportion of this capacity would be directly attributable to the OTL fishery.

Port facilities

Information on port infrastructure comes from records held by Department of Land and Water Conservation (DLWC) and licensing records for fish receivers held by NSW Fisheries. The operators in the ocean trap and line use ports for boat storage and operation. A list of all public port assets for NSW was obtained from the Department of Land and Water Conservation. This was then compared with areas of operation of the OTL fishers, fishing co-operatives and towns in coastal NSW. The major port facilities available to fishers in the OTL fishery and interview comments are attached to the right hand side of Table E3.

Table E3: The OTL fishery and public port assets in NSW. Comments on OTL use (Source: DLWC and NSW Fisheries Staff).

Table G5: The OPT fishery and public port assets in NSW (Source: DLWC)

Town	Port Assets	HBR	JET	WHF	ACC	OTL (Y/N)	Comment - OTL
Tweed Heads	Tweed Heads	1	2		1	Y	Boats use port
Brunswick Heads	Brunswick Heads	1	3	2	1	Y	Boats use port
Ballina	Ballina	1	1	2	1	Y	Boats use port
Evans Head	Evans Head	1	1	1	1	Y	Boats use port
Iluka	Iluka	1	2	2	1	Y	Boats use port
Yamba	Yamba	1	2	1	1	Y	Boats use port
Maclean	Maclean					N	N/A
Wolli	Wooli	1		1	1	Y	Boats use port
Coffs Harbour	Coffs Harbour	1		5	1	Y	Boats use port
	South West Rocks	1	2	1	1	Y	Boats use port
Port Macquarie	Port Macquarie	1		2	1	Y	Boats use port
Laurieton	Camden Haven	1	1	2	1	Y	Boats use port
Crowdy Head	Crowdy Head	1	2	1	1	Y	Boats use port
Taree						N	N/A
Tuncurry	Tuncurry	1	1	3		Y	Boats use port
Nelson Bay	Nelson Bay	1	1	5	1	Y	Boats use port
Tea Gardens	Tea Gardens	1		1		N	N/A
Wickham	Raymond Terrace	1	1		1	Y	Boats use port
Newcastle	Swansea	1	1			Y	Boats use port
Pittwaters						Y	Boats use port
Brisbane waters						Y	Boats use port
Mannering Park						N	N/A
Tacoma						N	N/A
Brooklyn	Brooklyn	1	1			Y	Boats use port
Pyrmont						Y	Boats use port
Mascot	Cooks River					Y	Boats use port
Wollongong	Wollongong	2	1	1	1	Y	Boats use port
	Bellambi	1	1			N	N/A
Berkley	Berkeley	1	1	2	1	N	N/A
	Port Kembla	1	1			?	May be some trailer boats are working
	Shellharbour	1		1	1	?	May be some trailer boats are working
	Kiama	1	1	1	1	Y	Boats use port
Nowra	Greenwell Point	1	1			Y	Boats use port
Huskisson						?	May be some trailer boats are working
Ulladulla	Ulladulla	1	1	2	1	Y	Boats use port
	Batemans Bay	1	2	2	1	Y	Boats use port
	Narooma	1	1	3	2	Y	Boats use port
Bermagui South	Bermagui	1	3		1	Y	Boats use port
Eden	Eden	1	2	3	1	Y	Boats use port
	Throsby Creek	1	2	2	1	N	N/A

(Key: HBR- Harbour; JET – Jetty; WHF – Wharf; ACC – Access ramp)

PNSW Guideline (c): **Identify direct (e.g. boat owners, skippers and crew) and indirect (e.g. traders and suppliers) employment by regions including the proportion of fishers**

with income from other commercial fisheries and/or other non-fishing employment, the seasonality of employment and the demographic profile of those directly and indirectly employed in the fishery.

The NSW fishing industry has direct employment in fishing operations and indirect employment through the cold stores, processors, suppliers and traders. Current information is available for direct fisher employment only, with the social survey giving new employment estimates i.e for current total of 654 fishing businesses in the OTL fishery. Indirect employment estimates are made based on multipliers presented later in this study.

1. Direct employment

Fishers are employed in their businesses and each business may have several fishers. Fishers can be either owner operators, nominated fishers, employees or crew depending on the fishery. However, the analysis is complicated by the ability of fishers to form several businesses, or be part of partnerships and companies. All this also takes place within the broader state wide activity patterns of fishers fishing in different fisheries where one person can be endorsed in up to six fisheries. The following facts from the database are provided at state-wide level, and for the OTL fishery.

The social survey investigated employment in the OTL fishery. There were 344 respondents holding OTL endorsements. Each was asked: How many people have you employed in the last 12 months? (Full time, F-T or Part time, P-T). The results are presented in Table E4. Of the 344 respondents, 187 had no employees and 157 had a total of 669 employees, of whom 331 were full-time and 338 part-time. Assuming the sample is representative, it is proposed to adjust the survey estimate for total 654 fishing businesses[10].

The fishers are also to be included in employment estimates and represent 654 fishing businesses both full-time and part-time. Only 307 (47%) fishers (both part time and full time) fished in the OTL fishery in 2001-2002. (NSWF)

Table E4: Estimation of number of employees in the fishery (Source: RM-SS).

No. of Employees	Frequency (businesses)	Total Employees	Full-time	Part-time
0	187	0	0	0
1	62	62	40	22
2	27	54	28	26
3	18	54	30	24
4	16	64	20	44
5	7	35	9	26
6	9	54	18	36
7	2	14	14	0
8	4	32	10	22
11	1	11	4	7
12	2	24	24	0
15	1	15	15	0
20	3	60	25	35
>20	5	190	94	96
Total	**344**	**669**	**331**	**338**

[10] Adjustment is proposed in the ratio of 654/344 = 1.9. It should be noted that the multiplying of this sample by 1.9 is almost certainly an over estimate of "OTL employees".

There are between 991[11] and 1,925[12] persons employed full-time and part-time in fishing businesses which hold an OTL endorsement. There is no indication as to the extent of part-time employment in this fishery. The estimates of employment need to be seen in the context of all fishing activity state-wide, rather than for each administered fishery and requires further investigation to exclude double counting.

Table E5 presents details about the percentage of OTL fishers employed in each district in NSW.

Table E5: Employment of ocean trap and line fishers by regions (Source: adapted from ABS)

Zone	Home District	Postcode population	P'code Fishers	P'code OTL Fishers	SEIFA	Unemployed (%) 2001*	Med. Ind. Income ($/wk) 2001*	Employed in C.F. (%) of labour force	Employed in OTL as (%) of labour force
1	TWEED	41,938	63	28	922.2	12.2	250.0	0.4	0.2
	RICHMOND	28,558	87	30	930.2	12.2	283.3	0.9	0.3
	Zone	**70,496**	**150**	**58**	**926.2**	**12.2**	**266.7**	**0.6**	**0.2**
2	CLARENCE	43,353	259	73	919.2	13.6	250.0	3.1	1.0
3	COFFS HARBOUR	55,625	110	70	939.8	17.5	275.0	0.7	0.5
	HASTINGS	61,291	90	41	936.4	14.4	250.0	0.7	0.3
	Zone	**116,916**	**200**	**111**	**938.1**	**16.0**	**262.5**	**0.7**	**0.4**
4	MANNING	37,878	80	31	914.1	11.5	250.0	0.7	0.3
	WALLIS LAKE	22,704	105	35	939.0	11.7	250.0	2.8	0.9
	PORT STEPHENS	52,562	101	21	966.6	10.4	316.7	1.3	0.2
	HUNTER	52,557	55	18	933.2	10.3	350.0	0.2	0.1
	CENTRAL COAST	206,143	102	36	976.8	6.5	416.7	0.0	0.0
	Zone	**371,844**	**443**	**141**	**945.9**	**10.1**	**316.7**	**1.0**	**0.3**
5	HAWKESBURY	2,380	30	1	1004.5	6.1	400.0	0.0	0.0
	SYDNEY	3,276,207	189	33	1047.0	6.1	450.0	0.0	0.0
	Zone	**3,278,587**	**219**	**34**	**1025.7**	**6.1**	**425.0**	**0.0**	**0.0**
6	ILLAWARRA	65,532	50	16	934.7	8.3	350.0	0.1	0.1
	SHOALHAVEN	53,871	75	35	945.1	10.9	300.0	0.8	0.3
	Zone	**119,403**	**125**	**51**	**939.9**	**9.6**	**325.0**	**0.5**	**0.2**
7	BATEMANS BAY	34,836	105	47	957.6	12.6	250.0	1.2	0.4
	MONTAGUE	8,135	53	37	955.1	13.0	250.0	1.5	1.1
	FAR SOUTH	3,726	61	21	916.2	9.3	250.0	2.6	0.9
	Zone	**46,697**	**219**	**105**	**943.0**	**11.6**	**250.0**	**1.8**	**0.8**
	Grand Total	**4,047,296**	**1615**	**573**	**945.3**	**11.1**	**306.0**	**0.9**	**0.3**

2. Indirect employment

The indirect employment estimates were made based on employment multiplier estimates. The employment multiplier estimates from fishing community studies in NSW range from 0.36 to 0.58 (Tamblyn and Powell, 1988; and Powell *et al.*, 1989). Assuming the direct

[11] (322 active OTL fishers + between 669 [sample data] and 1271 [expanded data] employees) i.e. 991 or 1593.

[12] (654 endorsed OTL fishers + between 669 [sample data] and 1271 [expanded data] employees) i.e. 1323 or 1925.

employment is between 991 and 1,925 jobs, the indirect employment in the OTL fishery is estimated from 364 to 1,130. The estimates are:

For 991 direct employees there will be between 364 and 582 indirect employees; and

For 1,925 direct employees there will be between 706 and 1,130 indirect employees

3. Sources of fishers' incomes

All fishers in the social survey were asked questions regarding the percentage of their income from fishing as compared to non fishing. Income from directorships and general investments was also identified as reported in Table E6.

Table E6 reports 277 of 355 (78%) fishers who responded to this question have 90-100% income from fishing, and another 36 (10%) fishers have over 50% income from fishing. Part-time fishing involvement is limited, with 33 from 355 fishers (9%) having less than 30% of income from fishing and the remaining income from other industries. Fishers that work in other industries is addressed in the social issues section.

The social survey employment estimates also include the employment of fishers' partners. In the survey sample, 34% (131 of 384) fishers had their marital partners involved in their fishing business, of which 46% were employed full-time.

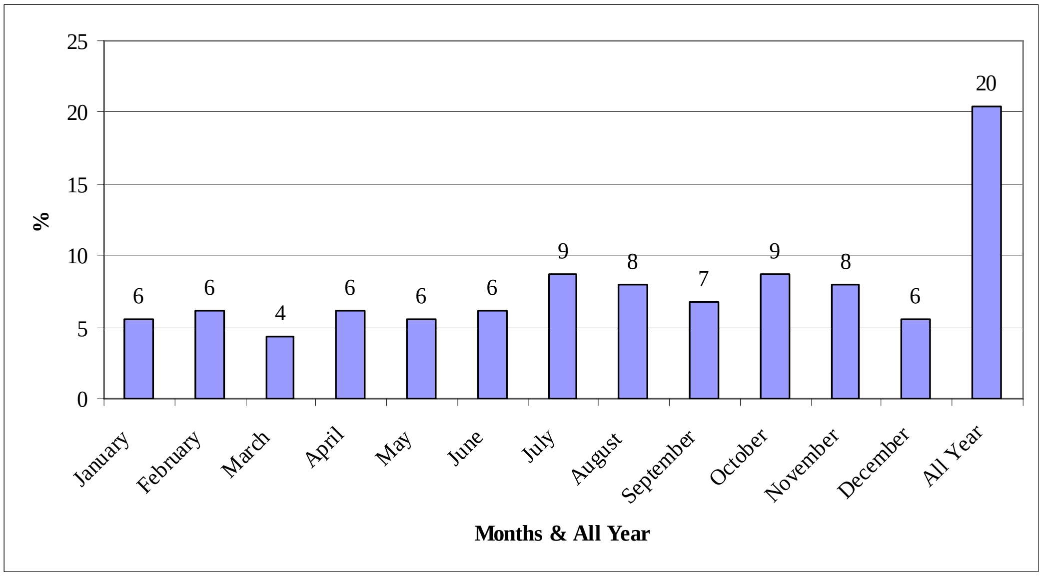
Table E6: The percentage of income from fishing and non-fishing sources in which OTL fishers participated in the last 12 months (Source: RM-SS)

	Source of Income (%)			
No. of fishers (n=355)	**OTL fishing**	**Fishing related work**	**General Investments**	**Other Industries**
25	<10	14	14	**63**
3	10-19	3	27	**60**
5	20-29	16	11	**53**
6	30-39	7	20	**43**
3	40-49	3	0	**57**
13	50-59	4	12	**32**
2	60-69	0	0	**40**
10	70-79	0	10	**17**
11	80-89	4	7	**8**
277	90-100	0	0	**0**

4. Seasonal employment

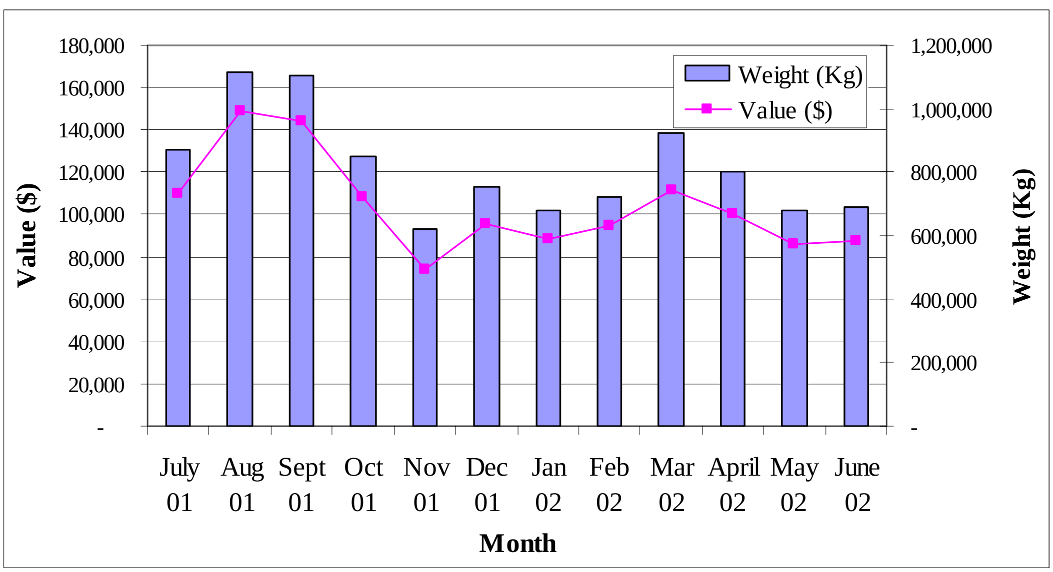
There was no previous data on seasonal employment prior to this study. Employment opportunities for fishers in other industries have been investigated through the social survey (RM-SS). The seasonality of part-time work in other industries was investigated in the social survey by asking "in what months did you undertake paid employment outside the fishing industry"? The survey results indicate that endorsed OTL fishers are working in other industries in all seasons, but higher numbers of OTL fishers work from July to November, and approximately 20% work all year round (see social section for further analysis of non-fishery employment). Figure E2 reports monthly frequencies for all fishers who worked in the OTL fishery and annual frequencies for those OTL fishers who worked all year.

Figure E2: Monthly frequency of employment outside fishing, (including all year round) in the OTL fishery (Source: RM-SS).



The seasonal occurrence of the fish catch is reported below as it gives some background to seasonality in the fishery and the need for labour (Figure E3). The NSW Fisheries catch and value data for 2001-2002 indicate that February to March and July to October are the seasons when more labour is required in the fishery.

Figure E3. Monthly variation in catch and value in the OTL fishery for 2001-2002 (NSWF - Sydney Index).



5. A demographic profile of ocean trap and line fishers

The social survey enables us to prepare a demographic profile of OTL fishers (Table E7). The social section of this report provides further demographics of OTL fishers.

Table E7: The demographic profile of OTL fishers (Source: RM-SS and NSWF licence data).

State-wide Profile*	All NSW	OTL
Mean age of OTL fishers	54.1	54.6
Age range	16-88	18-88
Percent males	97%	98%
Mean years resident in town	20.3	19.7
Mean years in Fishing Industry	22.1	26
Generations in Fishing Industry	1.5	1.7
Mean Hours /week in fishing industry	70.2	55.8
Percent currently employed in other industries	19%	20%
Housing Tenure		
Own	49%	50%
Paying off	32%	31%
Renting	16%	15%
Other	3%	4%
Education		
Did Not Finish Primary School	2%	2%
Finished Primary School	4%	2%
Year 7/ 1st Form	4%	4%
Year 8/ 2nd Form	10%	8%
Year 9/ 3rd Form	17%	16%
Year 10/ 4th Form	32%	32%
Year 11/ 5th Form	4%	4%
Year 12/ 6th Form	11%	13%
Trade Or TAFE Certificate(s)	10%	12%
Industry Or Business Course(s)	2%	2%
University Degree/ Tertiary Education	3%	3%
Other	1%	1%
Marital Status		
Married or relationship	80%	80%
Single	11%	10%
Other (Divorced, separated, widowed)	8%	8%
Partner employed in Fishing Business	32%	34%
Mean number of Children <16 years	0.92	0.97
(Other) Dependants		
None	63%	64%
Spouse	23%	19%
Children Over 16 yrs and Others	14%	17%
Employed Status		
An Owner/ Operator	87%	91%
A Non-Fishing Owner	3%	3%
An Employee Skipper	4%	3%
A Nominated Fisher/other	5%	3%
Employees (%)		
0	65%	54%
1 or more	35%	46%
Mean Individual net taxable income	$58,710	$63,251**
Mean Household net taxable income	$50,713	$63,375**
<$6,000	2%	1%
$6,000 - $9,999	1%	2%
$10,000 - $19,999	4%	4%
$20,000 - $29,999	12%	10%
$30,000 - $39,999	12%	10%
$40,000 - $49,999	7%	7%
$50,000 - $59,000	5%	6%
$60,000 - $69,999	5%	4%
$70,000 - $79,999	3%	4%
$80,000 - $89,999	3%	3%
$90,000 - $99,999	1%	1%
$100,000 +	5%	8%
* See Social section also Can't say	31%	30%
** Treat with caution Refused	9%	10%

In Table E7 the survey data for individual and household income should be treated with caution due to a low response rate and possible misunderstanding of the question as evidenced by similar individual and house hold income which is unlikely.

PNSW Guideline (d): **Outline the economic return from the fishery including its contribution to individual, regional and state income; and the value of licences currently held by individual fishers in the fisheries.**

1. The contribution of Ocean Trap and Line Fishery to NSW state economy

The details about the total catch and total value of catch associated with the Ocean Trap and Line Fishery in the 1997/98-2001/02 period are presented in figures E4. The total catch in the fishery 1997-2002 period decline from 2,296 tonnes (1997/98) to 1,473 tonnes (2001/02). The fishery had an estimated average value at first sale of $9.8 million as reported in Table BE8.

These estimates are for financial years and do not include the revenue from the Abalone fishery13. Given the first sale revenue estimates are from the Sydney index, they should be treated as a minimum estimate. Sydney Index may be an underestimate because the price is an average for species harvested by all fishing methods and across all fisheries, not just OTL. The species harvested exclusively by trap and line may attract higher prices due to greater quality than average species price at the Sydney Fish Market.

Table E8: The total revenue of fisheries production in different fisheries in NSW (excluding Abalone) in the years 1997-2002 (millions $ nominal, Source: NSWF- Sydney index).

Year	EG	EPT	OH	OPT	OFT	OTL	RL	Total
1997/98	19.0	2.6	7.2	20.9	5.2	11.2	4.2	70.3
1998/99	18.0	3.2	4.1	23.4	4.1	9.6	3.8	66.2
1999/00	17.0	3.8	4.4	22.4	3.9	9.8	4.5	65.8
2000/01	17.7	4.2	5.9	33.0	3.9	9.9	N/A	74.6
2001/02	15.0	1.7	8.5	23.5	3.1	8.3	4.4	64.5
Average	**17.3**	**3.1**	**6.0**	**24.6**	**4.0**	**9.8**	**4.2**	**69.0**
%	**25%**	**4%**	**9%**	**36%**	**6%**	**14%**	**6%**	**100%**

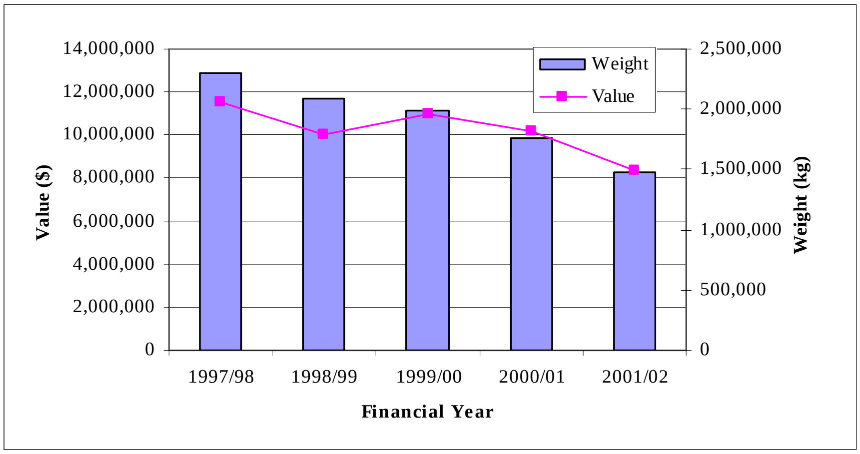
(Key: EG Estuary General; EPT Estuary Prawn Trawl; OH Ocean Haul; OPT Ocean Prawn Trawl; OFT Ocean Fish Trawl; OTL Ocean Trap and Line; RL Rock Lobster; N/A Not Available)

The total catch and value of the Ocean Trap and Line fishery in the 1997-2002 period is approximately 14% of the average revenue of the total annual fishery production in NSW as reported in Table E7 & Figure E4. Given the first sale revenue estimates from the Sydney

[13] The abalone fishery in 2002 financial year had estimated annual total revenue of $12.5m and was approximately 15% of the total annual fishery production in NSW of $81.7m.

index, they should be treated as a minimum estimate exclusive of alternative markets to Sydney, and fish marketed in export markets.

Figure E4: Total catch (Kg) and total value ($, nominal) of catch associated with the Ocean Trap and Line fishery in the 1997/98-2001/2002 period (Source: NSWF-Sydney Index).



2. The contribution of Ocean Trap and Line Fishery to regional incomes in NSW

OTL fishers operate regionally. The regional fishery revenue associated with OTL endorsed fishing businesses is reported in Table E9 for 2001/2002 across all fisheries giving the total value of catch in each district as a percentage. The state wide fishery relationships (excluding the Abalone and Lobster fisheries) reported in Table E9 reveal that the Clarence district has 21% of state wide fishing revenue, reflecting the OPT, EPT and EG fisheries in that region.

The districts north of Sydney have approximately 80% of the revenue from state wide fish production in the OTL fishery. The ocean trap and line fishers in the districts Shoalhaven, Montague, Sydney South, Central Coast, Batemans Bay, Coffs Harbour, Manning, Illawarra and Richmond make approximately 17-49% to the total revenue from fisheries in NSW.

Due to the mixed endorsement holdings of OTL businesses (Figure E5), the revenue associated with catches across several fisheries made by fishers and fishing businesses holding OTL endorsements is greater than $8.3 m per annum and was $13.4 m in 2001-2002 (see Table E10).

In all districts, except Hastings, Port Stephens and Sydney North, OTL fishers have more than 35% of revenue from the Ocean Trap and Line fishery and the remaining revenue comes from other fisheries in which OTL fishers are endorsed. In the northern region of the state, OTL fishers in Clarence, Coffs Harbour and Manning districts are more dependent on OTL fishing than others, and in the southern region of the state, fishers in Shoalhaven, Montague and Batemans Bay are more dependent on OTL fishing than other.

Figure E5 : OTL fishers endorsement holdings across other commercial fisheries (NSWF)

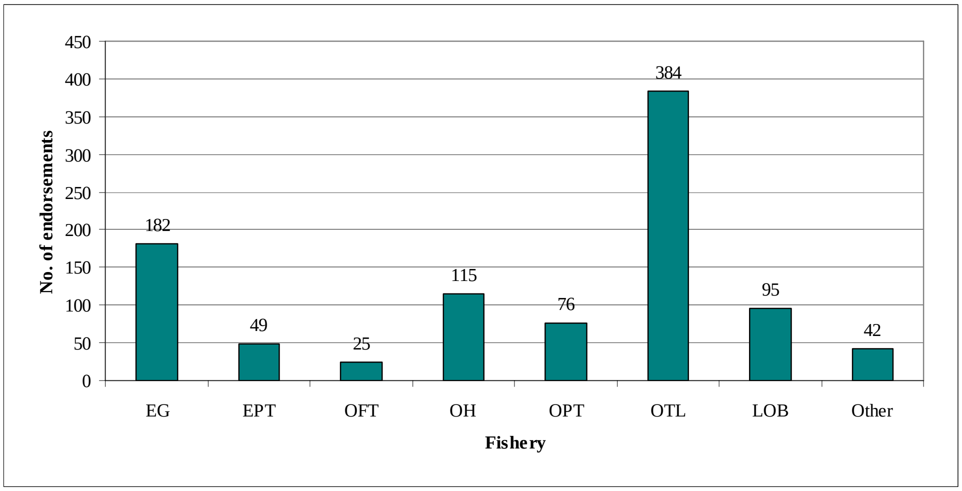


Table E9: State-wide fishery revenue in different fishery zones and districts of NSW in 2001-2002 ($, Source: NSWF- Sydney Index).

ZONE	DISTRICT	EG	EPT	OH	OPT	OFT	OTL	Total	% Total	OTL % of Total
1	TWEED	900,949	438	576,367	2,344,637	-	**387,299**	4,209,690	7%	**9%**
1	RICHMOND	1,007,363	-	-	3,341,739	-	**907,436**	5,256,538	9%	**17%**
2	CLARENCE	2,355,254	882,819	370,649	9,025,670	-	**187,256**	12,821,649	21%	**1%**
2	COFFS HARBOUR	408,534	-	246,167	2,761,949	-	**1,118,041**	4,534,691	8%	**25%**
3	HASTINGS	1,223,598	11,127	388,535	2,043,619	13,936	**261,298**	3,942,114	7%	**7%**
4	MANNING	869,773		492,739	446,096	917	**509,840**	2,319,366	4%	**22%**
4	WALLIS LAKE	2,320,590	10,071	720,373	589,809	1,781	**350,305**	3,992,930	7%	**9%**
4	PORT STEPHENS	635,945	7,804	263,353	844,338	812,998	**184,804**	2,749,242	5%	**7%**
4	HUNTER	1,176,752	195,268	105,178	825,905	1,092,836	**286,444**	3,682,383	6%	**8%**
4	CENTRAL COAST	954,193	67,976	94,519	-	-	**721,322**	1,838,009	3%	**39%**
5	HAWKESBURY	165,114	274,894	-	-	-	**-**	440,008	1%	**0%**
5	SYDNEY NORTH	413,546	133,614	1,192	599,900	742,429	**186,906**	2,077,586	3%	**9%**
5	SYDNEY SOUTH	311,096	30,182	35,547	34,306		**290,993**	702,124	1%	**41%**
6	ILLAWARRA	832,267	645	1,020,215	-	-	**600,185**	2,453,313	4%	**24%**
6	SHOALHAVEN	741,928	33,678	47,797	189,233	-	**963,499**	1,976,134	3%	**49%**
7	BATEMANS BAY	253,601	2,242	153,385	43,226	301,647	**390,939**	1,145,038	2%	**34%**
7	MONTAGUE	286,980	-	369,194	156,505	41,231	**694,518**	1,548,428	3%	**45%**
7	FAR SOUTH COAST	214,748	-	3,585,295	234,951	139,357	**289,764**	4,464,116	7%	**6%**
	TOTAL	**15,075,243**	**1,650,757**	**8,470,506**	**23,515,464**	**3,147,132**	**8,334,141**	**60,193,241**	**100%**	**14%**

Table E10: Fisher revenue for OTL fishers in the OTL and other fisheries in different districts of NSW in 2001-2002 ($, Source: NSWF- Sydney Index).

ZONE	DISTRICT	EG	EPT	FT	OH	OPT	OTL	Total	OTL % of Total
1	TWEED	85,672	-	-	74,756	62,605	**387,299**	610,333	**63%**
1	RICHMOND	239,499	-	-		146,010	**907,436**	1,292,945	**70%**
2	CLARENCE	135,349	17,119	-	39,902	1,380,403	**187,256**	1,760,029	**11%**
3	COFFS HARBOUR	17,080	-	-	27,018	45,874	**1,118,041**	1,208,012	**93%**
3	HASTINGS	19,350	-	-	96,903	376,901	**261,298**	754,451	**35%**
4	MANNING	38,960	-	-	110,422	-	**509,840**	659,222	**77%**
4	WALLIS LAKE	173,517	-	-	58,450	-	**350,305**	582,271	**60%**
4	KARUAH		-	-		-	**3,292**	3,292	**100%**
4	PORT STEPHENS	127,300	-	22,054	74,891	106,652	**184,804**	515,702	**36%**
4	HUNTER	153,424	-	-	6,417	-	**286,444**	446,286	**64%**
4	CENTRAL COAST	128,051	8,126	-	25,204	-	**721,322**	882,702	**82%**
6	SYDNEY NORTH	205,465	-	55,322	-	123,259	**186,906**	570,952	**33%**
6	SYDNEY SOUTH	74,495	-	-	35,547	-	**290,993**	401,035	**73%**
6	ILLAWARRA	194,167	-	-	93,610	-	**600,185**	887,962	**68%**
7	BATEMANS BAY	87,820	-	28,741	34,126	10,857	**390,939**	552,483	**71%**
6	SHOALHAVEN	81,949	-		26,598	-	**963,499**	1,072,047	**90%**
7	MONTAGUE	45,388	-	41,231	56,087	-	**694,518**	837,223	**83%**
7	FAR SOUTH COAST	34,415	-	-	-	3,201	**289,764**	327,379	**89%**
	TOTAL	1,841,900	25,244	147,348	759,932	2,255,761	**8,334,141**	13,364,327	**62%**

3. The contribution of the Ocean Trap and Line Fishery to fishers' individual incomes

The Ocean Trap and Line Fishery has commercially licensed fishers operating in coastal NSW. Fishing effort records are available through the NSW Fisheries logbook system. For the 624 fishing businesses with OTL endorsements, 443 had active fishing records in a range of commercial fisheries in 2001-2002 and 181 were not fishing Of the 443 active Fishing Businesses (FBs), 89 FBs fished only in others fisheries for which they were endorsed and 151 FBs fished in OTL in conjunction with other fisheries, and 203 FBs fished only in the OTL fishery.

Income from all sources

The social survey results indicate that mean household net income was around $63,375. Fewer fishers responded to the question asked in the social survey on individual and household incomes and the estimates are considered to be high, possibly due to confusion among respondents and should be treated with caution. (Table E7). A significant number of incomes of $100,000 or over were recorded (14%), but as it represents personal income from all industries, it may reflect financial returns and business interests from outside the OTL fishery.

Income from ocean trap and line fishing

Figure E6 displays the relationship between cumulative revenue and cumulative numbers of fishers in the OTL fishery. In businesses with an OTL endorsement it should be noted that:

the top 50% of fishing businesses take 92% of the fishery revenue;

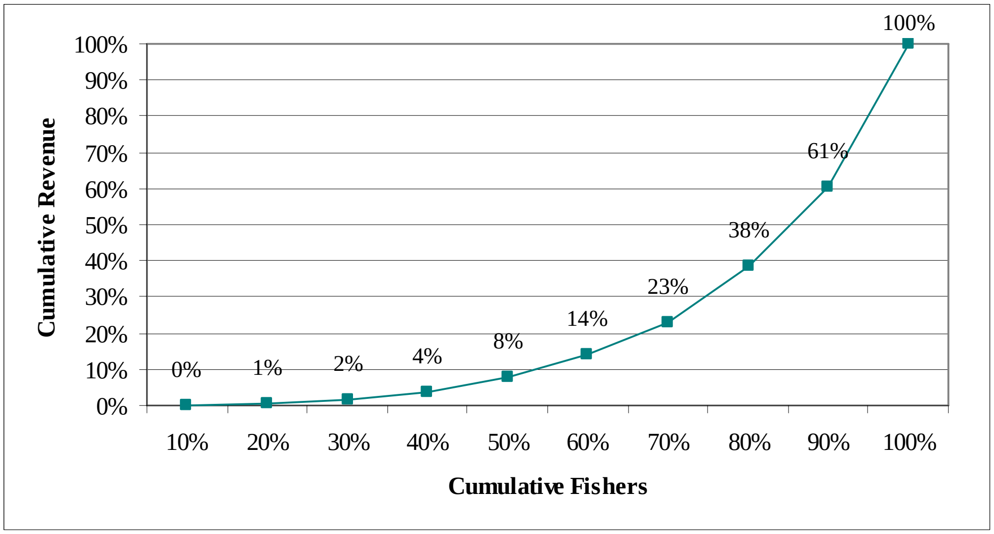
the top 10% take 39% of fishery revenue;

the top 20% take 62% of fishery revenue;

the top 30% take 77% of fishery revenue; and

the bottom 50% take only 8% of revenue, indicating part time fishers.

Figure E6: The cumulative revenue and cumulative number of endorsed fishers in the OTL fishery 2001-2002 (Source: NSWF-Sydney Index).



Economic performance of fishers

There is no previous information on economic performance of fishers in the OTL fishery. The only previous economic survey work covering some OTL fishers was by IPART (1998). The IPART study did a brief review of a cross section of fishing businesses in NSW, in order to establish their capacity to pay management charges. A fishing industry economic survey (RM-ES) was conducted in May 2001 to appraise fishing industry profitability and economic viability. The results should be treated with caution as the survey is for only one financial year only. The sample is assumed to be representative, but may not be given the diversity in the fishery. The information forwarded by fishers was taken in good faith but may have overestimated costs and under reported revenue.

Fishing businesses and owner operators act as firms fishing among a range of different commercial fisheries in which they are endorsed. An economic survey can measure the performance of the firm across all its fishing activities and give a profile of firms in the fishing industry. When it comes to assessing the economic performance of firms in a given fishery, the scope of production of the firms needs to be examined i.e. which combinations of fisheries does the firm access? The closest we can get to a measure of economic return of the fishery is to appraise the performance of businesses which have a greatest percentage of their effort in the OTL fishery. However results are reported for all businesses with OTL endorsements and for specific OTL fishing where relevant. This is required given the diversity of fishing operations and the inability of even the activity of “OTL only” fishers to represent the returns obtained from the fishery by a variety of businesses of different structures fishing the OTL fishery.

There are many businesses also fishing in the Estuary General, Lobster, Ocean Haul and Ocean Prawn Trawl fisheries as most OTL endorsement holders are also holders of EG, OH and OPT endorsements. Species taken in the OTL fishery are also taken by other commercial and recreational fishers. This must be taken into account in examining economic performance in the OTL fishery.

The economic survey indicates that 28% of OTL business respondents are earning an economic surplus assuming the levels of opportunity costs and economic depreciation required for long term viability. These operators are contributing to the local, state and national economy in terms of economic profit contributing to Gross Domestic Product (GDP). Approximately 72% of operators are, under the long-term viability measure, not contributing profit to GDP, but will contribute to economic activity through their purchases of inputs and factors of production (eg. labour and capital) and thus to GDP through the profits and labour payments of firms from whom they purchase inputs. Workers employed by unprofitable fishing firms also contribute to economic activity through their consumer purchases.

The results of the economic survey showed that the mean net economic return across businesses with OTL fishing endorsements was -4% to capital and the median net return was -23%, indicating 50% of operators falling below this when examined on a single operational year.

Businesses fishing OTL only (28 respondents), had a net return of -11%, indicating an economic loss over the opportunity cost of capital. The OTL businesses fishing both in OTL and other fisheries (33 respondents) had a net economic return of -18%, and the OTL fishers fishing in other fisheries (not in OTL) (34 respondents) had a net economic return of 5%. The results indicate significant long run economic viability issues for low performing businesses, particularly for those fishers less involved with OTL fishing.

Economic net returns within the social and socio-economic context of rural NSW requires further study, incorporating the contribution to household income from work in other sectors and family income, including welfare and social security payments. This should be part of future research work. This study is important because currently there is inadequate information on fishers and their family incomes, and the contribution of OTL fishery to the regional economy.

Distribution of revenue among endorsed OTL businesses

Tables E11, E12 and E13 indicate the variation in estimated fishing revenue and the level of dependence of multiple endorsement holders in the OTL fishery.

The distribution of average annual revenue for 354 active OTL businesses fishing within the OTL fishery in 2001-2002 is reported in Table E11. Approximately 29% of OTL fishing businesses are not fishing and another 14% are fishing only in other fisheries accounting for 33% of the total catch value (Table E12).

The revenues associated with each OTL endorsed catch combination are reported in Table E13. Major catch inter-dependencies of the Ocean Trap and Line fishery are with the Estuary General, Ocean Haul and Rock Lobster fisheries. The fishing businesses operating only in OTL have the lowest ($36,243) annual revenue from the fishery. However, the total value of catch taken by fishers operating only in the OTL fishery account for 56% of the total catch value (Table E13). A small number of fishing businesses (8 of 354) that are fishing in 4 different fisheries have the highest annual revenue ($107,158), which is twice the average revenue ($52,436) in the overall OTL fishery (Table E11). The distribution of annual revenue varies by fishing category that OTL fisheries involved, as reported by the coefficient of variation (Table E11).

Table E11: The distribution of average annual revenue for active OTL businesses fishing within the OTL fishery in 2001-2002 (Source: NSWF-Sydney Index).

No. of Active fisheries	No. Fishers	Total ($)	Average revenue ($)	Standard deviation	Coefficient of variation
1	203	4,711,598	36,243	44,916	1.2
2	120	8,495,179	64,849	98,260	1.5
3	21	2,049,466	55,391	38,852	0.7
4	8	750,107	107,158	106,401	1.0
5	2	91,367	45,683	28,266	0.6
Total	**354**	**16,097,716**	**52,436**	**74,845**	**1.4**

Table E12: The distribution of total returns for OTL endorsed fishers and other fishery endorsements (1999-2000) (Source: NSWF-Sydney Index).

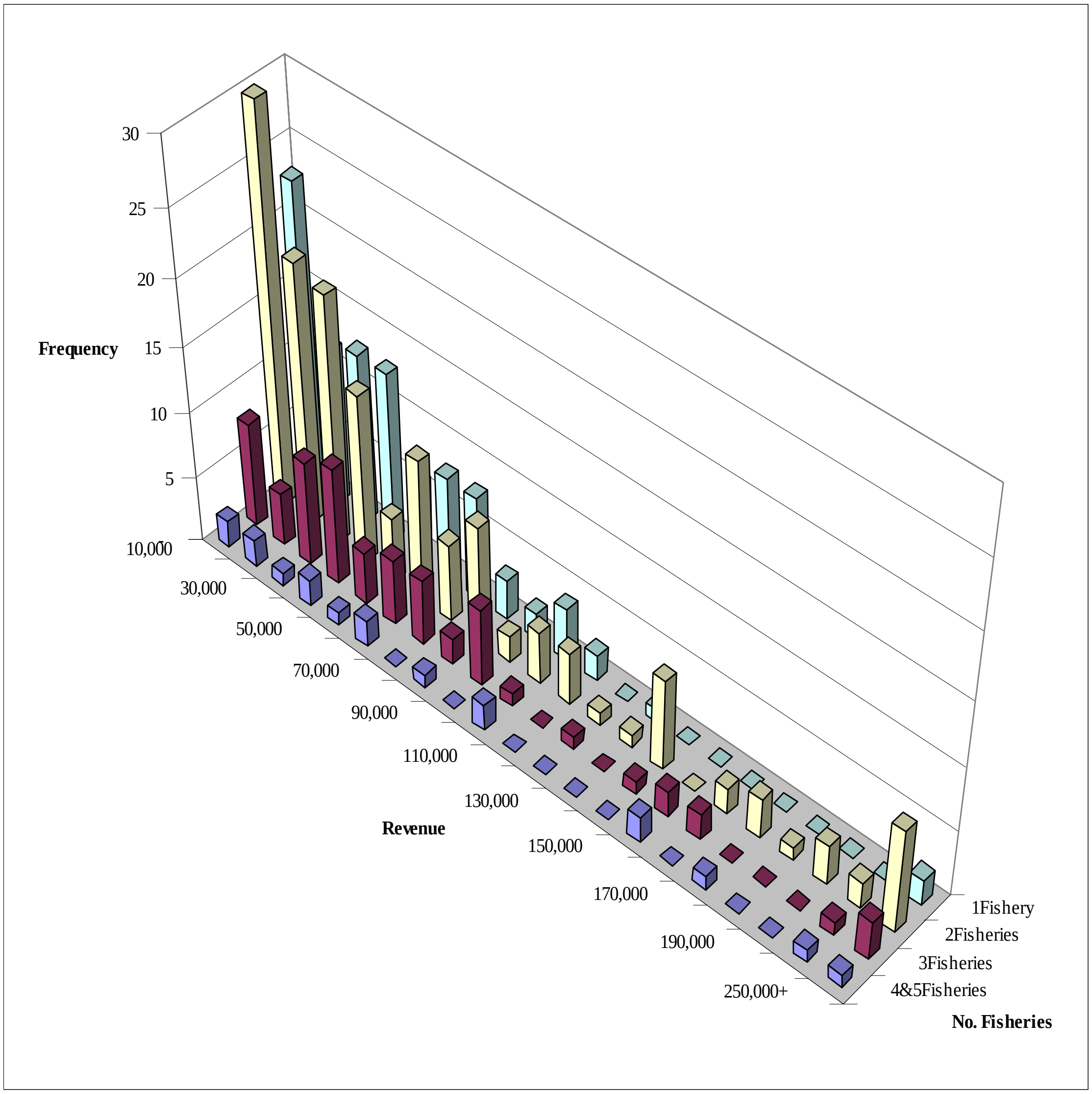
No. of active fisheries	No. Fishers	%	OTL Catch	%	Total	% OTL
Endorsed - no catch	181	29%	0	0	0	0%
Endorsed - other catch	89	14%	0	0	7,968,641	33%
1	203	33%	4,711,598	56%	4,711,598	20%
2	120	19%	2,957,870	35%	8,495,179	35%
3	21	3%	672,192	8%	2,049,466	9%
4	8	1%	74,854	1%	750,107	3%
5	2	0%	55,564	1%	91,367	0%
Total	**624**	**100%**	**8,472,078**	**100%**	**24,066,357**	**100%**

Table E13: The catch combinations in the OTL fishery by OTL endorsed fishers with other fishery endorsements 2001-2002 and inferred dependence (Source: NSWF-Sydney Index).

Catch Combination	No. of Fishers	%	OTL Catch ($)	%	Total Catch ($)	%	% OTL
OTL Only	203	33%	4,711,598	56%	4,711,598	20%	100%
OTL+EG	44	7%	854,200	10%	2,248,288	9%	38%
OTL+RL	34	5%	890,161	11%	2,154,202	9%	41%
OTL+OPT	15	2%	109,808	1%	2,889,617	12%	4%
OTL+OH	14	2%	786,209	9%	1,141,900	5%	69%
OTL+OH+EG	24	4%	526,105	6%	1,173,888	5%	45%
OTL+EG+RL	12	2%	213,046	3%	681,098	3%	31%
OTL+EG+EPT+OH+RL+others	8	1%	380,951	4%	1,097,124	5%	35%
Endorsed - no catch	181	29%	-	0%	-	0%	0%
Endorsed - other catch	89	14%	-	0%	7,968,641	33%	0%
Total	**624**	**100%**	**8,472,078**	**100%**	**24,066,357**	**100%**	**35%**

Gross returns by OTL endorsed fishing businesses are plotted for the single and multiple fishing businesses in Figure E7. The diversity in revenue among fishers, where a total of 64 OTL only fishers have fishing revenue below $20,000 per annum, probably being part-time fishers.

Figure E7: Frequency distribution of annual fishing revenue for active OTL fishers in 2001-2002, fishing OTL Only, 2, 3 or 4 fisheries (latent effort not included). (Source: NSWF-Sydney Index).



Switching behaviour

Fishers were asked to apportion effort in each endorsed fishery expressing it as a percentage of total annual effort. Similarly revenue was expressed as a percentage of total revenue in each fishery. The ratio of percentages (i.e. R (OTL) = % revenue in OTL / % effort in OTL) is an index of the revenue of effort from that fishery. Then we can compare R(OTL)/R(non-OTL) as a new relative ratio.

Out of 100 OTL fishers surveyed, 29 decided to fish in the OTL fishery only and 16 in non-OTL fisheries only. The remaining 55 fishers switched between fisheries. Of these, 12 fishers indicated higher daily returns to effort in OTL fishing, 26 indicated higher daily returns to effort in other fishing and the remaining 17 were indifferent. This indicates the diversity in fishing operations within the OTL fishery.

A cost-benefit schedule of the Ocean Trap and Line fishery

Environmental accounting under the principles of Ecologically Sustainable Development (ESD) requires that all inputs are priced at their true cost. In the fisheries case, this would include the operational costs, costs of management and ancillary services and the costs incurred in any depletion of the fish stock (ABARE, 2000). Fish also have a value as an unexploited stock in the sea, as well as existence and conservation values, which are less tangible.

The economics of fisheries management enables an appraisal to be made of the economic contribution of the fishery to the economy and to analyse the impact of the changes advocated in the FMS. ESD principles dictate that resources should be valued at their market values and those subsidies can be taken into account in the form of an environmental accounting statement. The NSWF costs of management, research and compliance, (less any of these cost recovered from industry), should be added to the costs of fishing operations to give a full economic cost. The rise or fall in the value of the fish stocks should also be included in an economic account as illustrated in Box E1 below:

Box E1: An economic account of the OTL fishery 2003/04

	($million)
Gross revenue from catch per annum (i)	8.33
Less economic cost of operations (ii)	9.76
Operational Economic surplus	-1.43
less cost subsidies (iii)	0.97
Total economic contribution	-2.40
Plus rise or fall in fish stocks (iv)	0.00
Total of environmental account	-2.40

(i) This is the estimated value of catch from all fishing businesses in the Ocean Trap and Line Fishery based on the 1999-2000 economic survey results.

(ii) This is the estimated economic cost of fishing inferred from the 1999-2000 economic survey results for all fishing businesses. The total economic costs include opportunity costs, costs of licences and some costs of management in fisher payments. Total economic cost in 2003-04 is 3% per annum greater than 1999-2000 data.

(iii) To the operational surplus (TR-TC) costs of management not attributed to fishers under current cost policy are added (i.e. management, research, compliance, etc). IPART estimates of this are $1.11m, less fishers payments already in economic costs 0.14m. This does not include Commonwealth fuel or other primary producer subsidies.

(vi) The change in value of the stocks is unknown and are assumed to be zero, but may not be.

The schedule illustrates how the operational performance of the fishery, management charges and stock health can be related. The fishery is estimated to be returning an economic loss due to low operational results.

4. The value of licences currently held by individual fishers in the fisheries

Detailed inference on licence trading is difficult due to the lack of discrete licence value information. Licences are sold as part of business packages and may include several endorsements and business assets. Where licence value estimates are available in a fishery they can reflect short run effects which are not necessarily associated with a healthy fishery, reflecting over-capacity or over-fishing (ABARE, 2000). Nonetheless, interpreted correctly, licence prices can be a useful indicator of the performance of the industry in generating net value or rent.

PNSW Guideline (e) **Existing economic multiplier effects, economic rents and community contributions.**

1. Economic rents and community contributions

Economic rent refers to the resource rent in a fishery. The resource rent is an economic surplus which is part of the difference between the Total Revenue of effort and the Total Cost of effort across the fishery. Resource rent is made up of different elements and is the surplus attributable to the marginal fisher's last unit of effort, times the units of effort applied to the fishery (Reid and Campbell, 1998). This reflects the value of access to the resource. The balance of total rent and resource rent are intra-marginal rents, attributable to the skills of fishers and reflect innovation and skills in a healthy industry.

The economic survey of the Ocean Trap and Line Fishery indicated that 28% of fishing businesses had an economic surplus. This information is inadequate to estimate the amount of resource rent in the fishery. There is a need to develop a bio-economic model which will relate the production of vessels, prices and costs of operation, to the biological production available in the fishery. From this, estimates of long term sustainable catch, the maximum economic rent and the optimum level of effort can be recommended for the fishery.

When resource rent is measured as the surplus from the marginal fisher's last unit of effort applied, it is likely that given the diversity in operations in the fishery, the marginal fisher's effort would reveal no resource rent. It is also likely that the more efficient fishers are in operating surplus due to their superior skills and knowledge.

As a result of insufficient controls on effort, there is growth overfishing of some species in the OTL fishery (NSW Fisheries 2003b) and the community has lost the economic benefits (resource rent) that would have otherwise been realised from the resource through effective management. Through effective management the resource can be harvested sustainably, stocks can be rebuilt for growth overfished species, and rent can be realised. However rebuilding stocks will cost resource users in the short term as they forgo catch. But in the long term there will be benefits from sustainable harvesting and this should translate into higher returns. There is a need for introducing new management tools to effectively control excess fishing effort in the fishery. The effective management of a fishery involves giving fishers a property right (Campbell and Haynes, 1990).

Contributions to the community can come in several forms. As previously discussed, revenue and employment are generated by those fishing. The economic contribution from commercial fisheries to the community will be discussed in the section on multiplier effects. However the long term contribution of the ocean fishery resources to society can only be realised through management of the fishing industry in order to produce resource rent. Underperformance of management leads to a loss of economic rent from the fishery and hence a loss for society.

If rent is generated by effective management of the fishery and best harvesting practices, it can be retrieved through royalty (ad valorem) charges by management, or it can be left with the fisher. How much rent is left with the fisher as a return on skills (intra-marginal rent as mentioned above) and how much is appropriated by the government, is a decision for government and the community. A cautious approach should be adopted when determining the proportion of resource rent that should be returned to the community and that which should stay with industry as a return on skills and innovation. If too much rent is extracted from the fishery and returned to the community the incentive for adoption of more efficient fishing technologies is lower and it may act as a disincentive for fishers with high levels of fishing skills to stay in the industry. It is suggested that a margin in rent extraction needs to be allowed to avoid potential inefficiencies which may arise if rent it is set too high. The size of this margin depends on the size of the potential inaccuracies in estimating rent (Campbell and Haynes, 1990).

Bio-economic modelling is needed to estimate the optimum level of fishing effort and to predict the maximum economic rent that may be realised in the fishery.

Some payments by fishers are transfers from fishers to government for management services provided. Hence fishers contribute to the community by paying for services which were formerly subsidised by the community. The Independent Pricing and Regulatory Tribunal of NSW estimated that it costs approximately $1.11m in 1998 to manage the OTL fishery, with $0.857m being considered as the efficient cost (IPART,1998). Currently fishers are paying around $0.14m which means $0.97m, management charges are subsidised. In November 2000, the Government announced that over the succeeding five years (2000-2005) NSW Fisheries would develop and implement a fair and transparent cost recovery framework. As of 2005-06 the new framework will be operating and under the FMS full cost recovery will be phased in over the next three years. With category 1 fisheries an annual community contribution payment of $100 per fisher is applicable.

In summary, the current management of the Ocean Trap and Line Fishery yields less resource rent than could be obtained under a management regime with reduced effort levels. Overfished stocks of some OTL target species is also a loss to the community. Through time the community loses the potential contributions which could be made from the resource rent generated by a profitable fishery.

2. Review of information on multipliers in the NSW fishing industry

Economic multipliers arise from the flow-on impacts of expenditure within a closed local economy and the revolving benefits of this.

There is no current information on the multipliers in the communities associated with the OTL fishery. In this section several historical fishing community studies which made estimates of multipliers and flow-on impacts in the NSW fishing industry are cited. These studies can be used as a guide to likely economic impacts of policies if used with some careful interpretation. Changes in the structure and operations of the industry since the years in which the studies were undertaken should be noted (Dr R. Powell, pers. comm.).

The available literature enables discussion of multipliers in four fishing communities in NSW, Eden and Ulladulla (Powell et al., 1989), the Northern NSW region (Tamblyn and Powell, 1988) and the Clarence region (McVerry, 1996). Table E14 presents multiplier estimates from the economic studies of fisheries in coastal regions of NSW.

Table E14: Output, income and employment multiplier estimates from fishing community studies in NSW (Tamblyn and Powell, 1988; McVerry, 1996; and Powell et al., 1989).

OUTPUT (a)	Initial	Production induced	Consumption induced	Total	Type II ratio
Northern NSW (1)					
Fishing	1	0.1933	0.7166	1.91	1.91
Clarence (2)					
Fishing	1	0.091	0.787	1.877	1.877
Ulladulla (3)					
Trawl	1	0.2368	0.3269	1.5637	1.5637
Non trawl	1	0.2233	0.3409	1.5642	1.5642
Eden (3)					
Trawl	1	0.218	0.2206	1.4387	1.4387
Non trawl	1	0.2203	0.1977	1.4179	1.417
Process+	1	0.4256	0.1051	1.5307	1.5307
INCOME (b)	**Initial**	**Production induced**	**Consumption induced**	**Total**	**Type II ratio**
Northern NSW (1)					
Fishing	0.4999	0.0556	0.2691	0.8264	1.662
Clarence (2)					
Fishing	0.59	0.026	0.308	0.924	1.566
Ulladulla (3)					
Trawl	0.2999	0.069	0.1266	0.4955	1.6524
Non trawl	0.3156	0.0692	0.1321	0.5168	1.6378
Eden (3)					
Trawl	0.2999	0.0498	0.0802	0.4299	1.4337
Non trawl	0.2489	0.0644	0.0719	0.3852	1.5475
Process+	0.0621	0.1044	0.0382	0.2047	3.2982
EMPLOYMENT (b)	**Initial**	**Production induced**	**Consumption induced**	**Total**	**Type II ratio**
Northern NSW (1)					
Fishing	0.0376	0.004	0.0181	0.0596	1.5868
Clarence (2)					
Fishing	0.029	0.001	0.014	0.044	1.499
Ulladulla (3)					
Trawl	0.0184	0.0036	0.0062	0.0282	1.5363
Non trawl	0.0268	0.0032	0.0065	0.0365	1.3592
Eden (3)					
Trawl	0.0184	0.0023	0.0033	0.0239	1.3009
Non trawl	0.0147	0.0024	0.0029	0.02	1.3669
Process+	0.0034	0.0055	0.0016	0.0106	3.06

(a) per dollar of output Sources: (1) Tamblyn & Powell, 1988
(b) per $'000 of output (2) McVerry, 1996.
(3) Powell et al. 1989

The economic significance of an industry, such as commercial fishing, can be measured in terms of direct and indirect effects. The direct effects are a measure of the value of output of the industry itself, the number of people employed and the income they receive. The indirect effects can be divided into production induced and consumption induced effects. Production induced effects are the industry's purchase of goods and services from other industries. Consumption induced effects arise from the spending of household income received as payment for labour. The multipliers indicate the size of those impacts relative to the level of sales and final demand. The Type II ratios reflect the relationship between the total impact (direct and indirect) to the direct effect.

For example, in Table E 14, an output Type II multiplier value of 1.91 infers that for every dollar of direct output, there is a total impact of $1.91 due to both direct ($1) and indirect ($0.91) effects. The consumption and production induced components of the $0.91, are $0.72 and $0.19 respectively. In Table E 14, an income initial income expenditure of $499 generates and additional $327 of income of which $55 are production induced effects and $269 are consumption induced effects. Thus the income Type II multiplier value is 1.66 (ratio of total to initial effect). In Table E 14, the employment Type II multiplier value is 1.58 indicating an additional 0.58 indirect jobs are created for each direct job generated.

A significant issue is whether the multipliers and/or estimated flow-on impacts include the downstream effects of transport, marketing and packing. The calculation of multipliers from fishing will only include the linkages effects that occur back through the supply of inputs to fishermen and not any effects downstream towards the consumer.

Given our interest is in the flow-on effects associated with the Ocean Trap and Line fishery in the current period, the use of historical information is limited and there is a need for collection of new information. It is likely that non-trawl results will be a representative source of multiplier values for impact appraisal in the OTL fishery.

Conclusion

Both the southern and northern studies indicate that the ratio of all effects, to direct fishing effects, is between 1.3 and 1.6 for expenditure, income and employment Type II multipliers (Tamblyn and Powell, 1988; Powell et al., 1988). The available results show that the larger part of the flow-ons will be consumption-induced effects. This may reflect a relatively low level of use of purchased operating inputs apart from labour or may be due to the fact that many of the specialist inputs used in fishing are not produced locally. The multiplier will be higher where there is a significant amount of on-shore activities associated with handling, marketing and transporting the catch. The more value adding undertaken within the local area, the higher the multiplier. That could result in expenditure multipliers near to 2.0 (Dr. R. Powell, pers. comm.).

The regional expenditure of fishers

The percentage of expenditure fishers that takes place within a local area can give an indication of the likely size of multipliers in a fishery. Fisher expenditures can be divided into expenditure on employment, inputs for the fishing process and capital items for fishing. The previous section examined results of detailed regional expenditure studies, which give multipliers showing employment and production induced expenditure effects. Capital and input expenditures are investigated below. Little information exists on regional expenditure interactions. For the Clarence region, McVerry (1996) estimated that 27% of fishing business expenditures move outside the region, leaving approximately 70% of the first sale value of catch in the local fishing community.

The regional nature of expenditures can also be seen by examining the larger scale purchases of the OTL endorsed businesses. In the social survey, 384 fishers were asked about the amount and location of their major purchase over $1,000, 232 fishers had no major expenditures. The frequency of locations of other expenditure locations are reported in Figure E7. Table E15 reports approximately $8m of items expended outside the OTL fisher's local area by the 384 fishers interviewed. Boats, inboard engines, fuel and repairs are the major expenditure items constituting 51% ($4m) of OTL expenditure outside of an OTL fisher's local area.

Table E16 reports the pattern of expenditure on major purchases (total number of purchases 342) for 232 of 384 fishers. Generally fishers living in towns of residence in the north and south of the state, purchase some major items in their respective areas, with Sydney having trade with a range of areas. There is a major purchase link between fishers residing in the northern region using Brisbane, Coffs Harbour and Melbourne for major OTL business purchases (see Figure E8 and Table E16)

FigureE8: Towns outside local area in which OTL fishers made a major expenditure over $1,000 in last 12 months (Source: RM-SS).

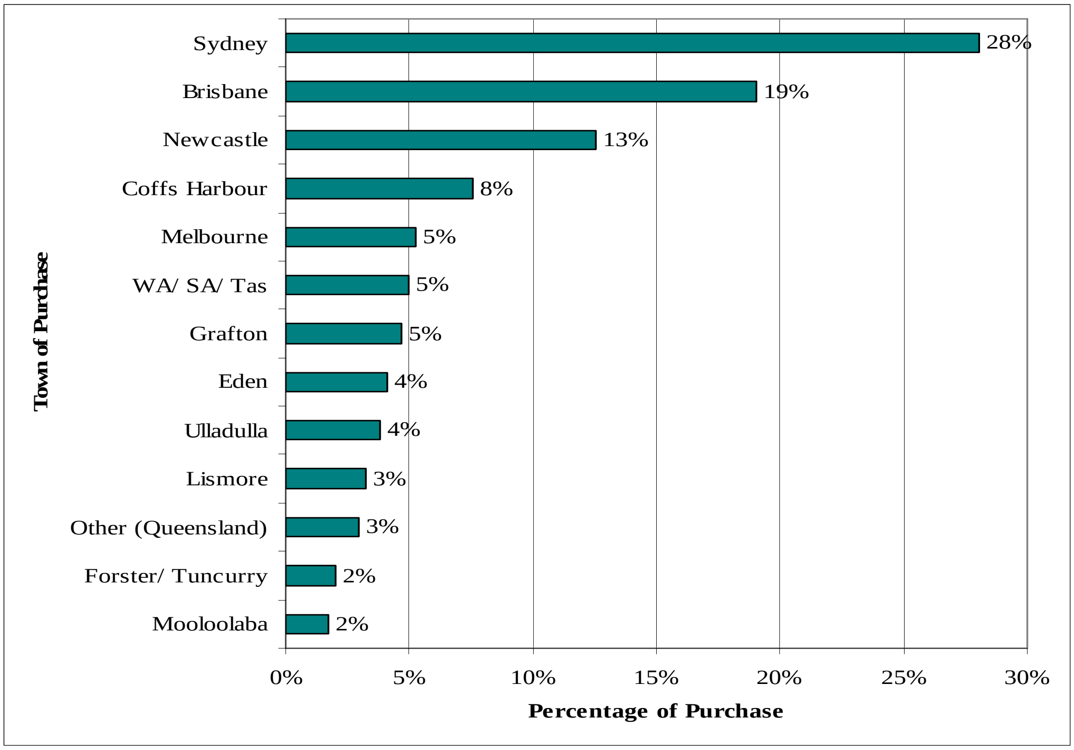


Table E15: Purchase of items outside local area in which OTL fishers made an expenditure over $1,000 in last 12 months (Source: RM-SS).

Item Purchased	Sum of Expenditure	%	Item Purchased	Sum of Expenditure	%
Boat/new Boat	2,758,000	34.5%	Freezers	27,500	0.3%
Other	2,239,325	28.0%	Hooks	27,500	0.3%
Inboard Engines	546,400	6.8%	Trailers	24,500	0.3%
Fuel/Oil	415,600	5.2%	Propellers	19,100	0.2%
Repairs	352,600	4.4%	Radar	11,150	0.1%
Car/Ute	237,000	3.0%	Gear Box	9,200	0.1%
Outboard engines	231,180	2.9%	Plotters	7,000	0.1%
Punts/ Dories	218,000	2.7%	Hauler/Coilers	6,000	0.1%
Fishing gear	177,500	2.2%	Traps	6,000	0.1%
Bait/ Ice	141,000	1.8%	Provisions	5,500	0.1%
Nets	119,600	1.5%	Paint	5,000	0.1%
Electronics	104,600	1.3%	Accommodation	5,000	0.1%
Licence fees	89,500	1.1%	Floats	4,030	0.1%
Winches	70,180	0.9%	GPS	3,900	0.0%
Wire	52,200	0.7%	Aluminum trays	3,500	0.0%
Ropes/Lines	33,980	0.4%	Fish Boxes	1,050	0.0%
Pump/ gen sets.	33,032	0.4%	Diving gear	1,000	0.0%
			Total	**7,819,697**	**100%**

Table E16: Table of town of residence versus town of major purchase location, in which OTL fishers made an expenditure of over $1,000 in last 12 months (Source: RM-SS).

	Town with major purchase over $1,000													
Town of Residence	**Mooloolaba**	**Brisbane**	**Lismore**	**Grafton**	**Coffs Harbour**	**Forster/ Tuncurry**	**Newcastle**	**Sydney**	**Ulladulla**	**Eden**	**Melbourne**	**WA/ SA/ Tas**	**Other (Queensland**	**TOTAL**
Tweed Heads	1	2	-	-	1	-	-	2	-	-	-	-	2	**7**
Evans Head	-	7	3	-	1	1	-	2	-	-	-	-	1	**15**
Clarence River	4	22	7	9	8	-	-	4	-	-	2	1	1	**54**
Macleay River	-	4	1	2	2	-	2	3	-	-	-	-	-	**14**
Coffs Harbour	1	10	-	4	3	-	3	7	1	-	2	1	-	**31**
Port Macquarie	-	2	-	-	1	-	1	5	1	-	1	-	-	**11**
Camden Haven River	-	-	-	-	2	-	-	2	-	-	-	-	1	**5**
Wallis Lake	-	1	-	-	1	1	1	4	-	-	1	-	-	**9**
Port Stephens	-	4	-	-	-	1	17	7	1	-	1	1	-	**32**
Lake Macquarie	-	-	-	-	-	-	2	1	-	-	-	-	-	**3**
Newcastle	-	-	-	1	1	1	3	2	1	-	-	-	-	**9**
Tuggerah Lakes	-	-	-	-	-	-	1	2	-	-	-	-	-	**3**
Hawkesbury River	-	-	-	-	-	-	3	7	-	-	-	-	-	**10**
Sydney Harbour	-	1	-	-	-	-	1	1	-	-	1	-	-	**4**
Botany Bay	-	1	-	-	-	-	-	-	-	-	2	-	-	**3**
Wollongong	-	1	-	-	-	-	-	4	-	-	-	-	-	**5**
Ulladulla	-	-	-	-	-	-	-	2	1	3	-	2	-	**8**
Batemans Bay	-	1	-	-	-	-	-	6	1	1	-	1	-	**10**
Bermagui	-	1	-	-	1	-	1	6	3	3	3	1	-	**19**
Eden	-	3	-	-	2	1	1	9	2	5	1	6	-	**30**
Other	-	5	-	-	3	2	7	20	2	2	4	4	5	**54**
Total	**6**	**65**	**11**	**16**	**26**	**7**	**43**	**96**	**13**	**14**	**18**	**17**	**10**	**336**

PNSW Guidelines (f) **Outline the markets for fish species (and the marketing forms) harvested in this fishery and the contribution these fisheries make towards supplying seafood to consumers on a State and regional basis.**

Marketing

In the period prior to deregulation of fish marketing, NSW had a system of fish marketing cooperatives, certificates of exemption and consents given to fishers to sell outside the regulated system. Deregulation of fish marketing has brought a new system and granted Fish Receivers certificates to fishers and fishing companies. Under the new system cooperatives have a less central place than before.

The economic survey revealed that OTL fishers exported 7.4% (OTL only 8.6%, OTL/others 7.8%, and others 6.0%) of their product by value, outside Australia (see Table E17). This equated to approximately $15,000 per fisher interviewed totalling approximately $1,500,000 among 100 businesses surveyed (Roy Morgan, 2001b).

The survey also collected information on the supply of the catch by OTL fisheries to local markets. The results indicate that OTL fishers tend to supply the catch to Cooperatives (53%) Sydney Fish Market (19%), Agents in NSW (16%) and also to shops (9%) as reported in Table E18 (Roy Morgan, 2001b). In the economic survey, OTL fishers were asked to state their main marketing options by type of fish receiver and therefore, the percentages showed in the Table 14b do not show product volume or value.

Some recent information on trends in national seafood marketing is presented in FRDC (2001), but has little content about the species caught in the Ocean Trap and Line fishery. Ruello and Associates (2000) review general retail and consumption of seafood in Sydney and emerging trends since a similar study of retail outlets in 1991. Fish caught by trap and line fishing have the return higher values than similar species caught by trawl. In addition the industry have moved to take advantage of quality in the market place with many producers adopting improved handling and processing techniques to add value to key species, particularly those desired by the restaurant trade (Pers. Comm. OTL MAC). There is no information on the extent of improved marketing practices in industry.

Table E17: Export from the OTL fishery outside Australia, extracted from the economic survey of operators (Source: RM-ES)

Data	OTL	OTL/Others	Others	Total
Average % export	8.6	7.8	6	7.4
StdDev of % exported	23.3	18	12.8	18.2
Total export ($)	731,298	431,540	370,639	1,533,477
Export/fisher ($)	22,853	12,692	10,901	15,335
Total fishers	32	34	34	100

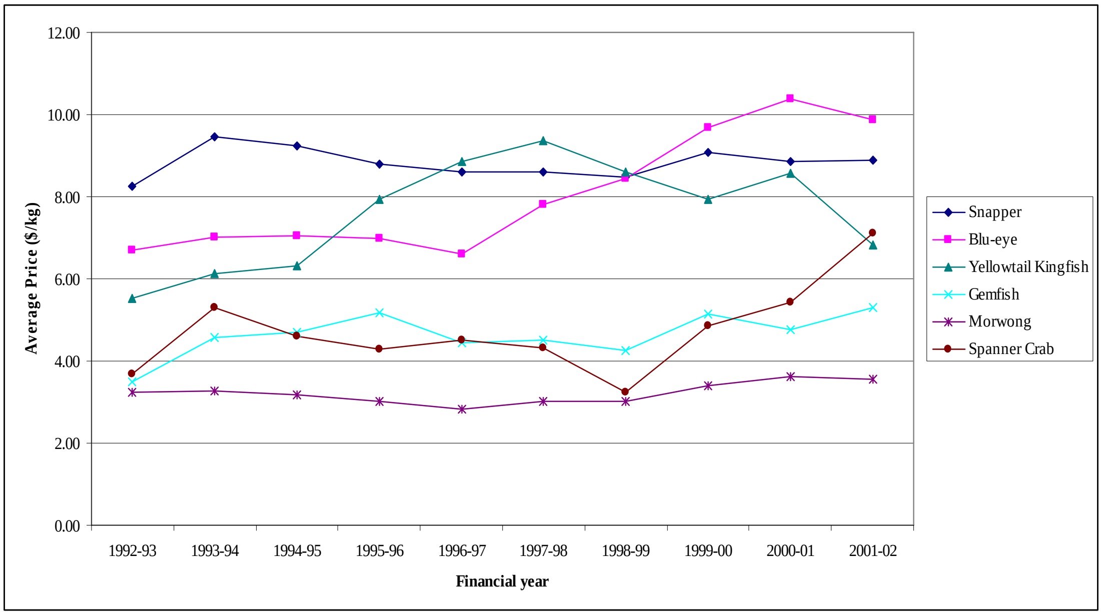
Table E18: Frequency of marketing alternatives for OTL fishers (Source: RM-ES). (Note: Only by number of fishers, not volume of product).

Market	OTL only	%	OTL/ Others	%	Total	%
Coops	23	53%	40	33%	63	39%
Sydney Fish Market	8	19%	28	23%	36	22%
Agents NSW	7	16%	20	17%	27	17%
Shops	4	9%	16	13%	20	12%
Agents VIC	1	2%	6	5%	7	4%
Restaurants	0	0%	5	4%	5	3%
Agents QLD	0	0%	4	3%	4	2%
Bait	0	0%	1	1%	1	1%
Total	**43**	**100%**	**120**	100%	**163**	**100%**

Trends in fish prices

The price of species in the OTL fishery depends on the method of capture, the handling of the species and the market examined. The Sydney price across all species of the OTL product in nominal terms in the last ten years (1992/93 -2001/02) is reported in Figure E9 (Source: NSWF- Sydney Index). In the case of blue-eye and spanner crab, there has been a notable increase in average prices. The price per kg of blue-eye has increased from \$6.7 in 1992 to \$9.9 in 2002. The price of spanner crab has more than doubled in four years from \$3.24/kg in 1998 to \$7.11/kg in 2002. The price of yellowtail kingfish has been declining since 1997 and there is no considerable variation in the prices of other target species in the OTL fishery.

Figure E9: Average price (\$/kg, nominal) of OTL fish across all species in the 1992-2002 period (Source: NSWF-Sydney Index).



Contribution of the OTL fishery towards supplying seafood to consumers

The OTL fishery supplied between 1,473 and 2,296 tonnes of fish during 1997/98-2001/02. The main species landed in 2000/01 by the Ocean Trap and Line Fishery sector were snapper, spanner crabs, yellowtail kingfish, leatherjackets, bonito and silver trevally. Other key species include rubberlip morwong, blue-eye, gummy shark, bar cod and yellowfin bream (NSW Fisheries 2003a).

PNSW Guideline (g) **Summarise the overall risks to the economic viability of the fishery from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.**

The review of the existing information on the Ocean Trap and Line Fishery and existing management arrangements indicates that the fishery is facing a number of risks. The following section describes the overall risks to the economic viability of the fishery.

The major risks to the economic viability of the fishery are:

- overfishing of the primary and key secondary species on which the fishery is based;
- potential activation of latent fishing effort including activation of excess endorsement and vessel capacity;
- current levels of fishing effort are in excess of the profit maximising level;
- insufficient management controls and lack of economic incentives to fishers to adjust effort levels to harvest the same amount of catch at lower costs, allocation of the amount of catch to be harvested, security of access rights, property rights, full rights for trading and transferring of licences, compensation of leaving the fishery due to permanent closures etc;
- loss of economic rent;
- increasing costs of management and the costs of restructuring the fishery;
- inadequate economic information to monitor the economic viability of the fishery; and
- inadequate information on the biology of the target species.

The other risks identified by NSW Fisheries (2003b) are not direct economic risks, but may impinge on the operations of industry. For example: Inaccuracy of catch reporting (species identification, bait taken for use in the fishing operations rather than for sale, and daily recording of catch); negative impacts on threatened and protected species such as grey nurse shark, black cod, seabirds and marine mammals; and the minimal negative impacts on ecological processes, biodiversity and habitats and by-catch in this fishery.

The major risks are described in the following sections.

Risk of overfishing of primary and key secondary species

Declining stock levels of both the primary and key secondary species on which the fishery is based is a major risk to the economic viability of the fishery. The impacts of depleting stocks are current and future revenue losses. Due to depletion in stock levels of target species fishers may increase their fishing effort on substitute species.

Available stock assessment information indicates that some of the primary species taken by trap and line fishing in ocean waters off NSW show signs of being growth overfished (e.g. silver trevally, redfish and snapper), or recruitment overfished (e.g. eastern gemfish) (NSW Fisheries 2003b). According to NSW Fisheries, eastern stock of gemfish underwent a collapse in recruitment and the stock has failed to recover (Rowling and Makin, 2001). The stock has been nominated for listing as endangered under the EPBC Act, and a decision regarding the nomination is pending (see Chapter D, Volume 2).

Risk from inadequate information on biological aspects of the fishery

In the OTL fishery, there is very little biological information available to estimate the level of stocks of important species. This needs to be improved. A large number of species are harvested by several fishing methods. Hence, the selectivity of fishing gear is important to avoid overexploitation of certain species. Recovery programs for overfished species must be developed and implemented so as fishers benefit from larger stocks.

Although biological data are available for several primary and secondary species, a comprehensive stock assessment is available only for gemfish (NSW Fisheries 2003a). Inadequate information about the status of the stock is a risk for economic viability if a stock is being growth overfished , for example, snapper.

Risks from excess capacity and potential activation of latent fishing effort

Out of 624 OTL endorsed fishing businesses, only 354 have reported fishing in the OTL fishery and other fisheries in 2001/01. There is a high level of vessel and fisher capacity associated with endorsement holders in the fishery.

The non fishing endorsement holders are referred to as latent effort in the fishery. Latent effort is defined as an endorsed fisher who has not submitted a catch return in a given period as they have not fished. In this fishery a fisher not reporting catch (i.e. submitting a catch return to NSW fisheries) is considered latent. In 2001/02, the percentage of latent endorsements in the OTL fishery ranges from 35% to 55% depending on the endorsement type (NSW Fisheries 2003b). These latent endorsements have considerable potential to increase fishing effort in response to improved economic conditions in the fishery. This activation could erode the profit of all operators in the fishery and hence make restructuring initiatives among active fishers potentially ineffective. Therefore it is important to remove all latent endorsements in the fishery and also contain active effort levels.

Risk of excess levels of active fishing effort

Despite restrictions on the number of endorsements and boat length, active fishing effort has increased over the years. The level of total effort is related to the number of operators fishing and the number of days fished. Total effort may also increase through improvements in gear technology and in the quality and durability of materials used in the construction of fish traps and lines. Continuing improvements in fishing technologies enable fishers to increase their total fishing effort.

Excessive levels of total effort are a major risk to the economic viability of the fishery. The present level of effort in the OTL fishery exceeds a level that would support commercially viable fishing businesses (NSW Fisheries, 2003b).

The economic survey indicates that a long-run economic surplus exists for only 28% of OTL fishing businesses surveyed, those businesses covering opportunity costs of capital, imputed labour and economic depreciation. The economic viability of the remaining 72% of businesses is thought to be below the level required to keep capital in the industry.

The risk to the economic viability of the fishery requires excess fishing effort to be addressed by implementing effective effort containment and capacity reduction policies. Currently there is not a management framework that can adjust overcapacity in the fishery by reducing the total number of fishing vessels and existing limits on fishing gear are inadequate.

Risk of insufficient management controls and lack of economic incentives to fishers

Current management arrangements are predominantly input based and have been insufficiently effective in containing total levels of fishing effort and in providing desirable economic incentives to fishers. There are too many fishers competing and no one can exclude anyone else because there are no exclusive access rights i.e. fishers are not assured of their rights to a portion of the catch, as would be the case under an output based catch quota regime.

In addition, there are no long term, secure, well defined and well developed access rights in the fishery. Fishers are not able to have long-term business plans based on current management arrangements. As existing policies have proved to be insufficiently effective in maintaining economic viability of the fishery and in restricting the depletion of stocks, there is a need to develop more incentive based management tools to harvest stock at lowest cost and for greatest return.

Increasing management and restructuring costs

A number of management fees are payable by OTL fishers and these management charges are likely to increase. Based on the economic survey it is estimated that only 28% of fishers may be able to pay additional management charges, the remaining fishers having difficulty in meeting full management costs. Improving sustainability and economic performance involves restructuring of the fishery by removing underperforming fishing businesses. This process may have additional costs (e.g. sharing additional management costs) for fishers who remain in the fishery. However, these additional costs may increase returns as some management costs are aimed at implementing programs that reduce excess fishing effort, protect and/or rebuild the stocks of target species.

If there is no cap on total fishing effort, a rise in either management costs or debt levels may lead to more fishing effort being produced by fishers to gain additional income. This is undesirable for general industry profitability, as there is already excess fishing effort in the fishery. In addition to structural adjustment, arrangements to minimise management costs and to increase incentives for fishers to be involved in management and in improving compliance levels are recommended.

Loss of economic rent

Currently the Ocean Trap and Line Fishery is not generating sufficient resource rent meaning that society is not getting maximum benefits from commercial harvesting of the resource. Existing information only enables us to identify the percentage of fishing businesses with economic surplus (i.e. 28%), and is inadequate to estimate the loss of economic rent from the Ocean Trap and Line Fishery. A bio-economic model is needed to estimate the optimum level of fishing effort and the maximum economic rent in the fishery as previously discussed. As there are a variety of fishing methods in OTL fishery, it is desirable to estimate the optimum level of fishing effort for each fishing method and for each of the major species.

Inadequate economic information to monitor economic viability of the fishery

There is currently no framework to monitor the economic viability of the fishery. Historically, NSW Fisheries research efforts focused on biological, ecological and technological aspects of the fisheries. The economic, social and institutional aspects have been insufficiently addressed, but most pressing problems are economic in nature.

A framework to monitor economic viability needs to be developed in conjunction with industry. It is also desirable to develop bio-economic models to determine optimum effort levels for each sector in the fishery. This would better enable policymakers to develop efficient long term policies for sustainable management of the fishery.

Risk of uncertainty

Uncertainty is a risk to the fishery as policy changes and the need for restructuring may reduce investment confidence until the benefits from management become apparent. Institutional issues like frequent changes in fisheries policies, and inconsistencies between State and Commonwealth legislation (e.g. different length regulations on certain species) create uncertainty within the industry (NSW Fisheries, 2003a). Such uncertainties impede development of long-term business plans that are important to achieve long-term economic viability of individual fishing businesses.

5. Social Issues

5.1 Fishers social capital

Introduction

The background to the review of social issues is given at the commencement of Section B. The available information is used to address the social issues surrounding the introduction of the FMS. Given the lack of previous studies, the review cannot fully complete the Department of Planning (DP) guidelines and gaps have been identified. The need for future research is presented in this section.

The environmental assessment guidelines issued by DP require examination of social information on fishers and their communities associated with the OTL fishery, including:

- the community values associated with the commercial fishery, in particular; social capital issues, skill base and transferability of skills;
- the community views and perceptions of the fishery and include a brief analysis of how these views and perceptions were formed;
- the importance of social identity and job satisfaction as a reason for being a commercial fisher in these fisheries; and
- the overall social risk to fishers from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

The DP guidelines for social issues will be followed below. The guidelines are presented as headings to guide the reader, with a response stated below each guideline.

PNSW Guideline (a) **Outline the community values associated with the commercial fishery, in particular; social capital issues, skill base and transferability of skills.**

The profile of fisher communities in coastal NSW for all commercial fishers is reported in *Appendix 3.* The information on OTL fishers and their communities has been extracted from ABS and licensing data and are summarised in Table S1, which reports social indices for OTL fishers at the zone and district level. This can be used in appraising management impacts at district or grouped post code level.

OTL fishers are most numerous in the Clarence, Coffs Harbour, Wallis Lake and Port Stephens regions in the north of the state and Shoalhaven, Batemans Bay, Montague and Far South Coast in the south of the state. Sydney south and Sydney north areas also have considerable number of OTL fishers (Table S1 and Figure S1). Table S1 also shows the relative importance of OTL fishery as part of the labour force in the region. The second last column in the table reports all commercial fishers as a percentage of the local working population and the last column reports OTL fishers as a percentage of the local working population. These are ABS data from the 2001 census.

Table S1: Summary table of social indices for OTL fishers in zones and districts of NSW (Source: ABS/BRS and NSWF licence data).

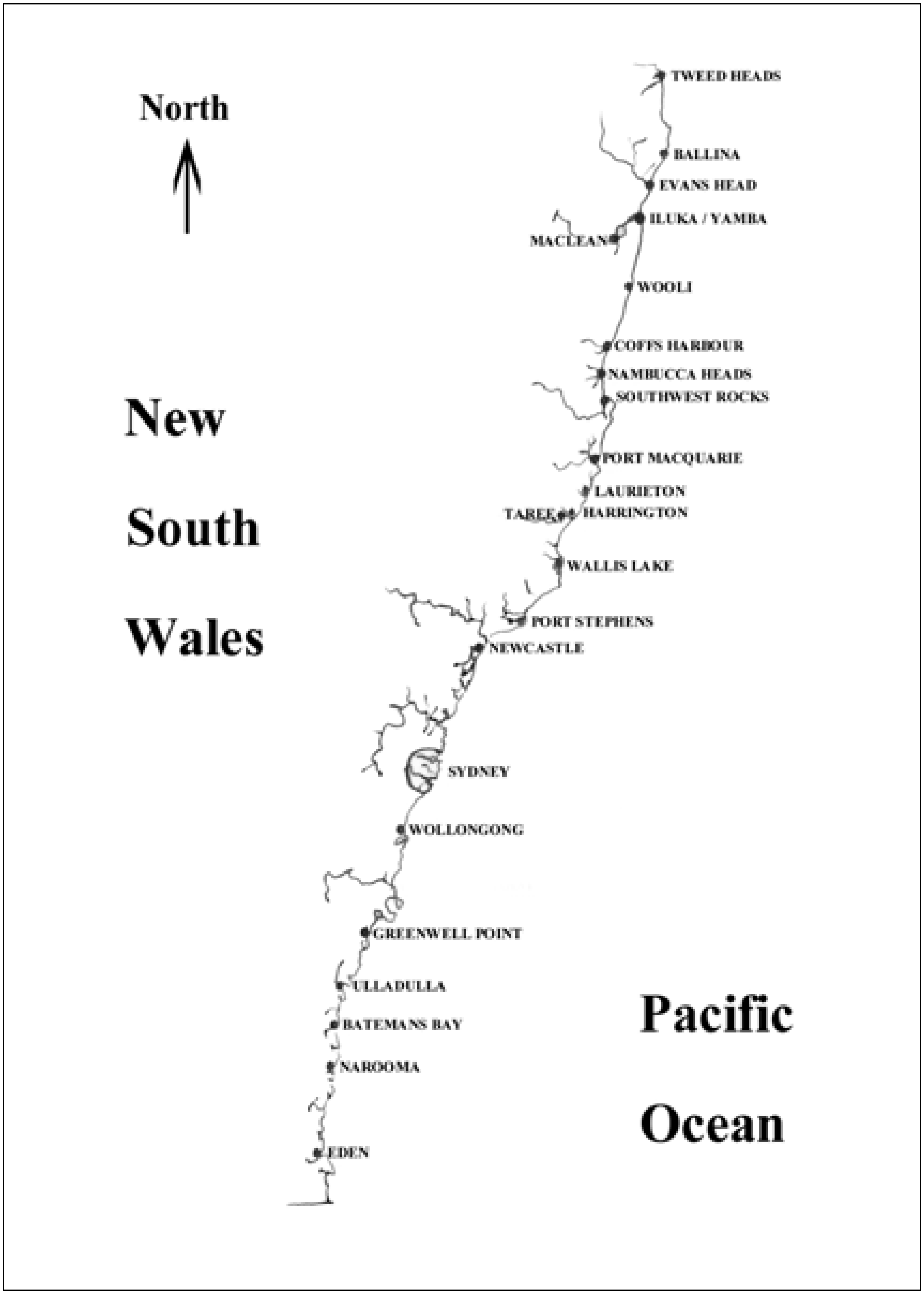
Zone	Home District	Postcode population	P'code Fishers	P'code OTL Fishers	SEIFA	Unemployed (%) 2001*	Med. Ind. Income ($/wk) 2001*	Employed in C.F. (%) of labour force	Employed in OTL as (%) of labour force
1	TWEED	41,938	63	28	922.17	12.20	250	0.37	0.17
	RICHMOND	28,558	87	30	930.16	12.23	283	0.85	0.30
	Zone	**70,496**	**150**	**58**	**926.16**	**12.22**	**267**	**0.61**	**0.2**
2	**CLARENCE**	**43,353**	**259**	**73**	**919.18**	**13.60**	**250**	**3.12**	**0.98**
3	COFFS HARBOUR	55,625	110	70	939.82	17.53	275	0.67	0.50
	HASTINGS	61,291	90	41	936.37	14.40	250	0.68	0.31
	Zone	**116,916**	**200**	**111**	**938.10**	**15.96**	**263**	**0.68**	**0.4**
4	MANNING	37,878	80	31	914.11	11.53	250	0.67	0.28
	WALLIS LAKE	22,704	105	35	938.98	11.70	250	2.78	0.88
	PORT STEPHENS	52,562	101	21	966.58	10.43	317	1.33	0.17
	HUNTER	52,557	55	18	933.24	10.30	350	0.18	0.09
	CENTRAL COAST	206,143	102	36	976.82	6.47	417	0.00	0.00
	Zone	**371,844**	**443**	**141**	**945.95**	**10.09**	**317**	**0.99**	**0.3**
5	HAWKESBURY	2,380	30	1	1004.47	6.05	400	0.00	0.00
	SYDNEY	3,276,207	189	33	1047.00	6.10	450	0.00	0.00
	Zone	**3,278,587**	**219**	**34**	**1025.73**	**6.08**	**425**	**0.00**	**0.0**
6	ILLAWARRA	65,532	50	16	934.67	8.33	350	0.13	0.06
	SHOALHAVEN	53,871	75	35	945.08	10.85	300	0.81	0.33
	Zone	**119,403**	**125**	**51**	**939.87**	**9.59**	**325**	**0.47**	**0.2**
7	BATEMANS BAY	34,836	105	47	957.63	12.63	250	1.18	0.38
	MONTAGUE	8,135	53	37	955.08	13.00	250	1.54	1.08
	FAR SOUTH COAST	3,726	61	21	916.20	9.30	250	2.56	0.88
	Zone	**46,697**	**219**	**105**	**942.97**	**11.64**	**250**	**1.76**	**0.8**
	Grand Total	**4,047,296**	**1615**	**573**	**945.28**	**11.15**	**306**	**0.92**	**0.33**

Key: Postcode population as of 1996; postcode fishers-for all NSW and OTL fishers; Unemployed by postcode as of 1996 census; SEIFA -Socio-economic index for areas (ABS, 1996 census), Med. Ind. Inc.- median individual income per week as of 1996 census; Employed in commercial fishing (or OTL) as percentage of labour force; see Appendix 1 for a fuller explanation of variables.

Fishers in the Clarence, Coffs Harbour and Montague areas, have the highest percentage of OTL fishers in the work force indicating economic and social dependence. In areas of higher general population, the method (i.e. fishers as percentage of labour force), does not reflect the size of the fishing community (for example, Central Coast and Sydney North & South), as the general work force is large relative to the number of commercial fishers.

The Ocean Trap and Line fishing business owners inhabit a range of small towns all along the NSW coast from the Queensland border in the north to the Victorian border in the south (Figure S1). The social survey identified that there were 384 OTL endorsement holders who responded to the survey using 62 “home ports” in NSW.

Figure S1: Map of fishing towns on the NSW coast.



The OTL fishers are approximately 35% of the total commercial fishers of New South Wales. Unemployment by region is higher in rural NSW and will be investigated later in this section. The Socio-Economic Index for Areas (SEIFA) is a measure of socio-economic disadvantage, relative to 1,000 units (ABS, 1996). In Table S1, most of rural NSW fishing zones are under 950 on the SEIFA index, while Hawkesbury and Sydney exceed 1,000. Median weekly income data for regions in 2001 show a similar situation to 1996 results, except in the Hunter and Illawara regions where weekly income is higher than other rural areas.

Table S2 reports major home post codes for OTL fishers within districts and illustrates the diversity in community structures and in the home locations of OTL fishers. OTL fishers form a substantial part of the NSW fishing community in many postcodes ranging from 4% to 90% of local fisher numbers. A significant number of postcode areas with OTL fishers fall below 920 on the SEIFA index of disadvantage and may well be more adversely impacted by changes under the FMS (For example: Tweed Heads, Clarence, Coffs Harbour, Manning, Illawara and Far South Coast). Similarly a range of areas record median individual weekly incomes below $250 in the 2001 census.

Several postcode areas such as Clarence, Coffs Harbour and Montague have a high percentage of OTL fishers in the work force. This percentage is also significant in Manning, Batemans Bay, Wallis Lake and Far South Coast areas. Conversely some postcodes areas have relatively few OTL fishers as a percentage of the work force (e.g. Central Coast, Sydney), though this should be interpreted with caution, given the weakness of this method in areas of high population.

Table S2 indicates the numbers of OTL endorsed fishers in each post code and this should be referred to in any inference. For example the Sydney area has the highest percentage (186 total and 33 OTL) of commercial fishers, but a very small percentage of the total labour force. The numbers of direct and indirect employees associated with the OTL fishery and the multiple endorsement structure are reviewed in the Economic section. The social survey enabled a social profile of OTL fishers to be developed as was reported in Table E7 (economic issues section).

The average age of NSW commercial fishers is 54.1 years and is higher than the 45.3 years recorded for all Queensland fishers (Fenton and Marshall, 2000). The average age of the OTL fishers is 54.6 years. Participation of females in direct fishing is 2% according to the survey and approximately 34% (131 of 384) of OTL fishers' partners are employed in OTL fishing businesses. Approximately 91% of OTL fishers are owner operators, average over 26 years of fishing experience, work an average of 55.8 hours per week, and 20% of OTL fishers work in other industries. Fishers have high levels of residency, averaging 19.7 years and high levels of home ownership, with 81% owning or paying off a home.

The 384 OTL fishers interviewed had low levels of formal education, with 64% achieving year 10 education or below. Approximately 14% had a trade or business training. Fishing forms a significant part of individual fisher's income, with 78% of fishers earning 90-100% of income from fishing (see Table E6 of the Economic section). Fisher net taxable income from all industries was $63,251 after tax, of an average household income of $63,375 indicating the overall contribution of 99% by fishers to household income. These estimates are considerably higher than for other fishers in NSW and may be due to a low number of fishers responding to this question or misinterpretation in responding to the question.

Table S2: ABS social index data on OTL fishing communities in NSW at the postcode level (Source ABS/BRS; NSWF licence data).

Zone	Home District	Post code	Town/Suburb	P'code Pop'n	P'code Fishers	P'code OTL Fishers	OTL fishers as % of all NSW	SEIFA	Unemployed (%) 2001*	Med. Ind. Income ($/wk) 2001*	Employed in C.F. (%) of labour force	Employed in OTL as (%) of labour force
1	TWEED	2485	TWEED HEADS	8,978	22	10	0.45	893	12.20	250	0.30	0.14
1	TWEED	2486	TWEED HEADS/BANORA POINT	24,984	22	10	0.45	953	12.20	250	0.41	0.19
1	TWEED	2487	CHINDERAH/OTHERS	7,976	19	8	0.42	921	12.20	250	0.41	0.17
1	RICHMOND	2472	BROADWATER/CORAKI	1,761	10	3	0.30	919	13.30	250	1.02	0.31
1	RICHMOND	2473	EVANS HEAD	2,613	25	11	0.44	900	13.30	250	1.02	0.45
1	RICHMOND	2478	BALLINA/OTHERS	24,184	52	16	0.31	972	10.10	350	0.52	0.16
2	CLARENCE	2460	LAWRENCE/OTHERS	29,145	24	3	0.13	951	13.60	250	1.21	0.15
2	CLARENCE	2463	MACLEAN/OTHERS	6,072	96	8	0.08	946	13.60	250	4.46	0.37
2	CLARENCE	2464	YAMBA/OTHERS	5,340	64	18	0.28	954	13.60	250	4.46	1.25
2	CLARENCE	2466	ILUKA	1,863	65	41	0.63	891	13.60	250	4.46	2.81
2	CLARENCE	2469	WOOMBAH/OTHERS	933	10	3	0.30	854	13.60	250	1.02	0.31
3	COFFS HARBOUR	2448	NAMBUCCA/OTHERS	8,690	18	10	0.56	927	18.30	250	0.80	0.44
3	COFFS HARBOUR	2450	COFFS HARBOUR	32,488	52	27	0.52	971	12.40	350	0.24	0.12
3	COFFS HARBOUR	2456	WOOLGOOLGA/URUNGA	11,848	20	15	0.75	944	19.70	250	0.46	0.35
3	COFFS HARBOUR	2462	WOOLI/OTHERS	2,599	20	18	0.90	917	19.70	250	1.19	1.07
3	HASTINGS	2431	SOUTH WEST ROCKS	3,965	33	20	0.61	926	16.50	250	0.78	0.47
3	HASTINGS	2440	CRESCENT HEADS/OTHERS	23,164	20	7	0.35	916	16.50	250	0.78	0.27
3	HASTINGS	2444	PORT MACQUARIE	34,162	37	14	0.38	966	10.20	250	0.48	0.18
4	MANNING	2427	HARRINGTON/COOPERNOOK	1,473	24	17	0.71	883	10.20	250	0.71	0.50
4	MANNING	2430	TAREE/OTHERS	28,312	35	8	0.23	950	12.20	250	0.71	0.16
4	MANNING	2443	LAURIETON/OTHERS	8,093	21	6	0.29	909	12.20	250	0.60	0.17
4	WALLIS LAKE	2423	BUNGWAHL/OTHERS	3,247	17	5	0.29	939	11.70	250	2.78	0.82
4	WALLIS LAKE	2428	FORSTER/TUNCURRY/OTHERS	19,457	88	30	0.34	939	11.70	250	2.78	0.95
4	PORT STEPHENS	2301	NELSON/SALAMANDER BAYS/OTH	25,046	27	1	0.04	997	9.80	350	1.04	0.04
4	PORT STEPHENS	2315	NELSON BAY/OTHERS	8,393	54	19	0.35	966	9.80	350	1.04	0.37
4	PORT STEPHENS	2324	TEA GARDENS/OTHERS	19,123	20	1	0.05	937	11.70	250	1.91	0.10
4	HUNTER	2280	BELMONT/OTHERS	22,225	10	6	0.60	989	9.50	350	0.05	0.03
4	HUNTER	2281	SWANSEA/OTHERS	11,349	15	4	0.27	935	9.50	350	0.05	0.01
4	HUNTER	2295	STOCKTON/OTHERS	5,058	12	7	0.58	918	11.10	350	0.56	0.32
4	HUNTER	2304	MAYFIELD/WARABROOK	13,925	18	1	0.06	890	11.10	350	0.07	0.00
4	CENTRAL COAST	2250	ERINA/OTHERS	57,810	10	6	0.60	1025	7.40	350	0.00	0.00
4	CENTRAL COAST	2251	AVOCA BEACH/OTHERS	29,370	11	8	0.73	1032	3.10	550	0.00	0.00
4	CENTRAL COAST	2256	WOY WOY/OTHERS	14,168	12	5	0.42	941	4.00	550	0.00	0.00
4	CENTRAL COAST	2257	EMPIRE BAY/OTHERS	25,326	10	6	0.60	957	7.40	350	0.00	0.00
4	CENTRAL COAST	2261	BERKELEY VALE/OTHERS	32,623	19	9	0.47	935	7.40	350	0.00	0.00
4	CENTRAL COAST	2259	MANNERING PARK/TACOMA/OTH	46,846	40	2	0.05	972	9.50	350	0.00	0.00
5	HAWKESBURY	2083	MOONEY MOONEY	1,450	12	1	0.08	1042	7.40	350	0.00	0.00
5	HAWKESBURY	2775	SPENCER	930	18	0	0.00	967	4.70	450	0.00	0.00
5	SYDNEY	2000	SYDNEY NORTH & SOUTH	3,276,207	189	33	0.17	1047	6.10	450	0.00	0.00
6	ILLAWARRA	2500	WOLLONGONG	32,326	10	4	0.40	998	9.10	350	0.10	0.04
6	ILLAWARRA	2502	PRIMBEE/OTHERS	13,000	10	1	0.10	847	9.10	350	0.10	0.01
6	ILLAWARRA	2506	BERKELEY	6,653	18	3	0.17	827	9.10	350	0.10	0.02
6	ILLAWARRA	2533	KIAMA	13,553	12	8	0.67	1067	6.00	350	0.23	0.15
6	SHOALHAVEN	2540	GREENWELL POINT/OTHERS	24,208	59	30	0.51	933	11.90	250	0.81	0.41
6	SHOALHAVEN	2541	NOWRA/OTHERS	29,663	16	5	0.31	957	9.80	350	0.81	0.25
7	BATEMANS BAY	2536	BATEMANS BAY/OTHERS	14,335	32	16	0.50	970	13.00	250	1.18	0.59
7	BATEMANS BAY	2537	MORUYA/OTHERS	9,002	10	1	0.10	960	13.00	250	1.54	0.15
7	BATEMANS BAY	2539	ULLADULLA/OTHERS	11,499	63	30	0.48	942	11.90	250	0.81	0.39
7	MONTAGUE	2546	NAROOMA/OTHERS	8,135	53	37	0.70	955	13.00	250	1.54	1.08
7	FAR SOUTH COAS	2551	EDEN	3,726	61	21	0.34	916	9.30	250	2.56	0.88
			Total		**1615**	**573**						

In examining dependants, it was found that 54% of OTL fishers had no dependent children below 16 years of age as reported in Table S3. The balance of 46% of fishers had 355 dependent children under 16, representing families with an average of 2.05 children per family.

Of 355 OTL endorsement holders responded, 230 had been fishing in OTL in the previous 12 months. The balance of sampled endorsement holders were fishing elsewhere.

Table S3: Dependent children below 16 years of age for OTL fishing businesses (RM-SS).

No. of Children	Frequency (Fishers)	Total no. of children	Percentage
0	208	0	54%
1	55	55	15%
2	69	138	39%
3	34	102	29%
4+	15	60	17%
Total	**381**	**355**	**100%**

Table S4 reports about 66% of OTL fishers had no financial dependents, 18% had dependent spouses and 16% had dependent grandparents, parents, stepchildren and children over 16 years.

Table S4: The number of dependants impacted by the removal of fishers in the 2002-2007 period (Source: RM-SS).

Dependent	No.of dependents	No.of dependents Adj	%
None	245	460	66%
Spouse	72	123	18%
Children and Others	67	114	16%
Total	**384**	**697**	**100%**

(Note: Adjustment is proposed in the ratio of 654/384=1.7. Sampled OTL fishers=384; Total OTL fishers = 654)

PNSW Guideline (b): **Outline community views and perceptions of the fishery and include a brief analysis of how these views and perceptions were formed.**

The OTL fishers are a part of the rural coastal NSW community, being spread all along the NSW coastal area. There have been no formal studies of community values, views and perceptions and requires further research.

Views of the community on commercial trap and line fishing are varied. The public often note occasional dead fish washed up on beach, odours and wastes associated with commercial fishing. Similarly landing sites and fish cleaning areas can reduce amenity. Definitive public views on fishing are difficult to obtain given the differing views on fishing issues within the community.

A public telephone survey was undertaken by Roy Morgan Research in 1999 investigating general community attitudes to a recreational fishing licence. There was a general community concern that the marine environment should be looked after. The Roy Morgan (1999) survey of 500 persons in NSW indicated that 95% of person felt it was important "that our fish stocks are well looked after". In the same survey 44% of responses prioritise "looking after the environment" as the most important aspect of managing fisheries.

The community expect OTL fishers to provide fresh seafood for the majority of the population who do not catch their own fish. This is also difficult to measure, but is evidenced by local demand for fish species taken by OTL fishers.

Coastal NSW has a great diversity in marine leisure activities. There is no definitive study on marine leisure activities in the NSW coastal region and data is lacking. Marine leisure activities tend to follow population distributions, or population movements, such as annual holidays to selected coastal regions.

Charter fishing usually goes offshore depending on the region. There is little formal whale watching activity, but general pleasure cruises occur in tourist venues close to Sydney (eg. Port Stephens etc). Recreational boating and diving takes place along the NSW coast.

The potential for conflict is minimised by commercial fishers not fishing openly at times of high tourist activity, or only fishing in areas not frequented by tourists. Tourists enjoy the fish cooked at the local fish shops or Co-ops, as evidenced by seafood sales in tourist destinations, but are also concerned over loss of environmental amenity (Roy Morgan, 1999).

The OTL fishers can both contribute and detract from visual amenity. Tourists expect to see small working boats, but may object to fish odours, traps and fish offal/ frames disposed of in inappropriate ways, such as on shore. Similarly, processing establishments and recreational fish cleaning areas can attract pelicans and birds to feed on scraps, which may not be seen as a visual or health amenity. Many of these issues can be addressed within industry and at the local council level.

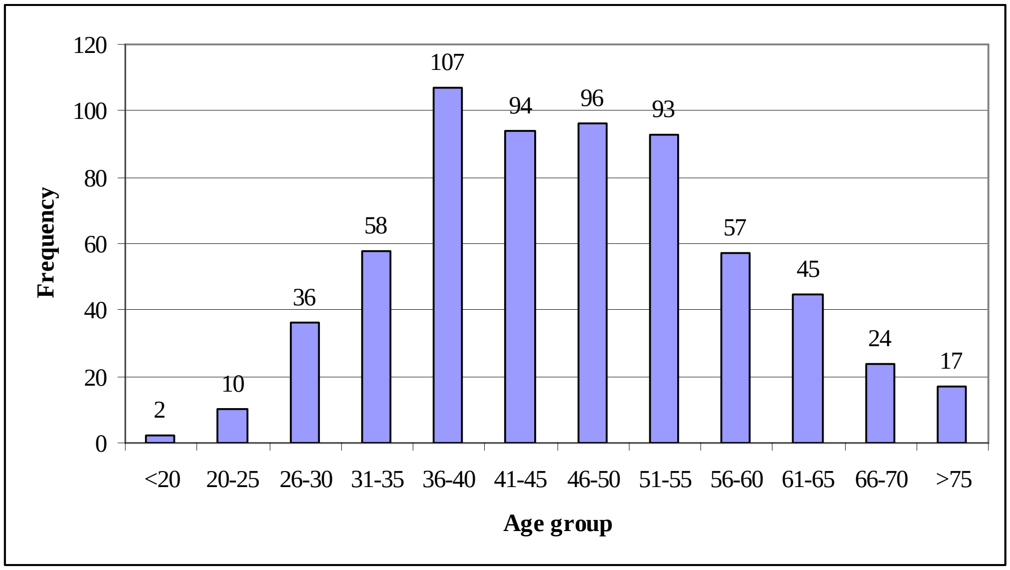
PNSW Guideline (c): **Determine the importance of social identity and job satisfaction as a reason for being a commercial fisher in these fisheries.**

The importance of social identity

There is no accepted definition of "fishing communities" and this requires further analysis of economic and social interactions and linkages between fishers and between communities (Fenton *et al* 2000).

The ages obtained from licence records of fishers operating in the 1999-2000 period are reported in Figure S2 for all OTL fishers and those active in 1999-2000. For 639 records the mean age is 54.6 years. Of these, 15 % are aged greater than 60 years and will be entitled to the age pension within the lifetime of the FMS.

Figure S2: Age distribution of OTL fishers (Source: NSWF licence records)



The regional location of fishers by district is reported in Tables S1 and S2. Fishers were asked about their pattern of travel for their main fishing activity. In Table S5, about 16% of fishers travel over 50km per day in their fishing operations. This may reflect the travel by OTL fishers from their other fishing activities or be time steaming to fishing locations.

Table S5: Travel distance to main fishing site in the OTL fishery (Source: RM- SS)

Distance/Time	Freqency	%
<25km, 1 hr by boat	209	56%
25km-50km, 1- 2 hrs by boat	84	23%
50km-100km, 2-3 hrs by boat	33	9%
>100km , >3 hrs by boat	26	7%
Can't say	19	5%
Total	**371**	**100%**

Fishers were asked how many years they have lived in their current postcode area. The results are reported in Table S6. Table S6 shows 76% of fishers have been living in the same postcode area for more than 10 years and only about 13% have moved their postcode residency in the last 5 years. The OTL fisher population is reasonably sessile, with limited operational traveling behaviour and has a significant number of fishers who have been resident in a local area for a long time. This is probably an indication of their community involvement in local areas.

Table S6: Residency at current postcode (Source: RM-SS)

Years	Frequency	%
<1	5	1%
1-5	45	12%
6-10	41	11%
11-15	36	9%
16 - 20	38	10%
21 - 25	51	13%
26 - 30	47	12%
Over 30 years	120	31%
Can't say	1	0%
Total	**384**	**100%**

There is no one accepted measure of social capital (NSW government, 1997b). Fishers are often a significant part of the social infrastructure in small coastal communities. For example, an illustration of the potential contribution of fishers to local social capital is reported in Table S7 from McVerry (1996). Fishers and their club memberships in the Clarence community are reported. Clubs can be a place for fishers to socialise with other fishers, workers and the community. There is no other available information on fishers and social capital in NSW.

Table S7: Fishers as a percentage of club memberships in the Clarence region (McVerry, 1996).

Type of Club	Fishers as % of club membership
Bowling Club	41
Golf Club	27
RSL	18
Soccer, Football, Coastguard	4
Surf, Cricket, Lions Clubs	3
Softball, Rowing, Horse, Clarence Catchment Management	2
Bike Club, Naval Reserve	1

Job satisfaction within the Ocean Trap and Line fishery

The social survey asked questions to provide information on industry working practices. Part of the fishers' life style is that fishing takes more hours than the conventional 40 hour week. Fishers were asked to estimate their average working week in normal, low and high seasons. The estimates from the telephone interview are reported in Figure S3.

The data suggest that normal weekly working hours are 54.9 per week. This is significantly in excess of the 42 hours per week estimated by ABS for fishers nationally (ABS, 1996). High season estimates exceed 70.4 hours/week while low season hours are 41.9 hours/week.

Figure S3: Hours worked per week in the Normal, Low and High seasons in the OTL fishery (Source: RM-SS).

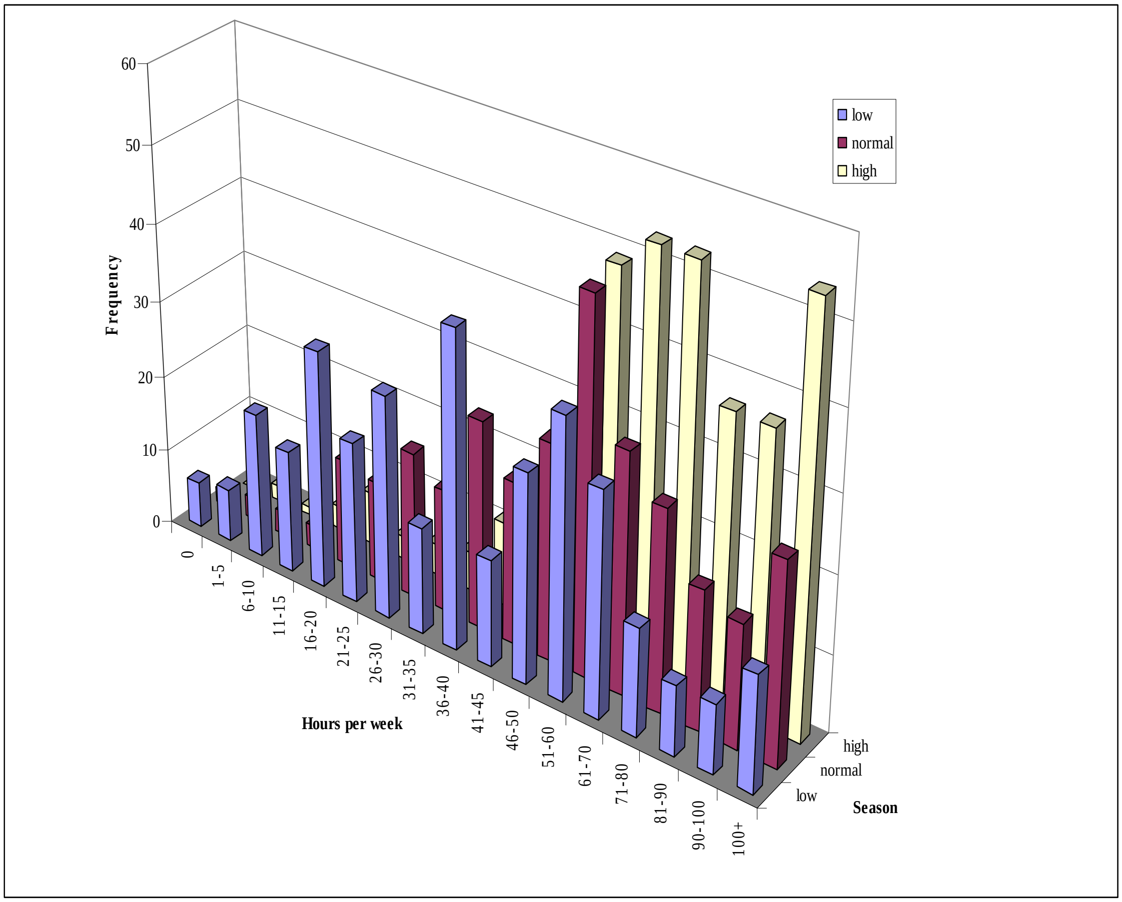
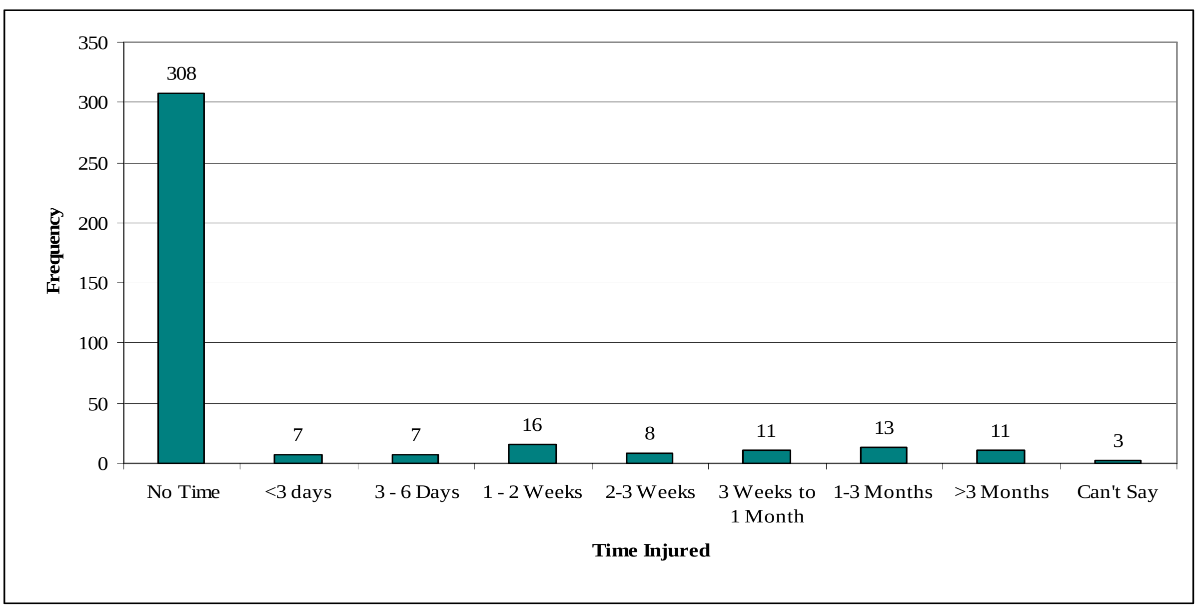


Figure S4: Duration of non-working time from industrial injury in commercial fishing in the OTL fishery (Source: RM-SS)



Fishing is a diverse activity and can lead to industrial injury. Figure 4 indicates the level of industry related injuries in the OTL fishery. Approximately 80% of fishers had no fishing injuries in the previous 12 months, but 15% of fishers were out of fishing for 2 weeks or more in the previous year, through industrial injury (59 fishers).

A measure of fisher's experience, which contributes to the sense of fishing industry involvement and community, is the years of fisher involvement with the industry. Aproximately 40% of OTL fishers have been licenced for more than 20 years in the fishing industry. Figure S5 reports number of years fishers had been in the NSW fishing industry as recorded in the social survey.

Figure S5: Number of years OTL fishers have been licenced in NSW (NSWF licence data).

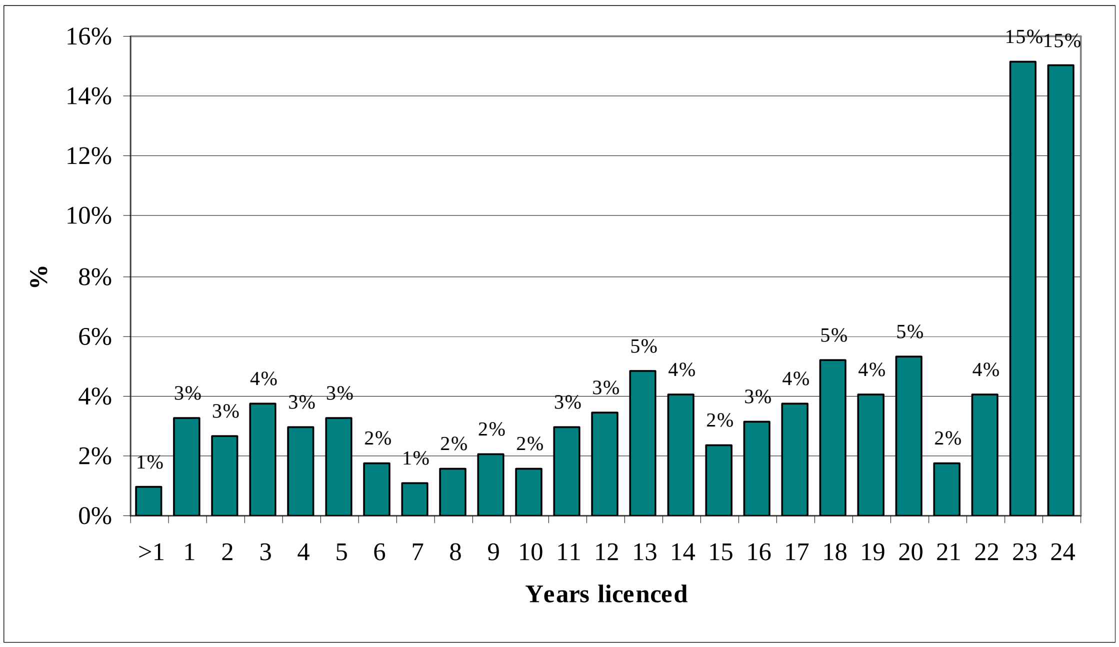
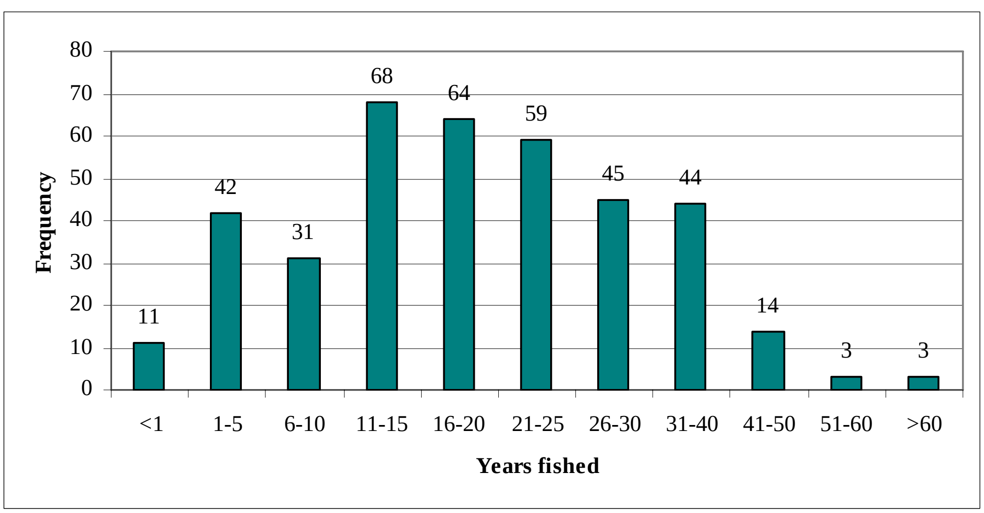
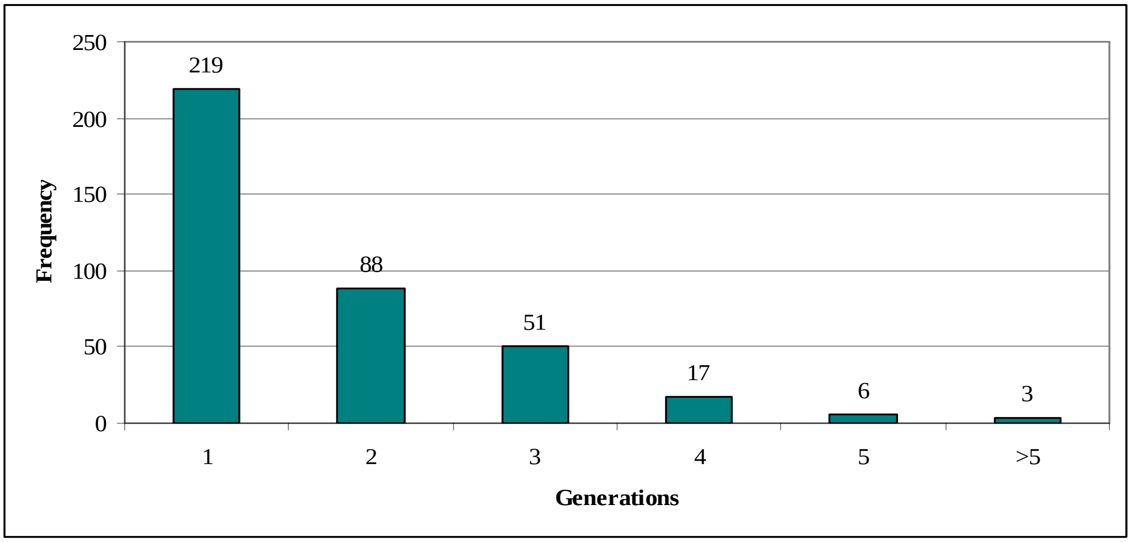


Figure S6: Frequency plot of years fished by OTL fishers in NSW fishing industry (Source: RM-SS).



Social capital is potentially seen in family involvement in fishing. Fishers were asked how many generations their family had been in the NSW Fishing industry and results are reported in Figure S7.

Figure S7: Frequency plot of number of generations in the OTL Fishery (Source: RM-SS).



Approximately 57% of OTL fishers are first generation fishers, 23% are second generation and 13% were from three or more generations. The 57% of first generation fishers, reflect entrants who may be more capable of adjustment, than fishers from multi-generational fishing families. There are 43% of fishers with two or more generations of involvement in fishing, which may indicate long-term social association and integration with communities and potential to be significant contributors to social capital.

The extent of part-time and full-time fishing is reported in the Economic Issues section. The fisher skills base was investigated through questions in the social survey. Fishers were asked about their current work in other industries and their capacity and willingness to transfer from fishing to other industries. Approximately 20% of OTL fishers worked in other industries. Of these 77 OTL fishers (from 384 interviewed) who were undertaking paid work outside the industry:

(22) 29% would consider earning all their income from that other industry;

(46) 60% would not; and

(9) 12% were undecided.

All 384 OTL fishers were asked about their capacity to consider alternative employment either full-time, part-time, or could not get employed outside fishing, as fishing is “all I know”:

15% (59) could get full-time employment outside fishing;

15% (58) could get part-time employment outside fishing

67% (259) could not get employed outside fishing – fishing is "all I know"; and

2% (8) don't know/ can't say.

The 259 fishers from 384 who answered "I probably could not get employed outside fishing, as fishing is all I know" were asked if they would consider retraining. A total of 22% (56) would and 73% (190) would not consider re-training and 5% (13) were undecided. The fishers who would not consider retraining were asked about their reasons which are reported in Table S8. Participants generally gave more than one response.

Table S8: Reasons for not considering retraining to industries outside fishing (Source: RM-SS).

Reason	Frequency	%
I'm Too Old	107	53%
Fishing Is The Only Industry I Know	73	36%
I Enjoy Fishing	73	36%
I've Invested In Fishing Equipment	26	13%
It's A Family Business	22	11%
Other	11	5%
Bad Health/ Injuries	11	5%
Risk Of Unemployment	9	4%
Illiterate/ Low Education	3	1%
Language Barrier	1	0%
Can't Say	1	0%
n=	203	100%

Age was the major reason for not considering retraining for 53% of the sample, followed by only having experience in the fishing industry, fishers' lifestyle and investment in the fishing business. All of these are inhibitors to the mobility of labour. Those who indicated a willingness to retrain were asked about their interest in retraining into other industries. The results are reported in Table S9. The OTL fishers showed interest in charter fishing, tourism/hospitality and building industries as their alternative employment/business opportunity.

Table S9: Industries which fisher would consider retraining into (Source: RM-SS).

Industry	Frequency	%
Charter Fishing	7	13%
Tourism/ Hospitality	6	11%
Building Industry	4	7%
Farming	2	4%
Government Employment	2	4%
Other	21	38%
Can't Say	20	36%
n=	**56**	100%

There has been little investigation of fisher mobility in the Australian fishing industry, but some notable social studies, such as Bell and Nalson's seminal study in 1974, focus on issues for NSW dairy farmers facing industry viability and restructuring issues. Farmers were found to have strong identification with the land, farming and had low mobility. A range of quotes about the mobility of farmers from Bell and Nalson, (1974) is presented in Box H1 and may apply to fishers in the OTL fishery.

Box H1: Quotes on social mobility issues for dairy farmers in northern NSW (Bell and Nalson, 1974).

It is not necessarily the worst farmers who leave the industry, but those who recognise other opportunities and are prepared to take the risk of turning to some other occupation. …..those that remain could be a hard core residue of economically and socially depressed farmers.

Farmers with off farm work were less inclined to be in poverty, compared with those without dual occupations

Few respondents had alternative work. Social explanations are that farmers are farmers by tradition and it may also reflect lack of available opportunities for alternative work in different areas.

Social reasons for exiting farming may be the long hours involved in the industry, affording little leisure time, the advanced age of respondents and their wives, a potential labour shortage through sons leaving the industry, and reasons such as sickness and disputes around farming issues.

Old farmers, with no one following in the business, were not prepared to invest in new equipment.

Parents may not be encouraging children into the industry, but encourage education etc.

"Retreat farming" with the farmer holding on until eligible to receive the old age pension. Wife dissatisfaction is a major social influence in the dairy sector.

Many respondents were third generation and value farming as a way of life. With the independence it affords, are loath to leave their local social environment, friends, neighbours and relatives and the voluntary associations in which they have been active.

Away from farming they will have to compete with others for land based jobs. There may be a shortage of part-time labouring jobs.

The intergenerational nature of occupational mobility - most farmers transfer from one type of farming to another. Socially many farmers stay within 30 miles of place of birth. These ties may prevent farmers taking opportunities outside their area.

Farmers are independent and have a history of shunning government initiatives preferring voluntary adjustment.

They also tend to shun the CES (Commonwealth Employment Service) and rely on their own initiative.

A study analogous to the Bell and Nalson's work is required across all fishers in NSW to confirm this material. There are significant social issues for fishers below retirement age seeking other employment. These will vary from area to area as indicated later in the social assessment.

Regions fished and regional unemployment statistics

The regional importance of the OTL fishery to the local community is reported in Table S1 and H2. Unemployment data is available from current ABS statistics (ABS, 2001) only at a more aggregated level than the 1996 census data, which is available for each postcode. Table S10 reports recent ABS unemployment data as of February 2001 for rural areas of coastal NSW.

Table S10: ABS statistical regions and rural coastal area male unemployment (ABS, Feb. 2001).

	Labour force('000)	**Unemployed Feb. 2001 ('000)**	**% Male**
Richmond-Tweed & Mid-North Coast SRs	106.1	15.8	14.9%
Gosford -Wyong SR	71.4	6.2	8.7%
Hunter SR	171.8	18.1	10.5%
Newcastle SR	149.8	17.4	10.5%
Sydney	-	-	6.0%
Illawarra SR	112.2	8.4	7.5%
South Eastern SR	152.9	12.2	8.0%

Regional unemployment data indicates higher rates of unemployment in areas away from Sydney, being higher in the north than in the south. Male unemployment by age group also varies in NSW as reported in Table S11.

Table S11: Percentage male unemployment in NSW (ABS, Feb. 2001).

Age	Percentage Male Unemployment
15-19	21.9
20-24	10.6
25-34	6.6
35-44	5
45-54	4.8
55 nad over	4.9

The fishing population in the OTL fishery is almost entirely male, with only 2% (9) female fishers from 384 social survey respondents. More detailed statistics for unemployment by regional postcode are available from ABS 1996 and 2001 census statistics in Table S2. This gives a long-term view of regional unemployment in postcodes of coastal NSW. The range of unemployment is from 7% in Sydney, to 27% in Woombah/Others area in the Clarence region. The impact of the FMS and unemployment are assessed in the second part of this report.

PNSW Guideline (d) **Summarise the overall social risk to fishers from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.**

The current profile of ocean trap and line fishers enables us to identify the overall social risks to fishers associated with the Ocean Trap and Line Fishery. The overall social risks to fishers from the current operational arrangements in the OTL fishery include:

reduction in employment;
loss of fishing lifestyle;
lack of alternative employment opportunities for those willing to exit the fishery;
inadequate involvement of fishery policy decision making and management;
conflicts among OTL fishers and also with other fishers;
uncertainty and lack of secure, well developed access rights; and
inadequate information on social aspects of the fishery.

Reduction in employment

Existing information shows that there are more fishers dependant on the ocean trap and line resource than can be supported in a well managed fishery. Between 991 and 1,925 persons are directly employed in OTL fishing and between 364 and 1130 are indirectly employed in the OTL fishery. Half of the businesses surveyed have their partners involved in their businesses. Approximately 34% of OTL fishers have financial dependents.

Given the 72% of OTL fishing businesses are not economically viable in the long run, some may choose to exit the fishery. Current management arrangements are not likely to maintain long run employment opportunities if economic health in the fishery deteriorates. It is necessary to reduce the number of fishing businesses in the fishery to improve economic viability and thus there is less employment. Displaced fishers may become increasingly dependent on other industries or social security benefits.

Loss of fishing lifestyle

There are 43% of OTL fishers with two or more generations of involvement in fishing. Fishers were insistent about their identity as fishers and were unable, or unwilling, to consider re-training. Fishing is a way of life for most fishers. When fisheries slowly deteriorate, so do their fishing communities and traditions. If there is no improvement in economic viability in the fishery, many fishing families associated with OTL fishing for generations may no longer be fishing.

Lack of alternative employment opportunities

As the fishing communities tend to focus around key coastal towns where employment opportunities are generally low, any reduction in fishing effort will have adverse impacts creating unemployment. Regional unemployment in NSW is higher on the North coast of NSW. This is a significant issue for both outgoing and aging fishers considering alternative employment.

Clarence, Coffs Harbour and Montague areas, have the highest percentage of OTL fishers in the work force indicating economic and social dependence. OTL fishers form a substantial part of the NSW fishing community in many postcodes ranging from 4% to 90% of local fisher numbers. A range of areas recorded median individual weekly incomes below $250 in the 2001 census.

Conflicts

There are number of unresolved issues between ocean trap and line fishers and other fishers regarding access to fishing grounds and shared fish stocks. These arise when fishers work in the same areas and target or incidentally catch the same species. For example traps and lines are prone to gear conflict incidents with other fishers, particularly when trawlers work in the same areas.

Lack of secure, well developed property rights

Lack of secure, well developed property rights is a risk to the fishery as fishers have not got a guarantee of sufficient tenure to plan for long term investment or business planning. An increase in tenure may give incentives for improved stewardship. Lack of secure, well developed property rights is a constraint to increase or maintain economic viability of the fishery and, hence, increases the risks of job losses and lower incomes. In addition, fishers will be unable to see fishing as their long-term employment and income source.

Inadequate information on social aspects of the fishery

The collection, analysis and application of socio-economic information has not previously been a priority in the list of NSW Fisheries research programs. Research programs to strengthen the socioeconomic database for the fishery and monitor socio-economic changes in the fishery must be developed. Information on fishers' views and perceptions towards key issues in the fishery, their behaviour under existing policies, and their ability to participate in management (e.g. co-management arrangements) is also necessary for effective management of the fishery. This information will enable MAC members and other interested parties to effectively assess the socioeconomic implications of existing policies and appropriately advise the policymakers.

SECTION E. ASSESSMENT OF THE POTENTIAL IMPACT OF IMPLEMENTING THE DRAFT FMS

The Department of Planning (DP) (formerly Planning NSW) Environmental Impact Statement (EIS) guidelines (PNSW 2003), require that the potential impacts of implementing the draft Ocean Trap and Line Fishery Management Strategy (FMS) are assessed.

In the following section we assess the potential economic and social impacts of management responses proposed in the FMS.

3. Economic Impacts

3.1 Introduction

As indicated in the FMS it is the NSW Government's intention to promote a viable fishing industry, consistent with ecological sustainability and ensure cost-effective and efficient management and compliance in the Ocean Trap and Line Fishery. A number of 'management responses' have been proposed in the FMS to achieve these goals. As required by the guidelines, this section outlines the potential change in economic viability of ocean trap and line operators as a result of implementing the draft FMS with a focus on assessing:

the ability of fishers to pay increased management costs in this fishery while taking into account increased management costs accrued in other NSW fisheries;

likely changes in patterns of investment (directly in fishing as well as in associated businesses such as processing facilities and slipways) on a State and regional basis as a result of implementing the draft FMS;

likely changes in employment in the fisheries on a State and regional basis as a result of implementing the draft FMS;

likely changes in economic returns to fishers on an individual, regional and State basis as a result of implementing the draft FMS;

estimate the likelihood of any new markets being developed for bycatch species and the likelihood the fishery could increasingly target these species if new markets are developed;

the impacts to seafood markets of any changes in seafood supply as a result of the draft FMS while taking into consideration the impact of other Fishery Management Strategies and other changes such as the implementation of marine parks; and

summarise the change in risks to the economic viability of the fishery from the management changes described in the draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

The wider NSW Government assessment framework

The purpose of economic appraisal, in an environmental context, is "*to achieve a socially efficient allocation of scarce resources i.e. one which maximises the return, including the environmental capital stock, in order to maximise economic welfare of all citizens over time*" (NSW Government 1997c Annex 5). This requires that benefits and costs are measured through market values. Total social costs and benefits also include running down, or building up of the environment (NSW Government 1997c Annex 5). The current analysis is undertaken in the light of these aspects.

Approach to the assessment

The DP guidelines require the focus of the assessment to be the impacts on *"the potential change in economic viability of ocean trap and line operators as a result of implementing the Draft FMS***"**. While most of the guidelines ask for industry impacts, guideline 3(g) indicates that *"the risks to the viability of the fishery"* should be assessed. The guidelines have focused on impacts on the fishing industry.

It is proposed that the following approach will be taken to analyse the economic impacts of the FMS. We will:

Identify and describe the management responses in the FMS with the potential to change in the economic viability of ocean trap and line operators;

Appraise management responses with economic impact on viability of the operators and on the fishery as presented in an overview table (Table E1); and

Identify and assess the most highly impacting viability issues in detail, with medium and low impact economic issues being discussed generically.

The available descriptive economic information has been described in the previous section. There is insufficient economic data available to appraise the impacts for several of the management responses proposed in the Fishery Management Strategy. This limit should be recognised by the reader and where insufficient data are available, this will be indicated. The goals in the FMS (see Chapter D, Volume 2) and management responses with economic impact are described in Table E1.

Table E1: Responses ranked by potential economic impacts

Management Response No.	Description of Management Response	Goals	Impact
2.3 (a,b)	Limit fishing gear and prohib the use of on-board automatic baiting machines	1,2,3,4,5	High
5.2 (a)	Optimise the biological yield in the fishery	2,4,5	High
5.3 (a) (i)	Capping the number of endorsements at currently active levels	1,2,3,4,5	High
5.3 (a) (ii)	Maximum effort level within 10 years	1,2,3,4,5	High
5.4 (a)	Implement the share management provisions of the FM Act 1994	5,6,7	High
5.4 (d)	Develop a cost recovery framework	4,5,6	High
6.3 (a)	Ensure effective and efficient management	5,6	High
2.1 (a-h)	Prevent overfishing of the stocks	1,2,3,4,5,6,7	Medium
2.2 (a,b)	Develop and implement a recovery program for overfished species	1,2,4,5	Medium
1.1 (c)	Use of closures to control fishing activities	1,2,3,4,5,6	Low
5.4 (a)	Refine performance indicators for monitoring viability trends	5,6,7	Low
5.4 (b)	Investigate data availability to assess the economic pultiplier effects	5,7	Low
5.4 (c')	Promote post harvest practices	5,6	Low
6.2 (a) 7.2 (a)	Identify research priorities and promote and support targeted research projects	1,2,3,4,5,6,7	Unknown

The management responses proposed to address these risks are assessed below.

3.2 The Assessment of the Ocean Trap and Line Fishery Management Strategy

The review of the existing situation (Section B) indicated risks to the economic viability of the Ocean Trap and Line Fishery from overfishing of target species, excess fishing effort, potential activation of latent fishing effort, ineffective management controls on fishing effort, lack of economic incentives to fishers to reduce fishing effort and increasing costs of management and restructuring. The following section assesses the proposed management responses to these risks and evaluates their potential impacts on the operators and on the fishery.

Management Response: (*5.1a) Implement the share management provisions of the *Fisheries Management Act 1994

Background:

The FMS proposes that the category 1 share management provisions allow for the allocation of shares in perpetuity, with the payment of statutory compensation for the market value of the shares if the Government decided to close the fishery and cancel the shares.

Assessment

Category 1 share management provides fishers with secure fishing access rights. If other regulations are effective in maintaining fishing effort at sustainable levels, secure fishing access rights will also provide incentives to fishers to develop long term business plans, use their businesses as security to obtain funds from financial organisations and manage their businesses accordingly. The property rights characteristics of the endorsement have been augmented by the increased divisibility of the shares and increasing the transferability which enables parts of endorsements to be traded or transferred

Currently category 1 shares are shares of access right, but need to be developed into a right to an amount of fishing effort or catch through quota, in order to be binding on producer behaviour. Otherwise controlling fishing effort and limiting catch will be difficult if we depend on an access right alone.

***Management responses:* 5.3 (a) Manage fishing effort in the Ocean Trap and Line Fishery by:**

(i) capping the number of each endorsement type at currently active levels; and

(ii) establishing a maximum level of fishing effort for each sector of the Ocean Trap and Line Fishery to be achieved within 10 years of the commencement of the share management plan.

Background:

Excess fishing effort has been identified as one of the major economic risks in this fishery. Part of this excess effort is latent, which is a potential risk to the fishery if it is activated. Fishers produce current levels of active effort which are above the profit maximising level of effort in the fishery. The FMS intends to initially cap the number of endorsements at currently active levels, establish appropriate effort levels and remove excess effort using appropriate structural adjustment tools. The process of structural adjustment will be aided by the share allocation process which differentiates between businesses with and without validated catch history. The following are the potential impacts of this management response.

Assessment

(i) Capping the number of each endorsement type at currently active levels

The FMS does not specify how the number of each endorsement type will be capped at currently active levels. We presume it may be achieved through the use of minimum shareholdings.

Shares have been allocated in the fishery on the basis of recognised catch history. Once a minimum shareholding requirement is set, shares would be traded between fishing businesses. some fishers would purchase shares so as to obtain the minimum shareholding requirement, while others may sell their shares and leave the fishery. It is expected that fishers with low share allocations will exit first, such as holders of inactive entitlements, low income, or elderly fishers. Fishers with high opportunity costs may also take the opportunity to exit the fishery and work somewhere else. The pattern of trading under share management should be monitored.

The short term economic risk to business viability will increase as the costs of remaining in the fishery are increased for those businesses that would need to purchase additional shares. Fishers may have to obtain funds from other sources to purchase additional shares and remain in the fishery, which will increase their debt levels. The returns to shareholders buying shares are the long term benefits of being in a fishery with fewer operators, rather than immediate gains in catch. The costs of purchasing shares may lead to increased active effort levels in the fishery as fishers seek additional catch to increase revenue. Thus a total effort cap is needed irrespective of the adjustment in endorsement numbers. Fishers who choose to exit the industry would have the opportunity to gain financially by selling shares.

In summary, during the period of adjustment via minimum share holdings, the impact on industry viability maybe negative for those fishers who need to purchase additional shares (Guideline 3d) and active effort levels may increase. The cost of fishing will eventually include the amount required to purchase additional shares to stay in the fishery. It is possible that fishing effort will increase as operators aim to obtain higher revenues. On the other hand, those fishers who choose to sell shares will realise a financial gain.

(ii) Establishing a maximum level of fishing effort for each sector

Irrespective of the capping of endorsement numbers, there is a need to define a maximum level of fishing effort in each sector of the fishery. The FMS proposes to establish effort targets to be achieved within 10 years, but how the maximum level of fishing effort will be arrived at and what level that will be, is not specified. It is these issues that will determine if adjustment will take 5, 10 or more years. The FMS intends to develop a model to inform decisions on the most appropriate way to apply minimum shareholdings and any other restructuring tools.

A bio-economic model is recommended to estimate long term sustainable catch, the maximum economic rent and the optimum level of effort in the fishery. Without such direction, industry and the department may not be able to contain, or reduce effort levels in each sector of the fishery.

A total effort target level set at less than currently active effort levels, would probably increase profitability in the fishery, though this depends on the costs of restructuring and management and the level of compliance with the total effort limit (Guideline 3).

Establishing the maximum level of fishing effort and effectively managing it may:

increase the ability of fishers to pay the full costs of management (Guideline 3a);

reduce investment in the fishery, as fishers may reduce their fishing operations, for example days fished, number of vessels used, number of employees etc (Guideline 3b);

reduce employment as effort in the fishery will be reduced (Guideline 3c); and

increase economic returns to fishers (Guideline 3d).

Using input controls to manage fishing effort

In the FMS, limiting fishing gear and prohibiting the use of on-board automatic baiting machines are proposed in order to contain effort levels. In an input-based control strategy there is always a possibility of substituting controlled inputs by other inputs. For example, controlling the number of boats may be substituted by fishers working more days/nights. The economic benefits from vessel capacity restrictions will depend on the regulations that maintain total capacity in the fishery.

In summary, the introduction of share management and a cap on endorsement numbers may not constrain total effort. A total effort ceiling may be required in each sector of the fishery. As it is unlikely that input-based controls will effectively contain total fishing effort in the fishery, output based mechanisms for managing target species should be investigated. The FMS proposes this for some species (e.g. spanner crab). The costs of applying an output control system need to be balanced against the potential benefits of such an approach.

Management Response: **(5.2 a) Determine and implement strategies for harvesting fish at a size that provides optimum biological yield and economic return for the primary and key secondary species in the longer term.**

Background

Many important species in the OTL fishery are being taken at sizes below the optimum size for the species resulting in growth overfishing. Target species must be captured at their optimum sizes to optimise biological yield for target species. The FMS aims to achieve optimal biological yield and increase economic return in the longer term.

Assessment

Optimising Biological Yield: To reduce capture of numerous fish species that are below optimum size requires addressing both growth overfishing and recruitment overfishing. Minimising the negative impact of fishing operations on marine ecosystem is also part of this process. This will have significant long term bio-economic implications for resource productivity, stock rebuilding and hence viability of the industry.

Maximising economic return: There is not adequate information available to assess economic viability at a species level. Information about the total catch of primary and key secondary species, size of species at capture, the total cost of harvesting each species, and the total revenue from each species, is required to develop a bio-economic model. It is likely that gear selectivity may be adjusted as part of the strategy to optimise biological yield. Harvesting larger, high value fish species is expected to generate higher economic returns to fishers. It should also lead to increased productivity from effort and assist in minimising the total cost of effort.

In addition to harvesting fish at a size that provides optimum economic return for the primary and key secondary species in the longer term, maximising economic return in the fishery requires strategies, as covered by management response 5.3 (a), to reduce fishing overcapacity, control fishing effort and remove latent fishing capacity. The economic return to the fishery can also be maximised by increasing the quantity and quality of the product to gain improved prices. This is covered in management response 5.4 (c).

Management Responses: **5.4(c) Identify and promote post-harvest practices which will ensure the best return in dollars per kilogram for product of the fishery.**

Improving post-harvest practices such as handling, processing, and distribution are important such that fish are marketed in a cost effective and efficient way and hence increase the economic returns in the fishery. For example, minimizing waste, adding value, developing new products, increasing consumers' safety and confidence, and ensuring consumers that the product was harvested in a sustainable manner, are some of the areas where fishers may increase their profits. OTL fishers have been seeking ways to increase the value of the product at market and are involved in chilling and specialist handling of product. The system for collection of fish price data needs to be able to capture the higher prices gained by such initiatives.

As promoting the best post-harvest practices requires efficient equipment, advanced technology and skilled people, the total investment in the seafood industry and the employment may increase.

Management Response**: (1.1 c) Use of fishing closures to control fishing activities within the Ocean Trap and Line Fishery.**

Background

Implementing existing area and time closures is necessary to: protect key fish habitats and to minimise impact on sensitive ocean habitat; avoid direct interactions with marine and terrestrial threatened species, populations or ecological communities; equitably share the resource between OTL fishers and other stakeholders or minimise conflict between resource users.

Assessment

The risk from having insufficient area closures for fish is potential stock depletion. Closures may have positive impacts on the ecosystem as they help damaged habitats to recover. However, if the total effort in the fishery is excessive, closing areas may only bring an undesirable increase in fishing activity in other areas. Assuming the FMS addresses effort levels as planned, closures may increase future yields in areas adjacent to closed areas and lead to an increase in total economic returns.

***Management responses*: 2.2(a) Where the Ocean Trap and Line Fishery is a major harvester of a species determined as overfished in NSW (recruitment or growth overfished) develop and implement a recovery program for that species as detailed in the harvest strategy; and 2.2(b) Where the fishery is a minor harvester of an overfished species, contribute to the development of any recovery program for the species and adopt any measures required by a program.**

Some target species in the OTL fishery are overfished and rebuilding those stocks is one of the priorities in the FMS. The FMS proposes to develop and implement recovery programs to rebuild overfished species through closures, changes in selectivity and size limits.

Restoring overfished populations will have number of biological, ecological and economic benefits. As overfished species are of high value (e.g. gemfish and snapper), the potential economic benefits of rebuilding stock of those species may be significant. In order to conduct cost benefit appraisals of programs we require more specific details of the proposed changes.

In gaining improved access rights, fishers should be encouraged to recognise economic benefits that can occur from good management and also recognise the economic benefits to society from recovered stocks. This may involve some communication with industry on the bio-economic arguments for letting fish stocks recovery i.e. to explain that proposed reductions in fish catch are an investment, rather than a legislative imposition. Fuller security of access should encourage fishers to build up the resource.

The short term loss should be compared with the potential gains and may give increased economic returns to fishers (Guideline 3d), increased jobs in the fishery (Guideline 3c), and an increased economic contribution to local, regional and national economies. But these benefits will largely depend on the rate of recovery of the fish stock in question and must be weighed against the costs of recovery programs.

***Management Response:* (5.4 a) Refine the performance indicator for monitoring trends in the commercial viability of typical fishing businesses within each designated commercial fishing activity, so as to be based on net returns**

Developing performance measures for assessing net returns requires surveys of industry profitability across a range of businesses in the fishery. Viability at the individual fishing business level is not the recommended way to monitor economic performance in a fishery (ABARE, 2002). There are privacy and confidentiality issues involved in monitoring individual businesses.

Periodic independent surveys and assessment of industry viability can enable managers to be aware of industry viability issues across the fishery. Subsequently simple calculations on a typical average business can be used to discuss potential problems with the viability of individual businesses. Such concerns can also be communicated to management through the MAC process.

Monitoring, as proposed, may reduce economic profitability due to the cost of the survey exercise (Guideline 3) and hence reduce the ability of fishers to pay increased management costs (Guideline 3a). However there are also benefits to industry in having the economic well being of the industry recorded.

***Management Response*: (5.4d) Develop a cost recovery framework in consultation with the MAC and the ministerial advisory body relating to commercial fishing**

Cost recovery is an important component of ecologically sustainable development in commercial fisheries as it should lead to the optimum amount of services being provided in the most efficient way. NSW Fisheries is currently developing a cost recovery framework which will be introduced in 2005-06. The policy is expected to recover the full costs of management from fishers in three years.

A range of regulatory and administrative fees are payable by OTL fishing businesses. Management charges will also increase as a result of implementing the FMS.

Increased management charges will have negative impacts on those fishing businesses that are economically underperforming under current management arrangements. The implementation of full cost recovery in the 2005-06 to 2007-08 time horizon may reinforce the achievement of the reduced effort levels proposed in the FMS given that some fishers may choose to exit the industry rather than pay restructuring and management costs. The ability of fishers to meet increased fishery management charges is discussed in the following sections.

Fisher's ability to meet management charges and pay a community contribution

The economics of fisheries management enables an appraisal to be made of the economic contribution of the fishery to the economy and to analyse the impact of the changes advocated in the FMS. ESD principles dictate that resources should be valued at their market price and that subsidies should be taken into account in the form of an environmental accounting statement as illustrated below in Box 2 for the OTL FMS (NSW Government, 1997). In Box 2 the intention to transfer management costs from the current subsidisation by government to full cost recovery can be seen. The economic performance in 2003-04 is assumed to be similar to the survey results for 1999-00. The table in Box 2 shows that unless profitability improves significantly over the next 5 years, the transfer of management costs to industry will impact industry viability. Under the FMS, the costs of management of the OTL fishery will be increased with new costs to fishers as reported in Box 2.

Box 2: A Management Cost Account for the OTL FMS.

Year	2003/04 ($million)	2005/06 ($million)	2007/08 ($million)
Gross revenue from catch (i)	8.33	8.58	9.38
Less economic cost of effort (ii)	9.62	9.91	10.21
Operational economic surplus	**-1.29**	**-1.33**	**-0.91**
Management charges to industry (iii)	0.14	0.38	0.86
Less cost subsidies (iv)	0.97	0.73	0.25
Additional cost of FMS (v)	0.00	0.06	0.06
Plus rise or fall in fish stocks (vi)	0.00	0.00	0.00
Total management costs	1.11	1.17	1.17
Total economic contribution	**-2.40**	**-2.50**	**-2.08**

* Share purchases

(i) This is the value of catch from all businesses in the fishery (see Box1) rising at 3% per annum due to c.p.i.

(ii) Total cost of effort less management charges (9.76 -0.14 = 9.62) rising by 3% per annum.

(iii) Cost of management attributed to fishers under current cost policy is added. IPART estimate of this cost is $1.1m, 1ess fishers' payments already in economic costs 0.14. In order to meet 100% management charges by 2007/08, fishers will have to pay an additional $194,000 per year.

(iv) Current $0.97subsidy will be reduced to $0.25 ($1.11m-$0.857m , not attributable to industry) by 2007/08.

(v) Estimate of additional cost of FMS will be part of a $440,000 estimated cost among all managed fisheries for new FMS initiatives. We assume $60,000 is attributed to OTL (to be confirmed).

(vi) The changes in value of the stocks are unknown and are assumed to be zero.

* Share purchases do not affect the economic surplus in the fishery, but are accounted for individual fishing business costs (see Box 3)

The estimated management costs per fisher are reported in Box 3. The cost per fisher of $501 in 2003-04 rises to $837 year 2, and is $2,006 by 2007/08. As with Box 2 it is apparent that an improvement in average business performance is required to meet the rise in management and FMS for fishers.

Box 3: Estimated costs per fisher under the OTLFMS (2003/04 -2007/08)

	2003/04 ($)	2005/06 ($)	2007/08 ($)
Operational Economic surplus	**- 1,972**	**-2,097**	**-1,571**
Management charges (i)	214	600	1,480
EIS process (ii)	80	-	-
FRDC (iii)	115	115	115
New FMS charges (iii) & (iv)	92	95	104
Share rental (iii)	-	100	100
Total charges	501	910	1,799
Total economic contribution	-2,473	-3,007	-3,370
Share purchases (v)	see footnote		

(i) IPART estimate of this cost is $1.11m. Current management charges ($140,000/654 =$214). By 05/06 ($380,000/634=$600). 100% charges recovered by 2007/08 (857,000/579=$1,480)

(ii) EIS costs @$230 per fisher assuming involvement in a single fishery.

(iii) Estimate of additional cost of FMS assumed to be $60,000p.a. Additional FMS charges in 2003/04, 2004/05 and 2007/07 ($60,000/ 654;$60,000/ 634; $60,000/579)

(iv) c.p.i is not included.

(v) Share purchases will be related to the minimum shareholding adjustment proposed. Preliminary estimates suggest up to $7,500 per fisher in an adjustment program that would remove latent effort.

* Operational economic surplus from Box 2

In summary, NSW Fisheries is developing a cost recovery framework which will be introduced in 2005-06 to recover the costs that have been identified as attributable to the industry. It is estimated that management charges will increase by $239,000 per year to meet the full cost of managing the fishery in 3 years, i.e. by 2007-08.

The intention of the FMS is to move towards making the OTL fishery become more economically viable within 5 years. The projections in Box 2 and 3 assume the FMS can deliver the envisaged economic position in the time available while implementing cost recovery. A boost in industry profitability will be required. This may involve moving to a limit on effort, or catch, if effort levels are not sufficiently contained through implementation of recommendations in the FMS. The current data on costs and benefits are approximations and unknown elements, such as the increase or decrease in the stocks of fish on which the fishery depends, require further research and is a gap identified by this study.

Dominion notes that the department has acknowledged the industry's limited ability to pay management costs through the decision to commence the FMS monitoring program (observers and stock assessment) on a small scale and at minimal cost to industry.

Management response: **(5.4b) Investigate the data available to assess the economic multiplier (flow-on) effects of commercial fishing, including the Ocean Trap and Line Fishery, to the broader community, and develop strategies to improve the quality/usefulness of such data.**

Currently there is limited information to assess the economic multiplier effect of commercial fishing in NSW. Investigating the availability of the data and developing strategies to improve the quality and usefulness of such data will increase the ability to estimate the impacts of fishing in terms of output, income and employment. This will also contribute to the socio-economic database for each commercial fishery in the state.

Management Response: **6.3(a) Develop and implement a fishing business card system**

The development of a business card system enables a pool of commercially licensed fishers to be available to operate businesses on behalf of a shareholder. This should reduce the delays currently experienced by business owners fulfilling transfer paperwork when wanting another fisher to work on their boat. The business card system also gives fishers a more transferable employment right. .

The objective of the FMS with regards to this management response is to 'ensure effective and efficient management of the Ocean Trap and Line Fishery'. The provision of efficient and cost effective fisheries management involves not only providing a given level of management services at least cost, but also ensuring that the management services provided produce the highest possible net benefits to the fishery (Latacz-Lohmann 2001). The proposed management response ' to develop and implement a fishing business card system is a minor initiative among the possible responses that may be proposed to provide effective and efficient management.

Fuller incorporation of cost-effective and efficient management requires a framework for improving the quality of fishery management service delivery. There should be specification of each of the services to be delivered and clarification of acceptable performance standards within the agreed costs of management. The effectiveness and efficiency of a management service delivery framework requires further development under the FMS, before it can be assessed.

(g) Summarise the change in risks to the economic viability of the fishery from the management changes described in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring *(Guideline 3 (g))*

The review of economic issues in the Section B identifies the following risks to the economic viability of the fishery:

overfishing of the primary and key secondary species on which the fishery is based;
current levels of fishing effort are in excess of the profit maximising level;
insufficiently effective management controls and lack of economic incentives to fishers;
loss of economic rent;
increasing costs of management and the costs of restructuring the fishery;
inadequate economic information to monitor the economic viability of the fishery; and
harvesting of fish stocks below optimum biological and market yield.

In this section, we summarise the change in these risks as a result of implementing the FMS.

Overfishing of the primary and key secondary species

The review of existing information indicates that some of the primary and key secondary species are growth overfished and this adds to the risk of these stocks collapsing.

The management responses proposed in the FMS to prevent overfishing of the stocks of primary and key secondary species (2.1 a-n), promote the recovery of overfished species (2.2 a&b) and conserve fish stocks by managing levels of active fishing capacity in the fishery (2.3 a&b) are likely to have positive impacts on overfished stocks of primary and key secondary species. Therefore, the risk of overfishing of fish stocks is expected to be reduced.

The increased biological data through these programs will help develop comprehensive stock assessments of primary and key secondary species. The FMS intends to monitor the size and age composition of the 25 primary and key secondary commercial species. The approach should consider the multi-species nature of catches in this fishery, although this is partly addressed through management response 1.2 (b) which proposes the introduction of escape panels.

As input based controls may prove to be ineffective, there is also a need for investigating the suitability of quota management for some OTL species. The FMS addresses this issue by proposing an investigation into the feasibility of introducing a quota system for spanner crabs. This is a step forward towards investigating efficient and effective management strategies for target species in the OTL fishery.

Current levels of fishing effort are in excess of the profit maximising level

The major economic risk in the fishery is excess fishing effort. This needs to be reduced to a level that would support fishing businesses that are economically viable. In particular, there is potential for fishing effort to increase through the activation of latent effort in response to improved economic conditions in the fishery.

The FMS proposes to address the risk of excess fishing effort in the fishery by capping the number of each endorsement type at currently active levels and to establish the maximum level of fishing effort for each sector of the OTL fishery to be achieved within 10 years of the commencement of the share management plan by adjusting number of endorsements through minimum shareholdings. The assessment indicates the following implications.

Capping the number of each endorsement type at currently active level.

Implementing the minimum shareholding requirements under the share management plan, may eliminate the risk of potential activation of latent vessels in the fishery if the minimum shareholding is set at a level that removes all latent effort, and the opportunity cost of holding a latent endorsement is not higher than the return from selling shares. The FMS proposes to develop modelling to inform decisions on the most appropriate way to apply minimum shareholdings and any other restructuring tools. This issue cannot be assessed further unless there are specified criteria to determine the level constituting active effort.

Attempting to hold total effort at current levels through minimum shareholdings may only be temporary, as total effort levels will undoubtedly rise as fishers seek more revenue to meet increased costs.

Capping the number of each endorsement type at currently active level may not necessarily contain effort at current levels, as fishing vessels may fish more time and use more advanced technology to make vessels more efficient (technology creep). This will add more effort to already excess active effort in the fishery. Therefore, the level of this risk increases as technology advances. As current levels of fishing effort are in excess of the profit maximising level, any further increase in active effort will increase the risk to the long run economic viability of the fishery. Therefore, it is necessary to reduce 'active effort' in the fishery to sustainable levels.

The FMS addresses the risk of potential activation of latent effort, but the issue of reduction of active effort needs implementation of effective tools. Restrictions on input controls are becoming less effective because of effort substitution due to continuing improvements in fishing technologies and hence increase in total fishing effort. Therefore, in the longer term, the containment of fishing effort may require an evaluation of moving towards output controls.

Establishing maximum level of fishing effort within 10 years

Capacity adjustment to establish maximum level of fishing effort for each sector of the OTL fishery to be achieved within 10 years will require some fishers to buy additional shares to remain in the fishery. The benefits from this adjustment depend on the level of active fishing effort in the fishery.

It is likely that the profitability of the remaining fishing businesses will not increase without a substantial reduction in the total level of active fishing effort. In addition, a 10 year period is seems to be too long, as fishers require to meet full cost of management within 5 years of from commencement of fishery management plan. Therefore, the risk of excess effort in the fishery remains as the desired level is not stated.

Lack of economic incentives to fishers

Implementation of the share management provisions of the *Fisheries Management Act 1994 (5.1a)* will provide more security through new category 1 access rights. Fishers will also have economic incentives to adjust their fishing businesses (e.g. buying out excess fishing effort, developing long-term business plans, and using licenses as security in obtaining additional funds from financial institutions) and hence experience an increase in the economic viability of the fishery. Under share management provisions fishers will be compensated if government decides to close fishing areas permanently to commercial fishing.

Implementation of category 1 shares addresses the access insecurity issue, but without further limitations in effort or catch, the economic incentives to steward the resource are not developed and fishers only have a more divisible access right than was previously held. This will enable adjustment of capacity, but does not give fishers the desired economic incentives and hence uncertainly remains in the fishery.

There is currently no resource rent in the fishery

Currently there is insufficient information to estimate the level of economic rent that could accrue in the fishery under different effort levels. Existing information has indicated that issues related to excess fishing effort (increased fishing costs), overexploitation of target species (reduced catch) and rebuilding of overfished stocks (possibility of increasing catch,) need to be addressed in order to increase economic returns to fishers and hence generate economic rent in the fishery.

The FMS proposes a number of management responses to promote the economic viability (5.4) of the fishery. The FMS addresses the overcapacity in the fishery through implementing minimum shareholdings limit to adjust total number of endorsement holders and hence manage fishing effort. The FMS also addresses issues related to sustainable management of stocks of primary and key secondary species as described in the earlier sections. Promoting best post-harvest practices (5.4c) will ensure maximise economic returns to fishers and hence increase the economic viability of the fishery.

The FMS does not sufficiently detail the desired level of fishing effort in the fishery, or the proposed reduction in number of vessels required to increase, let alone maximise, resource rent. The management responses proposed in the FMS are aimed to address excess effort and to encourage fishers to harvest the resource in a more sustainable manner, thereby increasing returns to fishers.

The time frame for resource rent to become available may be greater than five years and depends on the ability of adjustment tools such as minimum shareholdings to remove latent effort and reduce active effort in the fishery. Such input restrictions are eroded by improving technology and may ultimately require total effort to be reduced annually by the rate of technical change. The risk of not generating maximum resource rent remains and must be addressed by efficient management tools controlling total effort in the fishery.

Increasing costs of management and the costs of restructuring the fishery

NSW Fisheries is intending to pass full management charges on to industry in the next 5 years. This means the fishery must be restructured within that period to ensure each sector in the fishery is economically viable and fishers are able to meet increased management charges.

As a result of cost recovery, costs of management will increase. As the fishery is economically underperforming (only 28% of fishing businesses have economic surplus), it is envisaged that many fishers will have difficulty in meeting additional management charges.. Some less efficient fishers may choose to exit the fishery and seek other employment.

Removing latent effort would equate to a 29% reduction in total number of fishing businesses in the fishery in 2003/04. This would put an additional 29% increase on fishers management charges who share total management costs in the fishery.

Costs of restructuring impact the ability of the fishing enterprise to pay debt charges incurred in purchasing shares. However for the debt incurred, the business receives increased assets and each exiting fisher also receives payment through selling their shares. Restructuring costs are therefore different in impact to the fixed nature of management costs. The risk of fishers ability for not paying full cost of management may be reduced in the long-run as the FMS proposes a number of programs that increase the economic viability in the fishery.

Inadequate economic information to monitor the economic viability of the fishery

The need for economic research has been recognised by proposing to develop and implement a Research Strategic Plan for designated fishing activities taking account of the priorities for research outlined in the harvest strategy and promote and support targeted research projects (7.2a). A number of research areas for further research are also identified in the FMS, including economic and social factors affecting the fishery, the effects of management charges on fishing businesses and communities, monitoring trends in the commercial viability of typical fishing businesses, and investigating the data availability to assess the economic multipliers of the OTL fishery. It is necessary to monitor the economic performance of each sector in the fishery and also identify areas that would reduce management charges and increase efficiency.

4. Social Issues

The environmental assessment guidelines issued by the DP require that we assess the potential social impacts of implementing the draft FMS against the following criteria:

likely changes in social impacts on fishers, their families or any local communities;
whether the risk of social impacts are changed;
whether the level of job satisfaction among commercial fishers is likely to change; and
likely employment fate of any fishers exiting the industry.

Social issues arising from implementing a new management plan fall into several categories.

Firstly, there are socio-economic impacts arising directly from how the fisheries management strategy impacts the resource and the social system involving fishers, including the community.

Secondly, a plan brings changes, with social issues to be addressed by fishers. The socio-economic impacts are most readily quantified. Other measures of the capacity and willingness of fishers to respond or incorporate change are more difficult to estimate, requiring substantial fisher consultation and communication.

Other elements may be deemed to be important to individual fishers, but there is insufficient baseline information to independently evaluate fishers' opinions. The analysis is constrained by the available information, the resources available to the study and the lack of adequate background information in this emerging area. The following framework was used to assess the potential social impacts of implementing the Ocean Trap and Line Fishery Management Strategy.

4.1 Assessment framework

In the NSW Government's guidelines (NSW Government 1997b) for assessing social impacts, the following measures of community wellbeing are recommended:

economic and financial measures - income measures, poverty lines, household expenditure, quality of life measures - leisure time, air and water quality, rates of illness and life expectancy, educational attainment levels, housing size and density, availability of social services; and

an assessment of intangible factors- quality of life measures, such as community spirit, levels of social cohesion, confidence in public institutions and intangible aspects of social well being including "social capital".

The NSW Government guidelines indicate there is no one measure of social well being and that while economic measures dominate many assessments, the quality of life measures and intangibles should be considered in policy assessment. Governments can use social assessments to "better anticipate the effects on policies and programs". When social impacts are made more transparent, policy trade-offs are highlighted and subsidiary policies to deal with negative impacts on particular areas and groups may be formulated (NSW Government, 1997b).

The NSW Government Guidelines suggest "it is not possible to establish a single SIA methodology to apply at a state-wide policy and program level because of the nature and impact of the policies often extend across regions and groups" (NSW Government, 1997b, p9). The guidelines set a broad perspective or framework for social assessment summarised in a "quick test summary table" (NSW Government, 1997b, p23) as shown in Box S1.

Box S1: Quick test summary table (adapted from NSW Government, 1997b).

1) Describe the policy objective;
2) Identify the social impacts of the proposed policy;
3) Measuring change and social impacts;
4) Evaluating social impacts and social justice principles; and
5) Responding to impacts (monitoring, management and mitigation)

Further Government guidelines extend to the *Rural Community Impacts Statements* (NSW Government 1997a). In these the economic and social characteristics of rural communities in NSW are specifically recognised and recommended to be included in government decision making as summarised in Box S2. It is likely that rural fishing communities in coastal NSW struggle with similar issues.

Box S2: Summary of Characteristics Rural Communities after NSW Government (1997a).

Geographic isolation - business being based at a distance from suppliers or markets;

A narrow and variable economic base- being dependant on one industry, coal mining, forestry, fishing etc, also being influence by public sector employment changes;

Physical isolation and small population size - individual families may live outside community centres and a greater distance from a more substantial regional service centre. Isolation limits social interaction, cultural and employment opportunities and access to public sector services and facilities. Communities may have small populations and express feelings of vulnerability being at a distance from the central decision making process.

A strong 'self help' culture - rural and regional communities are often "typified by values of self reliance, resourcefulness and independence, often responding to opportunities or threats with a strong and cohesive communal spirit".

A strong attachment to place - strong emotional/cultural attachments to as geographical location or place.

Rural industries have a major impact in the environment - rural and regional communities are custodians of most of the land of the state and intensively use natural resources.

Economic performance is dependent on environmental conditions - primary industries depend on environmental resources used as their inputs.

Social impacts and fisheries management

The social impact assessment of fisheries management strategies in NSW is a new development and requires some adaptation of accepted analytical frameworks for assessment to suit the fisheries issues and to fulfil the environmental assessment guidelines issued by DP.

In natural resource studies a four stage procedural framework is proposed by Fenton *et al* (2000) as:

assessment (including scoping and profiling);

prediction;

mitigation; and

monitoring.

These steps concur with the DP and NSW Government Social Impact guidelines (NSW Government 1997b). However, the appraisal of social impacts of management of a natural resource also needs to incorporate the linkages between the changes in the social system induced by management and the affect on the resource system, and how changes in the resource system impact the social system. Fenton *et al* (2000) recommend that the direction, strength, duration and positive and negative effects of the social system/resource system interactions, also need to be recognised. This can happen at several levels, but has a high information requirement beyond the scope of the current study and is recommended for further investigation.

The current study prioritises the socio-economic impacts from the fisheries management strategy. There are four basic questions need to be answered in Social Impact Analysis of any proposed fisheries management strategy, including (1) who will be affected; (2) what will happen to the people affected; (3) what social changes will occur under each proposed management alternative; and (4) how will any changes affect the social fabric and stability of the fishery and fishing communities (NMFS, 2000).

4.2 Assessment of the Ocean Trap and Line Fishery Management Strategy

The following procedure was used to identify and assess the potential social impacts of implementing the FMS.

The social impacts of each management strategy response are identified on fishers and the community and responses ranked into three levels – High, Medium and Low. The ranking reflects the predicted scale of total social impact. For example, total social impact may be determined as a function of the number of fishers affected by a policy, times the degree of impact of the policy on each fisher, or on the community. Other policies impacting less people or impacting to a minor extent are then relatively less impacting in total.

The implications of major impacts on fishers, their families and local communities were examined.

Priority was given to the socio-economic dislocation arising from impacts identified in the previous economic assessment, given their potential impact greatest numbers of fishers and families in the fishing community. These management responses will have major social impacts on ocean trap and line fishers as it leads to restructuring the entire fishery in terms of access and the level of effort.

The management goals and the responses in the Fishery Management Strategy were examined and those with potential social impacts are presented in Table S1.

Table S1: Ranking of socially impacting responses for the OTL Fisheries Management Strategy.

Management Response No.	Description of Management Response	Goals	Impact
5.3 (a) (i)	Capping the number of endorsements at currently active levels	1,2,3,4,5	High
5.3 (a) (ii)	Maximum effort level within 10 years	1,2,3,4,5	High
5.4 (a)	Implement the share management provisions of the FM Act 1994	5,6,7	High
5.4 (d)	Develop a cost recovery framework	4,5,6	High
1.2 (e)	Develop a code of conduct	1,2,3,4,6	Medium
4.5 (a)	Indentify high interaction areas and resolve any conflicts	1,2,3,4,6	Medium
6.1 (a)	Develop, implement and monitor a compliance plan	1,2,3,4,5,6	Medium
6.1 (c)	Implement a penalty points scheme	1,2,3,4,5,6	Medium
6.3 (a)	Develop and implement a fishing business card system	5,6	Medium
1.1 (c)	Use of closures to control fishing activities	1,2,3,4,5,6	Low
1.2 (f)	Use of more selective fishing mathods	1,2,3	Low
4.2 (a)	Monitor management arrangements and the annual landings outside NSW jurisdiction	1,2,3,4,5,6,7	Low
7.1(a)	Promote awareness of the Ocean Trap and Line Fishery	6,7,	Low
6.2 (a) 7.2 (a)	Identify research priorities and promote and support targeted research projects	1,2,3,4,5,6,7	Unknown

Guideline 4 (a): **Identify any likely changes in social impacts as a results of implementing the Draft FMS.**

Potential social impacts of implementing the draft Ocean Trap and Line Fishery management strategy are addressed below.

(1) Secure access to the fishery

***Management responses* 5.1 (a): Implement the share management provisions of the Fisheries Management Act 1994.**

Lack of secure access rights and economic incentives is a major issue for OTL fishers. The FMS proposes to address this issue through the implementation of category 1 share management system. The Category 1 share management system provides secure fishing access rights to fishers.

Given the tradability, transferability and divisibility characteristics of shares, fishers will have more incentives to adjust their businesses to increase economic returns and promote sustainable fishing practices in the industry to protect fish stock on which their businesses depend. The system gives fishers stronger fishing rights and a market for shares, enabling fishers to exit with a payment on sale of shares. Fishing businesses that are not commercially performing well may also choose to sell their businesses and exit the fishery to start another business. It is not evident as yet how the shares in the fishery will be allocated and therefore the level of impacts on fishers are not estimated.

(2) Displacement of fishers

***Management Responses:* 5.3 (a) Manage fishing effort in the Ocean Trap and Line Fishery by:**

(i) capping the number of each endorsement type at currently active levels; and

(ii) establishing a maximum level of fishing effort for each sector of the Ocean Trap and Line Fishery to be achieved within 10 years of the commencement of the share management plan.

The proposed responses in the OTL fishery impact fishers in several ways. The high number of OTL entitlements and latent effort may reflect diversified fishing businesses where many fishers are part-time and fish seasonally in the OTL fishery. Approximately 62% of OTL businesses revenue is from the OTL fishery (see Table E3). Responses proposed under the FMS will reduce the number of fishing businesses through implementation of minimum shareholding limit at the fishing business level. Capping the number of endorsements at currently active level means the latent effort in the fishery will be removed. It is not clear how this will be achieved, but it will impact and displace some fishers. However, the move to shareholdings will enable fishers to exit the fishery with a payment. The resource will also be more adequately safeguarded through the ability of industry to respond to fluctuations through more transparent access mechanisms and ways to adjust effort in the fishery.

Estimates of adjustment in the OTL fishery in the economic issues section indicate that between 14% (fishing in other fisheries) and 29% (latent) businesses could be removed by share trading. Fishers earning less than $10,000 are part-time fishers stating a willingness to work in other industries full-time. For both latent effort and low catchers, there is a limited capacity and willingness to retrain.

This opportunity to exit may be taken by fishers over 60 years of age as a "superannuation package". Part of the mitigation would be to investigate the position of elderly fishers and the impact of selling shares and receiving money on their age pension. Preliminary discussions with Centrelink indicate that income and asset tests apply and that a home owning fisher with partner would be able to have $200,500 in assets in addition to their home, before the pension payment would be reduced. Few OTL businesses would exceed $100,000 and pension entitlements are unlikely to be impacted, though this depends on the financial status of the fisher.

The results of the social survey indicate that both business and lifestyle are important aspects of fishing communities. Some fishers are rural, low income part-time fishers, representing a "cottage industry", rather than the professional full-time industry. This requires further study.

Based on social survey (RM_SS) results the numbers of dependants associated with current 654 OTL respondents are estimated at 237. This is an upper estimate, as if older fishers exit the fishery, then the number of dependent children below 16 reduce towards zero.

The impact of fisher displacement on the communities will also depend on the exiting fishers' catch levels (their current contribution towards output) and their alternative income source on leaving fishing. A multiplier of 1.5-2.0 (Dr R. Powell, pers. comm.) would apply to impacts where no other income, including social security was available. Displacing fishers, those are not fishing or partially involved, under share management will only reduce catch by a few percent. Many of the fishers will move to other opportunities, or to the age pension and welfare. Any negative multiplier effects from any the change would be small in the regional economy. However, there may be local distributional impacts in small townships where fishers live. Payment received from selling shares may assist the local economy, depending on the pattern of trade. Debt levels among the remaining fishers would likely rise with economic and social consequences as they have to buy additional shares to remain in the fishery. Should an area have a large number of low incomes or elderly fishers, the impact of adjustment might be greater in that area. The pattern of trading under share management should be monitored.

(3) Equity

Management responses: **4.1 & 4.2 Provide for appropriate access to the fisheries resource by other stakeholders (e.g. recreational, Indigenous), acknowledging the need of seafood consumers to access fresh quality fish; and provide for fair and equitable sharing of the fisheries resource with other commercial fisheries (NSW, interstate and Commonwealth)**

The FMS aims to appropriately share the resource and carry out fishing in a manner that minimises negative social impacts.

Given the diverse range of endorsement holders and fishing methods, full cooperation of all OTL fishers and other stakeholders will be needed to successfully address these issues. Estimating catch taken by all stakeholders provides the level of fishing activity in the fishery and establishes appropriate effort levels and develop regulations. Many primary and secondary species targeted by OTL fishers are also targeted by other fishers operating in NSW and other states and commonwealth waters. Therefore, NSW OTL fishery policies must take into consideration of developments in other policies and ensure consistency. This will help reduce conflicts and risk of overexploiting resources.

Efficient management of resources and effective implementation of policies will only be possible if all stakeholders have recognised access to resources. For example, currently Indigenous fishers do not have recognised access rights in the OTL fishery.

Loss of fisher access to their traditional fishing grounds

It is important to implement time and area closures to protect juveniles and spawning stocks. There is no information to assess the direct and indirect use values of the closures of fishing grounds. This requires further investigation. Negative social impact of implementing fishing closures include loss of fishers access to their traditional fishing grounds, increasing fishers in other, particularly, adjacent fishing areas, decrease in revenues in the short-term and increase in enforcement costs.

(4) Conflicts

There are a number of conflicts in the OTL fishery as some species are taken in different commercial fisheries both within and outside NSW waters and the same areas are fished by different fishers. Conflicts also exist between commercial fishers and other sectors. In addition, lack of knowledge about certain regulations, may lead to increased social conflict within industry sectors and between industry and other sectors .

The reduction of conflict is needed in the OTL fishery. The FMS proposes to identify areas of high interaction between the OTL and other resource users and respond appropriately to resolve any conflicts that arise. Mechanisms for better cooperation among fishers include the area and time closures to lessen conflict between fishers.

Communication, awareness, and the management advisory committee process are central to reducing conflicts. Fishers must be informed of long term benefits in reducing conflict and promoting more regulated harvesting. Developing a code of practice will help fishers to reduce unsustainable practices which in turn increase compliance and reduce conflicts among fishers and between fishers and other stakeholders. Implementing awareness programs to educate all stakeholders is also important to understand key issues and policies and hence reduce conflicts.

(5) Effective and efficient compliance, research and management

The FMS aims to achieve effective and efficient compliance in the fishery through developing and implementing a state-wide compliance plan, and a penalty points scheme. The FMS also proposes to investigate the feasibility of the vessel monitoring system with a view to implementing the system if it is found to be a cost-effective adjunct to existing compliance and/or catch reporting methods.

The implementation of the FMS will bring several challenges for compliance. It is envisaged that if the FMS responses are followed and communication and compliance are recognised in the co-management framework, then this will assist with the levels of compliance. The active involvement of all stakeholders in decision-making and implementing policies will increase efficiency and effectiveness of compliance programs.

Currently, compliance plans are developed at the district level. Developing a compliance plan on a state-wide basis and implementing in each of the fishery sectors will reduce implementation costs and maintain uniform compliance strategy to avoid conflicts between fishers operating in different districts/regions.

Endorsement suspension and share forfeiture are proposed to be implemented for serious offences. The increases in the cost of operations and displacement of fishers may lead to an increase in illegal fishing. This would have to be monitored, particularly through information from fishers in each sector of the fishery.

The ability of management to accurately monitor catch levels and to maintain sustainable stocks is important. The economic survey revealed the importance of accurate catch, effort and price data to the management system. The integrity and accuracy of catch data needs to be upheld to guarantee sustainability. As incentives will exist to sell unrecorded catch for cash in order to meet new FMS charges, and when days fished become limited and minimum shareholdings apply, there will need to be substantial monitoring of the catch in the fishery.

Use of new technology, e.g. vessel monitoring system, to monitor, better information, co-management arrangements are necessary to reduce management and administrative costs in the fishery.

(6) Cost-recovery

Cost recovery contributes to the sustainable management of the fishery as it values all inputs to the fishery at their true cost. However currently the fishery is economically underperforming and many fishers do not have the capacity to pay full management costs. The long-term viability of approximately 72% of OTL fishing businesses is questionable, but has to be interpreted within the context of seasonal and part-time nature of fishing operations in the fishery, and the concept of the rural lifestyle and impediments to altering that lifestyle as previously discussed. The current survey results shed light on IPART's previous finding that "70% of fishers will encounter problems in their capacity to pay higher management charges" (IPART, 1998 p 63).

Under the proposed FMS, the management charges will be fully recovered in the 2005-2008 period. Unless the economic viability of the fishery improves many operators will have difficulty in meeting additional management or restructuring costs, as reported in the OTL assessment.

The FMS could be clearer on the details of restructuring through a series of management responses. If proposed management responses are effective in reducing active effort in the fishery, it is envisaged that the ability of fishers to pay full management costs will be increased. Recovering full management costs while the fishery is adjusting, assumes improved profitability over current levels and is probably optimistic. The FMS aims to build a framework under which structural adjustment can take place. It is necessary to take the above issues (e.g. incentives for fishers to operate their fishing businesses in an economically viable manner) into consideration in developing a cost recovery framework.

(7) Potential Regional impacts of implementing the FMS

Regional impacts of any changes under the FMS can be estimated from the information reported from ABS social data in Table S1. The impacts of a 29% reduction in fisher numbers across the OTL fishing communities through the removal of latent effort is envisaged for assessment purposes and is reported in Table S13.

The number of OTL fishers in Clarence, Coffs Harbour, Batemans Bay and Hastings are highest. Table S13 indicates the potential impact on fishing communities of a 29% reduction in fisher numbers. Table S13 is also an index of the vulnerability of OTL fishing communities generated from ranking of community income dependence and the ranked SEIFA index giving each equal weighting.

Table S13: Summary table of social indices for OTL fishers with an estimated reduction of 29% in fisher numbers (latent effort) shown by district and zone (Source: ABS and NSWF)

Zone	Home District	Postcode population	P'code Fishers	P'code OTL Fishers	29% reduction in OTL fishers	SEIFA	Unemployed (%) 2001*	Med. Ind. Income ($/wk) 2001*	Employed in C.F. (%) of labour force	Employed in OTL as (%) of labour force
1	TWEED	41,938	63	28	**19.88**	922.2	12.2	250	0.37	0.17
	RICHMOND	28,558	87	30	**21.3**	930.2	12.2	283	0.85	0.30
	Zone	**70,496**	**150**	**58**	**41.18**	**926.2**	**12.2**	**266.7**	**0.6**	**0.2**
2	**CLARENCE**	**43,353**	**259**	**73**	**51.83**	**919.2**	**13.6**	**250**	**3.12**	**0.98**
3	COFFS HARBOUR	55,625	110	70	**49.7**	939.8	17.5	275	0.67	0.50
	HASTINGS	61,291	90	41	**29.11**	936.4	14.4	250	0.68	0.31
	Zone	**116,916**	**200**	**111**	**78.81**	**938.1**	**16.0**	**262.5**	**0.7**	**0.4**
4	MANNING	37,878	80	31	**22.01**	914.1	11.5	250	0.67	0.28
	WALLIS LAKE	22,704	105	35	**24.85**	939.0	11.7	250	2.78	0.88
	PORT STEPHENS	52,562	101	21	**14.91**	966.6	10.4	317	1.33	0.17
	HUNTER	52,557	55	18	**12.78**	933.2	10.3	350	0.18	0.09
	CENTRAL COAST	206,143	102	36	**25.56**	976.8	6.5	417	0.00	0.00
	Zone	**371,844**	**443**	**141**	**100.11**	**945.9**	**10.1**	**316.7**	**1.0**	**0.3**
5	HAWKESBURY	2,380	30	1	**0.71**	1004.5	6.1	400	0.00	0.00
	SYDNEY	3,276,207	189	33	**23.43**	1047.0	6.1	450	0.00	0.00
	Zone	**3,278,587**	**219**	**34**	**24.14**	**1025.7**	**6.1**	**425.0**	**0.0**	**0.0**
6	ILLAWARRA	65,532	50	16	**11.36**	934.7	8.3	350	0.13	0.06
	SHOALHAVEN	53,871	75	35	**24.85**	945.1	10.9	300	0.81	0.33
	Zone	**119,403**	**125**	**51**	**36.21**	**939.9**	**9.6**	**325.0**	**0.5**	**0.2**
7	BATEMANS BAY	34,836	105	47	**33.37**	957.6	12.6	250	1.18	0.38
	MONTAGUE	8,135	53	37	**26.27**	955.1	13.0	250	1.54	1.08
	FAR SOUTH COAST	3,726	61	21	**14.91**	916.2	9.3	250	2.56	0.88
	Zone	**46,697**	**219**	**105**	**74.55**	**943.0**	**11.6**	**250.0**	**1.8**	**0.8**
	Grand Total	**4,047,296**	**1615**	**573**	**406.83**	**945.3**	**11.1**	**306**	**0.92**	**0.33**

An estimate of OTL fishing community vulnerability to social and economic impacts is reported in Table S14. This ranks OTL fishers as proportion of labour force, ranked highest to lowest to show dependence, and the SEIFA index, ranked lowest to highest to show relative disadvantage. They are combined to give a joint ranking of community vulnerability.

The OTL fishing communities in the Montague, Clarence areas are most vulnerable, followed by the Wallis Lake and Coffs Harbour areas. This does not mean that fishing families in other areas are less impacted by policies, but that these communities have more socio-economic alternatives than small rural isolated communities in coastal NSW. They are most vulnerable to changes from the socio-economic impacts under the FMS given their higher dependence, lower SEIFA score, or a combination of both. For these communities, high unemployment also indicates potential difficulty in fishers finding alternative employment outside fishing.

Table S14: Joint ranking of community vulnerability in the OTL fishery (Source: ABS and NSWF).

Home District	Employed in OTL as (%) of labour force	Rank labour	SEIFA	Rank SEIFA	Joint rank score	Unemployed (%) 2001*	Med. Ind. Income ($/wk) 2001*
MONTAGUE	0.98	2	919.2	3	**5**	13.6	250
CLARENCE	0.88	3	916.2	2	**5**	9.3	250
WALLIS LAKE	0.28	10	914.1	1	**11**	11.5	250
COFFS HARBOUR	0.88	3	939.0	9	**12**	11.7	250
FAR SOUTH COAST	1.08	1	955.1	13	**14**	13.0	250
SHOALHAVEN	0.30	9	930.2	5	**14**	12.2	283
BATEMANS BAY	0.17	11	922.2	4	**15**	12.2	250
HASTINGS	0.50	5	939.8	10	**15**	17.5	275
RICHMOND	0.31	8	936.4	8	**16**	14.4	250
MANNING	0.33	7	945.1	11	**18**	10.9	300
PORT STEPHENS	0.09	13	933.2	6	**19**	10.3	350
TWEED	0.38	6	957.6	14	**20**	12.6	250
HUNTER	0.06	14	934.7	7	**21**	8.3	350
ILLAWARRA	0.17	11	966.6	15	**26**	10.4	317
SYDNEY	0.00	15	976.8	16	**31**	6.5	417
HAWKESBURY	0.00	15	1004.5	17	**32**	6.1	400
CENTRAL COAST	0.00	15	1047.0	18	**33**	6.1	450
Total	**0.33**		**945.3**	**12**		**11.1**	**306**

Guideline 4 (b): **Assess whether the risk of social impacts are changed by the management measures in the Draft FMS.**

The review of the existing situation (Section B, Social Issues) identified the overall social risks to fishers from the current operational arrangements in the OTL fishery. In this section we analyse whether these risk are likely to change as a result of implementing the OTL FMS. We envisage the following changes in overall social risks in the fishery:

fishery restructuring will reduce the total number of endorsement holders and a maximum limit on the number of endorsements within 10 years will also reduce employment;

under category 1 share management, fishers will have the incentive to operate fishing as a commercial activity rather than as a lifestyle. Fishers who's main objective is not maximising economic return, may choose to exit the fishery rather than incur management and restructuring costs;

fishers exiting the fishery will need to find alternative employment or rely on the social security system. As most rural areas already have high unemployment, some fishers may face problems in finding alternative employment or in starting other businesses;

there may be some reduction in conflicts as allocation of access rights and compliance issues are comparatively well addressed in the FMS. There is, however, a potential for new conflicts regarding allocation of shares, sharing responsibilities, authority and accountability of policy decision-making and management, and funding future research programs; and

there will be improvement in socio-economic monitoring of the fishery as the FMS proposes to improve economic and social research.

In summary, as a result of implementing the proposed management responses in the FMS fishers will have more secure access rights and hence improved stewardship incentives. Cost recovery and minimum shareholdings adjustments may lead to some fishers exiting the fishery receiving the proceeds from the sale of their shares. The risk of increasing fishing is effort in the fishery is educed by the FMS, but effort may increase in response to increases in costs.

Some of the outgoing fishers will retire and others may have difficulty in finding alternative employment opportunities, particularly in rural areas. Fishing activities will be efficiently monitored and user conflicts are likely to be reduced. The socio-economic monitoring and understanding of the fishery will be increased as a result of implementing the FMS.

References

ABARE (2000). Indicators of Economic Performance in Australian Fisheries. A Report to the Fisheries Resources Research Fund, October.

ABS (1996). Housing and Population Census Results. Australian Bureau of Statistics.

ABS (2000). Wages and Earnings. Australian Bureau of Statistics, 6302.0.

ABS (2001). Labour Force NSW and ACT, Australian Bureau of Statistics, 6201.1.

Bell, J.H. and J.S. Nalson (1974). Occupational and Residential Mobility of Ex-dairy Farmers on the North Coast of New South Wales: a Study of Alternative Occupations. Department of Sociology, University of New England, Armidale.

BRS (2001). ABS data for NSW fishers – information supplied by BRS Social Science Unit.

Cacho, O.J. 2000. The Role of Bioeconomic Models in Renewable Resource Management and Assessment of Solution Techniques. Paper presented at the symposium: "*Integrating Approaches for Natural Resource Management and Policy Analysis: Bioeconomic Models, Multi-Agent Systems, and Cellular Automata*" at the XXIV International Conference of Agricultural Economists (IAAE), Berlin, August 2000. Available at http://www.zef.de/download/iaae_symp/cacho_paper.pdf

Campbell, D. and J. Haynes. (1990). Resource Rent in Fisheries. Discussion Paper 90-10. Australian Bureau of Agricultural and Resource Economics, Canaberra. pp. 35.

Campbell, H.F. and R.B. Nicholl (1994). The Economics of the Japanese Tuna Fleet in Ed H.Campbell & A.Owen. The Economics of PNGs tuna fisheries. ACIAR monograph No. 28.

Dominion (2000a). Market Impacts of Estuarine Fishery Adjustment in NSW. Report to NSW Fisheries.

Dominion (2000b). Changing the Management of Fisheries in NSW. Report to NSW Fisheries.

DUAP (1997). Economic Impact Statement Manual. Department of Urban Affairs and Planning.

DUAP (2001). The Directors Guidelines, Department of Urban Affairs and Planning (final version) May 2001.

FAO. (1998). Guidelines for the routine collection of capture fishery data. FAO Fish. Tech. Pap, 382: 113 p.

Fenton, D.M., S. Coakes and N. Marshall (2000). Social Assessment in Natural Resource Management: The Development and Application of Town Resource Cluster Analysis (TRC Analysis). CRC Reef Research Centre, James Cook University, Townsville, Queensland.

Fenton, M. and N. Marshall (2001). A Guide to the Fishers of Queensland (Draft report). CRC Reef Research Centre, James Cook University, Townsville, Queensland.

FRDC (2000). Retail Sale and Consumption of Seafood, Fisheries Research and Development Corporation, Canberra.

Goulstone, A. and A. McIlgorm (2001). Initial Allocation of Harvesting Rights in the NSW Ocean trap and Line Fishery, Australia. In R. Shotton (ed.) *Case Studies on the Allocation of Transferable Quota Rights in Fisheries,* FAO Fisheries Technical Paper, No411. Rome, pp159-170.

Hassalls and Assoc. (1999). An Economic Assessment of the NSW Abalone and Rock Lobster Commercial Fisheries in NSW. A report to NSW Fisheries.

IPART (1998). Pricing Principles for Management Charges in NSW Commercial fisheries. Independent Pricing and Regulatory Tribunal of NSW, April.

Metzner, R. and P. Rawlinson (1999). Fisheries Structural Adjustment: Towards a National Framework, Commonwealth Department of Primary Industries and Energy.

McVerry, S. (1996). A Socio-economic Evaluation of the Clarence River Commercial Fisheries. Unpublished undergraduate study, Faculty of Resource Science and Management, Southern Cross University.

NSW Fisheries (2003a). Ocean Trap and Line – fishery profile. www.fisheries.nsw.gov.au (last accessed March 17, 2003)

NSW Fisheries (2003b). Preparing the first draft fishery management strategy for the Ocean Trap and Line Fishery: overview paper for industry discussion. June 2003.

NSW Government (1998). Guidelines for Economic Appraisal, Principles and Procedures simplified. The NSW Treasury.

NSW Government (1997a). Guidelines for the Preparation of Rural Communities Impact Statements, Office of Rural Communities, March.

NSW Government (1997b). Guidelines for Assessing Social Impacts, Social Policy Development Unit, The Cabinet Office, December.

NSW Government (1997c). Economic Assessment of Environmental Impacts, Annex 5 in Guidelines for Economic Appraisal. The NSW Treasury.

NSW Government (1999). New South Wales Treasury Economic Appraisal: Principles and Procedures Simplified. Policy and Guidelines paper, Office of Financial Management. March.

Newcastle Marine Brokers (2000). Fishing Licence Information from Newcastle Marine Brokers to Safefood NSW. Unpublished information from Mr Don Moore, Newcastle Marine Brokers (NMB).

NSW-NRAC (1995). Regional Audit of the Upper North east of NSW, Study C, Structural Analysis of the Regional Economy, NSW Natural Resources Audit Council, Sydney.

Powell, R.A., R. Jensen and L. Horwood (1989). The Effects of Policy Change on South-East Trawl Fishing Communities. Report to the Steering Committee on Long- Term Management of the South East Trawl fishery. University of New England and Department of Primary Industries and Energy, Canberra.

Reid, C.R.M. and H.F. Campbell (1998). Bio-economic Analysis of the Queensland Beam Trawl Fishery. Dept. of Economics, University of Queensland and FRDC (94/035).

Roy Morgan (1999). Recreational Fishing Licence Survey of 500 Persons in the Community. Confidential Document Prepared for NSW Fisheries, Roy Morgan Research, Sydney.

Roy Morgan (2001a). Social Survey Results, Unpublished Research, Roy Morgan Research, Sydney.

Roy Morgan (2001b). Economic Survey Results, Unpublished Research, Roy Morgan Research, Sydney.

Ruello and Associates (2000). Retail Sale and Consumption of Seafood. A Study Prepared for the Fisheries Research and Development Corporation (FRDC), July, 2000.

Safe Food (2001). Proposed Food Production (Seafood Safety Scheme) Regulation; Regulatory Impact Statement (RIS), June 2001. Safe Food, NSW.

SCFA (2001). Ecologically Sustainable Development and Fisheries. Project funded by the Standing Committee on Fisheries and Aquaculture (SCFA) and Fisheries Research and Development Corporation (FRDC).

SFM (2001). Seafood Handling Guidelines. Sydney Fish Markets Ltd, Pyrmont.

Standen, B.J. (1972). Evaluation of the Efficiency of Resource Use on Farms and the Welfare of Farm People. Australian Journal of Agricultural Economic, Vol.16(1). p34-44, April.

Tamblyn, C. and R.A. Powell (1988). Input and Output study of the North Coast Agriculture and Fisheries Industries, NSW Dept. of Agriculture, Wollongbar.

Appendix 1: The NSW fishery economic survey and the OTL fishery

This appendix summarises the methods and results of an economic survey of operators in the OTL fishery. A state-wide economic survey was distributed by Roy Morgan Research Ltd (Roy Morgan, 2001b) and analysed for the OTL fishery as part of the current study. The survey had 259 responses from 1,640 fishing businesses contacted (15.7%). In the OTL fishery 100 of 299 active fishers responded (33%) The purpose of the survey was to determine the operational surplus of a range of fishing operators in the OTL fishery.

The resource rent is an economic surplus which is part of the difference between the Total Revenue of effort and the Total Cost of effort across the fishery. Resource rent is made up of different elements and is the surplus attributable to the marginal fisher's last unit of effort, times the units of effort applied to the fishery (Reid and Campbell, 1998). This reflects the value of access to the resource. The balance of total rent and resource rent are intra-marginal rents, attributable to the skills of fishers and reflect innovation and skills in a healthy industry.

Estimation of rent also requires incorporation of effort and species considerations and is made more difficult by the multiple fishery behaviour of different fishing firms. Any profitability estimates in fisheries need to be related to the resource through bio-economic modelling to see if they are economically sustainable. This is not possible with information and data currently available.

Sustainability and fishing firms

In the NSW fishing industry we have fishing businesses and fishers contracted to those entities. The issues for sustainable management of the fishery resources is the overall level of effort exerted by industry on the fishery resources in NSW and the distribution of that effort among the various fish stocks. Under current management measures, effort is contained by regulations, endorsements, limits on fishing times, areas, gears and by the economics of operations. We wish to find if it pays to go fishing. However, the ongoing containment of effort requires a downward adjustment in the number of firms in the industry due to technical advancement, and rises in costs of fishing operations (Metzner and Rawlinson, 1999).

Total effort in the industry can be reduced by direct retirement of fishing businesses where money for voluntary adjustment is available, or by other industry self funded adjustment arrangements. After adjustment, remaining businesses may have improved economic performance for the same or less effort levels, due to more available catch being available in a region, and experience less congestion and competition between fishing operations. In any economically efficient change to the policy regime the winners' gains exceed the losers' losses, and a transfer payment may be possible through a levy on those fishers remaining. A central issue is the exit decision of firms from the industry. Where a firm fishes one fishery, this exit decision may be estimated more readily than if a firm has divided its fishing between two or more administered fisheries.

Current fishery endorsement capacity exceeds the level of effort applied to the OTL fishery. This then leaves "latent effort" which is primarily an administrative construct (see Appendix G1), except where fishers are genuinely not able to fish their endorsement due to ill health as previous discussed.

What should be the measure of economic health of the fishing industry?

A healthy fishing industry is one that derives enough sustainable revenue to cover its annual operating, fixed and capital costs which are determined through survey methods. They include wages, including imputed wage to the owner/operator, running costs, maintenance and repairs, insurance, and levies which reflect fishery management costs. Capital costs are harder to measure, but in principle they represent the annual interest and depreciation on the vessel and gear. Interest cost is the rate of return which the capital could earn in another use: it is calculated as a percentage of the capital value where the percentage is the risk adjusted cost of capital. Depreciation is an annual cost which recognises the finite life of a fishing vessel. In principle, the annual depreciation compounded forward at the market rate of interest should provide a sum large enough to replace the vessel at the end of its economic life.

There are three main measures of the value of the capital of a fishing firm. These are the value of the vessel and gear:

at historic cost – what was originally paid for the asset;

at indemnity value –the insured value which is taken to be an estimate of current market value; and

at replacement cost – what a new vessel and gear would cost.

The replacement cost is the basis for measuring the long-run health of the industry. If firms are able to earn the required risk adjusted rate of return and set aside sufficient funds to purchase a new vessel when the existing vessel is fully depreciated, then it is viable in the long-run. If revenue fell short of that amount then we would expect to see the market value of vessels falling, and perhaps some highly geared firms having trouble meeting loan interest and repayment schedules.

An important proviso to the above discussion is that the calculations are based on sustainable revenue, which may not be the case in a cross-sectional one year financial survey of fishing operations. It is a characteristic of the fishing industry that when stock conditions are bad, vessels are sometimes able to maintain their revenue to some extent by increasing effort; surviving by running down a different form of capital - the fish stock.

Appraising economic viability

Fishing enterprise viability can be estimated through accounting data collected in a survey. This gives an accounting view of a firm's individual performance, but is not good for measuring performance across different businesses in the fishing industry, or between industries. Economists adjust accounting data to gain more useful industry economic performance measures.

The residual of total revenue less operating costs is operating profit. Depreciation and the opportunity cost of capital are deducted to give economic profit or loss (Campbell and Nicholl, 1994). In the study a 7% opportunity cost of capital was included in economic costs after ABARE, (2000) which is 3% less than applied in Reid and Campbell, (1998) and Hassall and Associates (1999). Fisheries management charges and licence fees are included in operational costs, even though they are not technically a factor of production being a transfer payment from industry to government in respect of access and management services.

Labour costs are imputed from questions in the survey regarding days fished and unpaid days worked by the fishers and his family in the fishing industry. Wages rates for non-managerial private sector employment (trades and unskilled labour) were used to calculate an imputed value of labour (ABS, 2001). The basis of imputation was for an annual average wage of $34,320, ($660 per week) imputed on a daily basis. Imputation was made for paid an unpaid days and at a lesser fractional rate for staff and family members.

The discounted annualised sum was calculated in respect of meeting the replacement cost of the assets at the end of their lifespan from current income flows. The great variety in size and ages of vessels and capital equipment in the OTL fishery pose interesting questions in the analysis. When capital is valued at its opportunity cost, some small scale fishing operations with fully depreciated capital equipment lead to traditional measures of profitability, such as return to capital, being less applicable than for an industrial fishing fleet. Rates of return may be apparently high, or low, due to minimal capital value.

Ocean Trap and Line Fishery Profitability Results

[Note: this material is supplied under the normal disclaimer in respect of information supplied by fishers etc].

There were a total of 100 economic surveys from OTL endorsement holders. The surveys were divided into three groups for analysis: all OTL fishing businesses; OTL and Others businesses; and others with other businesses and are reported in Appendix Table EA2. This division was made to recognise the different levels of dependence on active OTL fishing among businesses with OTL endorsements.

Appendix Table EA2: Respondent numbers, mean business revenue and range of revenues for the three fisher business groups in the NSW Ocean Trap and Line fishery (Source: RM-ES).

Vessel category	Respondent numbers	Minimum revenue	Average revenue
OTL only	32	63,970	73,754
OTL and Others	34	120,700	73,080
Others	34	6,600	179,159
Total	100	63,970	109,363

The variety in business categories and activity levels among fishers are evident. Table E10 shows the revenue from different endorsement combinations in the OTL fishery.

Accounting measures

The survey results are reported in Appendix Table EA3.

Appendix Table EA3: The accounting revenues and costs for a representative Ocean Trap and Line fishing business (Source: RM-ES).

$	OTL only	OTL/other	Other	Average Vessel
Gross revenue	73,754	73,080	179,159	109,363
Direct costs*	38,581	35,562	96,294	56,784
Indirect costs**	25,391	19,863	44,408	29,838
Total costs	63,971	55,425	140,701	86,622
Gross operating profit	**9,783**	**17,655**	**38,458**	**22,740**
these costs include:				
* wages	7,513	8,611	29,544	15,234
** Interest	4,933	1,363	4,847	3,678

$	OTL only	OTL/other	Other	Average Vessel
Gross revenue	100%	100%	100%	100%
Direct costs*	52%	49%	54%	52%
Indirect costs**	34%	27%	25%	27%
Total costs	87%	76%	79%	79%
Gross operating profit	**13%**	**24%**	**21%**	**21%**

The results report that direct operating expenses, such as bait, fuel, boat repairs, fishing gear repairs, freight costs and wages to employees, are 52%, 49% and 54% of revenue in the three activity group - OTL, OTL/Others, and Others respectively (see Table EA3). Indirect costs, such as boat and vehicle registrations, insurances, fishery management charges, rates, bank and business administration expenses, were 34%, 27% and 25% of revenue respectively, making total operational costs 87%, 76% and 79% of total revenue.

The wages recorded for were for employees as opposed to payments to owner operators, and were between 8% and 16% revenue, meaning the survey data for wages did not record payments by the business to the owner as wages. About 50% of the OTL fishers sampled had no interest payments to meet and 25% had annual interest payments of greater than $1,600 per annum. Operating profit in the three business categories (OTL only, OTL/Others and Others), is apparently 13%, 24% and 21% of gross revenue. Owner/fishers draw wages from their operating profit and little accounting profit is probable. In summary, conclusions on long run viability are difficult to draw from the accounting data and it requires an economic approach.

Economic Results

The economic survey results include adjustments to give the economic depreciation, the imputed cost of labour and opportunity cost of capital and are reported in Appendix Table EA4. The results for long run viability are presented in Box EA1 below.

Box EA1: Long run economic viability – covering economic depreciation.

In the long term the following had positive economic returns in excess of all costs including economic depreciation:

6 of the 28 (21%) OTL only fishing businesses;

10 of the 33 (30%) OTL/Other businesses; and

10 of the 34 (29%) Others businesses.

In total this indicates that 26 from 93 (28%) of OTL endorsed fishing businesses were above long run economic viability, covering opportunity costs of capital, imputed labour and depreciation on the basis of being able to replace capital at the end of the lifespan of their assets.

Long run economic surplus exists for 28% of OTL fishing businesses examined, being greatest in the fishing businesses operating in other fisheries. The OTL businesses fishing in other fisheries had an average economic rate of return to capital of 5%. The OTL and OTL/Other businesses had a negative net economic return of -11% and -18% respectively, which is an indicator of rent in the fishery, providing conditions for fish sustainable stocks, capital capacity, prices of fish and inputs, and the management structure of the fishery are all met (ABARE, 2000; p16). The average net returns was -4%, the median being -23%, with 50% of all OTL businesses having less than -23% net return.

Discussion of Economic Viability and the OTL Fishery

The viability of fishing businesses in the OTL fishery is investigated by the economic survey. This was for one financial year only. It should be augmented by a series of annual surveys to see profitability over a longer time horizon. The level of net returns are related to the value chosen for the opportunity cost of capital and the value placed on capital assets in survey responses (ABARE, 2000).

The accounting measure does not include any opportunity costs and indicates that for many fishers payment to the operator will come out of the business after other deductions – “fishing for wages”. The economic surplus available varies between the three fishing operations and is highest for the OTL /Others businesses with more than 18% of gross revenue.

Appendix Table EA4: Results of the Economic survey of the Ocean Trap and Line fishing businesses in the financial year 1999-2000 (Source: RM-ES).

$	OTL only	OTL/other	Other	Average Vessel
Gross revenue	**73,754**	**73,080**	**179,159**	**109,363**
Less costs				
Cooperative expenses	3,318	3,745	4,553	3,877
Bait	4,039	2,390	1,229	2,536
Boat fuel	8,216	7,372	25,783	13,782
Repairs	5,557	4,234	15,914	8,555
Fishing gear	3,205	4,800	9,370	5,808
Vehicle fuel	1,686	2,785	5,003	3,169
Freight	3,999	880	3,650	2,812
Other Costs	1,048	745	1,248	1,013
Imputed labour	31,400	37,398	39,805	36,297
Total Direct Costs	**62,468**	**64,349**	**106,555**	**77,847**
Boat registration fees	1,123	1,229	2,884	1,746
Vehicle registration	516	853	1,390	919
Insurance	1,444	1,553	6,985	3,329
Fishery Man. Charges	288	1,683	2,456	1,490
Comm. Fish Licence	974	982	2,087	1,347
Accounting	675	996	1,990	1,224
Phone	796	1,291	1,902	1,340
Power	439	516	1,198	723
Rates	1,034	854	1,712	1,198
Bank	255	347	1,035	546
Economic depreciation	6,210	2,972	10,894	6,702
Op. cost of capital	7,901	6,447	17,019	10,507
Repairs	404	207	3,560	1,388
Repairs vehicle	1,185	1,958	2,646	1,938
Travel	612	955	821	798
Other costs	176	2,101	2,592	1,642
Total Indirect Costs	**24,031**	**24,943**	**61,173**	**36,837**
Total Economic Costs	**86,499**	**89,292**	**167,727**	**114,684**
Economic Gross Profit	**- 12,745**	**- 16,212**	**11,432**	**- 5,322**
Capital Asset Value	**112,874**	**92,098**	**243,134**	**150,099**
Economic rate of return to capital	**-11%**	**-18%**	**5%**	**-4%**
Observations	32	34	34	100

It is likely that fishers forgo payment for the time involved with the fishing business. The high labour commitment to fishing in the OTL is reported in Appendix Table EA5 where the average OTL fisher spends 63% of their time on “unpaid” tasks of fishing, delivery time, repairs, maintenance, management and administration. Appendix Table EA5 indicates labour is also contributed by family at a rate of 26% of fisher days and this was also included in the imputed labour cost.

Appendix Table EA5: The annual average unpaid and paid days of fishing by businesses in the OTL fishery (Source: RM-ES).

	OTL	**OTL/Others**	**Others**	**All**
No. of Respondents	32	34	34	100
Total Fisher days paid	143	206	211	188
Total fisher days unpaid	117	120	119	119
Fisher unpaid days as % of paid	82%	58%	56%	63%
Family days unpaid	51	28	66	49
Family days unpaid as % of paid fisher days	36%	14%	31%	26%

For example if the fisher's partner or family member works for less than the imputed pay rate, and the operators earn a satisfactory return, then the imputed wage calculation is possibly unreasonable (Standen, 1972; ABARE, 2000). Fishers may take less wages than the imputed rate to keep the business operational, in the face of alternative earning opportunities. Opportunity costs of capital can be forgone, as can depreciation, with fishers hoping to keep current assets operational beyond their envisaged lifespan, or to locate a second hand vessel if a replacement is required.

In discussing efficiency and farmer welfare in the NSW farming sector, Standen (1972) noted that replacement cost based measures for depreciation and off-farm imputed earnings may be invalid measures of opportunity costs of these resources in the rural industry context, tending to overstate off-farm benefits. For some fishers the opportunity costs for labour outside fishing may be close to zero, or if pensionable age, social security payments of up to approximately $10,000 per annum. Commonly fishers indicate they forgo payment for lifestyle and autonomy**.** This may even extend to short-term periods where fishers forgo wages, cease fishing or move to other industries until fishing improves. This substitution between fishing and other industries is likely an efficient strategy for fishers to remain in fishing in the long-term.

There are also impediments to fishers exiting the fishing industry. Lack of marketable fishing rights with restrictions on transferability, limit the sale of fishing licenses. Exiting the industry also involves outlays on transport, food and lodgings incurred during an industry transfer period. The prospect of false starts in new employment also restricts exiting and the psychic costs of changing occupation and place of living. The fishers in the OTL fishery maybe identify with the following quote made in respect of NSW Dairy Farmers:

"If higher incomes are available only with a change in employment or location, then strong attachment to present positions could mean that the individuals would not be better off in the alternative positions" (Standen, 1972).

The current analysis does not attempt to value these non-pecuniary values of going fishing and few other economic studies attempt this.

Conclusions

Long run economic surplus exists for 28% of OTL fishing businesses examined, being greatest in the fishing businesses operating in other fisheries. The OTL fishing businesses fishing in other fisheries had an average economic rate of return to capital of 5%. The OTL and OTL/Other businesses had negative net economic returns of -11% and -18%

respectively, which are indicators of rent in the fishery, providing conditions for sustainable stocks, capital capacity, prices of fish and inputs, and the management structure of the fishery are all met (ABARE, 2000; p16). The average net returns was –4%, the median being 1%, with 50% of all OTL businesses having less than 1% net return.

The long-term viability of the lowest half of OTL fishing businesses is questionable, but has to be interpreted within the context of seasonal and part-time nature of fishing operations in the fishery, and the concept of the rural lifestyle and impediments to altering that lifestyle as previously discussed. The median rate of net return is 1% to capital, indicating half the businesses were below this rate of return in the 1999-2000 financial year. Many of these fishers indicated that in the survey period, refit or breakdown had impaired their fishing performance leading to costs and limited income.

The current survey results shed light on IPART's previous finding that "70% of fishers will encounter problems in their capacity to pay higher management charges" (IPART, 1998 p 63). Many operators will have difficulty in meeting additional management or additional restructuring costs, as reported in the OTL assessment.

Economic return, national income and licence values

The economic survey if representative of industry indicates that 49% of businesses interviewed are contributing to the local, state and national economy in terms of economic profit – ie. producing an economic surplus.

Imputed fish market data indicates low increases in fish price trend at less than 1% per annum, though information on some prices from outside Sydney indicate that higher fish prices may lead to a potential rise in endorsement and business values. Inference as to the price structure of licence trades is not possible due to a lack of licence purchase information.

Other evidence of perceived economic surplus may include the entry of new fishers, which has happened in recent years (see fishers and licence duration in social section), but this may be as much a social phenomenon due to sons of fishers entering, rather than and indicator of fishing prosperity.

Appendix 2: The Social Survey of the NSW Fishery

The available information in NSW was previously limited and relied entirely on the NSWF licensing system. Recognising this, a social survey was undertaken by telephone in May 2001 (RM-SS). The social survey had 870 replies from 1,751 fishing businesses contacted in NSW as reported in Appendix Box 2.

Appendix Box 2: The response rate for the NSW social telephone survey (Source: RM-SS).

	Frequency	%
Completed questionnaires	870	50%
No reply	115	7%
Engaged	36	2%
Unobtainable	136	8%
Appointments	59	3%
Repeated calls (6)	78	4%
Total unable to contact	424	24%
Refusals	278	16%
Terminations	179	10%
Refusals/terminations	457	26%
Total	**1,751**	**100%**

The response rate across all fishers in NSW was 50%. These figures compare well with the telephone survey of Queensland fishers (Fenton and Marshall, 2001), though there are 26% of refusals/ terminations and approximately 24% of fishers were unable to be contacted.

Some 10% of interviews were terminated, usually due to language problems during the interview (Roy Morgan, 2001a). The completed interview results may not adequately reflect fishers from non-English speaking backgrounds. Approximately 16% of fishers declined to participate in the survey.

Of the total statewide replies, 384 replies (44.1%) were from Ocean Trap and Line endorsement holders who constitute 39.7% of all endorsement holders statewide. Of 384 OTL endorsement holders responded, 310 (81%) had been fishing in the previous 12 months. Data records show there are 654 OTL businesses in the OTL fishery and 409 (63%) went fishing in 2001-2002. The sampled fishers are more active than the endorsed population.

Appendix 3: Fisher Community Profile of Commercial Fishers in NSW

There has been no previous attempt to present a fishing community profile of the NSW Fishing Industry. The relevant social data of fishers in NSW was obtained from the ABS statistics via the Bureau of Rural Science Social Science unit and the numbers of commercial fishers in NSW from NSW Fisheries records. These are reported in Table EA6.

Appendix Table EA6: Social index data for NSW Fishing communities at the postcode level (Source: ABS, 1996 /BRS and NSWF).

Zone	Home District	P. code	Town/Suburb	No. Fishers	Total Population	Unemployed (%)	SEIFA	Med. Ind. Income (wk)	Employed in C.F. (%) of labour force
1	TWEED	2485	TWEED HEADS	22	8,978	20.0	893	200-299	0.3
1	TWEED	2486	TWEED HEADS/BANORA POINT	22	24,984	14.4	953	200-299	0.41
1	TWEED	2487	CHINDERAH/OTHERS	19	7,976	16.2	921	200-299	0.41
1	RICHMOND	2472	BROADWATER/CORAKI	10	1,761	19.5	919	200-299	1.02
1	RICHMOND	2473	EVANS HEAD	25	2,613	16.8	900	160-199	1.02
1	RICHMOND	2478	BALLINA/OTHERS	52	24,184	13.7	972	200-299	0.52
2	CLARENCE	2460	LAWRENCE/OTHERS	24	29,145	14.8	951	200-299	1.212
2	CLARENCE	2463	MACLEAN/OTHERS	96	6,072	16.2	946	200-299	4.46
2	CLARENCE	2464	YAMBA/OTHERS	64	5,340	17.1	954	200-299	4.46
2	CLARENCE	2466	ILUKA	65	1,863	18.6	891	160-199	4.46
2	CLARENCE	2469	WOOMBAH/OTHERS	10	933	27.2	854	160-199	1.02
3	COFFS HARBOUR	2448	NAMBUCCA/OTHERS	18	8,690	19.1	927	160-199	0.8
3	COFFS HARBOUR	2450	COFFS HARBOUR	52	32,488	15.8	971	200-299	0.24
3	COFFS HARBOUR	2456	WOOLGOOLGA/URUNGA	20	11,848	20.5	944	200-299	0.46
3	COFFS HARBOUR	2462	WOOLI/OTHERS	20	2,599	20.0	917	160-199	1.19
3	HASTINGS	2431	SOUTH WEST ROCKS	33	3,965	18.6	926	160-199	0.78
3	HASTINGS	2440	CRESCENT HEADS/OTHERS	20	23,164	19.3	916	200-299	0.78
3	HASTINGS	2444	PORT MACQUARIE	37	34,162	15.2	966	200-299	0.48
4	MANNING	2427	HARRINGTON/COOPERNOOK	24	1,473	18.0	883	160-199	0.71
4	MANNING	2430	TAREE/OTHERS	35	28,312	14.0	950	200-299	0.71
4	MANNING	2443	LAURIETON/OTHERS	21	8,093	20.6	909	160-199	0.595
4	WALLIS LAKE	2423	BUNGWAHL/OTHERS	17	3,247	14.5	939	200-299	2.78
4	WALLIS LAKE	2428	FORSTER/TUNCURRY/OTHERS	88	19,457	15.1	939	200-299	2.78
4	PORT STEPHENS	2301	NELSON/SALAMANDER BAYS/OTHERS	27	25,046	11.1	997	200-299	1.04
4	PORT STEPHENS	2315	NELSON BAY/OTHERS	54	8,393	14.3	966	200-299	1.04
4	PORT STEPHENS	2324	TEA GARDENS/OTHERS	20	19,123	13.6	937	200-299	1.91
4	HUNTER	2280	BELMONT/OTHERS	10	22,225	10.5	989	200-299	0.05
4	HUNTER	2281	SWANSEA/OTHERS	15	11,349	14.3	935	160-199	0.05
4	HUNTER	2295	STOCKTON/OTHERS	12	5,058	12.8	918	200-299	0.555
4	HUNTER	2304	MAYFIELD/WARABROOK	18	13,925	17.6	890	200-299	0.07
4	CENTRAL COAST	2250	ERINA/OTHERS	10	57,810	7.7	1025	300-399	0
4	CENTRAL COAST	2251	AVOCA BEACH/OTHERS	11	29,370	8.5	1032	200-299	0
4	CENTRAL COAST	2256	WOY WOY/OTHERS	12	14,168	11.1	941	200-299	0
4	CENTRAL COAST	2257	EMPIRE BAY/OTHERS	10	25,326	11.6	957	200-299	0
4	CENTRAL COAST	2261	BERKELEY VALE/OTHERS	19	32,623	14.1	935	200-299	0
4	CENTRAL COAST	2259	MANNERING PARK/TACOMA/OTHERS	40	46,846	10.6	972	200-299	0
5	HAWKESBURY	2083	MOONEY MOONEY	12	1,450	5.7	1042	300-399	0
5	HAWKESBURY	2775	SPENCER	18	930	9.2	967	200-299	0
5	SYDNEY	171400	SYDNEY NORTH & SOUTH	189	3,276,207	7.3	1047	300-399	0
6	ILLAWARRA	2500	WOLLONGONG	10	32,326	12.6	998	200-299	0.1
6	ILLAWARRA	2502	PRIMBEE/OTHERS	10	13,000	18.9	847	160-199	0.1
6	ILLAWARRA	2506	BERKELEY	18	6,653	19.0	827	160-199	0.1
6	ILLAWARRA	2533	KIAMA	12	13,553	7.6	1067	200-299	0.23
6	SHOALHAVEN	2540	GREENWELL POINT/OTHERS	59	24,208	18.2	933	160-199	0.81
6	SHOALHAVEN	2541	NOWRA/OTHERS	16	29,663	12.0	957	200-299	0.81
7	BATEMANS BAY	2536	BATEMANS BAY/OTHERS	32	14,335	15.5	970	200-299	1.175
7	BATEMANS BAY	2537	MORUYA/OTHERS	10	9,002	18.2	960	200-299	1.54
7	BATEMANS BAY	2539	ULLADULLA/OTHERS	63	11,499	17.4	942	160-199	0.81
7	MONTAGUE	2546	NAROOMA/OTHERS	53	8,135	15.9	955	160-199	1.54
7	FAR SOUTH COAST	2551	EDEN	61	3,726	12.1	916	200-299	2.56
			Total	**1615**					

Explanation of Relevant Social Data for NSW Fishing Postcode Areas.

The data contained within Appendix Table S1 has been acquired from the Australian Bureau of Statistics (ABS) Housing and Population census 1996. The data on zones, districts, postcodes and fishers numbers is from NSWF.

Population -The total population is for the postcodes as in the 1996 census data (ABS, 1996).

Unemployment -Unemployment is the proportion of the labour force seeking either part-time or full-time employment, expressed as a percentage at postcode level from the 1996 census data (ABS, 1996).

SEIFA Index of Disadvantage - The Australian Bureau of Statistics (ABS) developed the Socio-Economic Index for Areas (SEIFA) of relative disadvantage from the 1996 population census. Areas with the greatest disadvantage have high proportions of low income families, unemployed people, people without educational qualifications, households renting public housing and people in low-skilled occupations. The SEIFA score for Australia as a whole is standardised at 1,000. Australia's non-metropolitan average is 972, so, a SEIFA[14] score of 941 (as is the case with Woy Woy/others), which is 31 points lower than Australia's non-metropolitan average, would indicate the town's residents are more disadvantaged than most of non-metropolitan Australia.

Weekly Median Individual Income - The ABS' 1996 housing and population census derives information about individual income from income categories. The median income is that income category that splits the population, ie. it refers to the category where 50 percent of the population from an area selected area has income categories either above or of the same category as the median. For example, in Spencer, 50 percent of the population earned between $0 and $299 per week and 50 percent earned $200 or more per week. Sydney's median individual income ($300 - $399) is one of the highest in this sample, compared to Wooli's in the Coffs Harbour district, which is one of the lowest ($160 - $199).

Employment in Fishing -Employment[15] in the fishing industry has been expressed as a percentage of the Total Labour Force (TLF). For example, 2.78 percent of Forster/Tuncurry's labour force is employed in commercial fishing. The commercial fishing category includes all of the following possible sub-categories: Rock lobster fishing; Prawn fishing; Finfish fishing; Squid jigging; Line fishing; Marine fishing; Marine fishing undefined; Aquaculture; and Commercial fishing undefined.

The data in Appendix Table S1 is for postcodes with more than 10 NSW commercial fishers. This means that 1,615 fishers from a total of 1,920 are included in the analysis. The other 305 live in postcodes areas with less than 10 fishers are omitted. This should be borne in mind in the analysis of results.

Maps of ABS data on unemployment, SEIFA index, employment in commercial fishing and weekly average income from the national census are reported in Appendix H4.

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[14] "The ABS does not supply SEIFA values at the post code level. Supply options are at the level of the Statistical Local Area (SLA) or census Collection District (CD). To present SEIFA values at the postcode level it was necessary to calculate a mean score from all SLAs that intersected the post code in question. While this method results in an estimated SEIFA value for postcodes, it can be regarded as a fairly accurate estimation because SEIFA scores are strongly correlated with local geography" (BRS, 2001).

[15] "The BRS do not have a NSW data set on employment in commercial fishing at the postcode level. Data is at the SLA level. For consistency, the data is again presented at the postcode level by calculating a mean score from all SLAs that intersected the post codes. Again, it is considered that this is fairly accurate estimation given the circumstances of local geography" (BRS, 2001).

APPENDIX B4

ASSESSMENT OF IMPACTS ON HERITAGE AND INDIGENOUS ISSUES

(UMWELT [AUSTRALIA] PTY LTD)

NSW Fisheries

Ocean Trap and Line Fishery Management Strategy – Assessment of Indigenous Issues and Historic Heritage Issues

June 2004

Umwelt
Environmental Consultants

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PART 1

APPENDICES

Foreword

This report addresses potential interactions between the ocean trap and line commercial fishery and the cultural heritage values of marine waters.

Part 1 of the report addresses Aboriginal cultural heritage and community values.

Part 2 of the report deals with historic heritage, and particularly with the interaction of ocean trap and line activities with shipwrecks that are distributed along the NSW coast.

Each Part provides background information to describe the nature of relevant cultural resources and values, considers the management objectives and actions that are identified in the draft Ocean Trap and Line Fishery Management Strategy, and provides recommendations for the future sustainable management of the ocean trap and line fishery in relation to these values.

Executive Summary: Indigenous Issues

This assessment addresses six issues as required by the DIPNR Environmental Assessment Guideline.

1. The interests of Aboriginal people in the resources and habitats targeted by the Ocean Trap and Line Fishery

Many Aboriginal people in regional coastal communities of NSW express the view that ocean fishing is part of their cultural identity. Most often, the fishing that is described is inshore fishing, based on beaches or rock platforms, although there is no doubt that some people also fished the ocean from canoes in traditional times and continued this tradition as ocean fishing from small boats in contemporary times. This fishing is for subsistence and socio-cultural purposes. People fish to feed their families, but also to meet obligations for looking after other people in their community, either as part of daily routines, or for special events such as funerals. Aboriginal Elders still pass on stories and information about places and species of traditional importance to their children and grandchildren.

During consultation that has been conducted for this project and other recent research on Indigenous fishing, Aboriginal people have consistently reported:

- strong interests in rights to access ocean resources (including a sense of 'ownership' of the seas and their products);
- strong interests in the sustainability of ocean fisheries, drawing on a belief that in the past, Aboriginal people fished for what their families needed, but always left some to ensure that they could come back again in the future;
- that transfer of traditional ecological knowledge from one generation to another is culturally important and is dependent on access to fishery resources extending beyond the concept of recreational fishing; and
- interests in the well being of particular species.

When discussing commercial fishery management, Aboriginal community respondents did not differentiate clearly between one commercial fishery and another, and there was a tendency to bundle all commercial fishery issues up together (eg people commented on pipi restrictions, oysters, abalone and estuarine fishery species as well as ocean species).

2. Sites and Places of value to Aboriginal communities

The physical evidence of past ocean fishing practices is (poorly) preserved in midden sites on headlands and behind ocean beaches along the NSW coast. There is minimal risk that the operation of the commercial Ocean Trap and Line fishery will impact on these archaeological sites. Some Aboriginal communities (such as Yarrawarra) have documented places of contemporary value, where social activities associated with fishing have occurred within memory and continue to occur. The documentation of these places helps to understand the relationship of local communities to the natural landscape. As with archaeological sites, there is minimal risk that these places of value will be impacted by the operation of the commercial Ocean Trap and Line fishery.

There are stories from communities right along the coast of Aboriginal people having a special relationship with dolphins; of women and men calling to (sometimes singing) dolphins from beaches and headlands. On the south coast, this extends to historical accounts of collaboration of Aboriginal people and dolphins in whale hunting and driving fish species close to shore where they could be caught. The operation of the Ocean Trap and Line fishery will not impact on these values.

3. Potential impacts on traditional fishing practices and access

Schnierer and Faulkner (2002) document the results of consultation with Aboriginal people in coastal communities in NSW, about species targeted by Aboriginal fishers, and the ways in which they utilise aquatic resources for food, medicines and other parts of their daily lives. The research also provides information about the reasons for fishing. It is these reasons, and particularly the cultural identity of Aboriginal fishing, which separate the fishing activities reported by Indigenous people from other fishing in the general community.

Eighty-one per cent of respondents noted that they fished either to supplement their family's diet or to share with their extended family (especially Elders). However, whilst these subsistence/dietary reasons for fishing are clearly important and continue traditional practices, other reasons for fishing indicate particular characteristics of Indigenous fishing that distinguish it from fishing by other groups in the community. These reasons are directly linked to community ties to the land and water 'country' and the passing on of traditional cultural knowledge. No other groups have the cultural ties to the land and water that Aboriginal people express.

The existence of commercial ocean fisheries does not in itself detract from Aboriginal access to traditional fisheries. Community members believe, however, that the low representation of Aboriginal people in the commercial sector, the regulation of the commercial fishery and the imposition of strict bag limits for non commercial fishers disadvantages them and conflicts with traditional fishing customs.

4. Aboriginal participation in the commercial Ocean Trap and Line Fishery

No Aboriginal people currently appear to hold a commercial licence in the Ocean Trap and Line Fishery and there appears to be little direct engagement between Aboriginal people and the commercial Ocean Trap and Line sector. People state that they do not participate because they do not have the capital to invest in commercial vessels and equipment and traditional skills have been lost over generations of disadvantage.

During consultation, Aboriginal people have expressed strong views that the wealth generated from use of marine resources (including, but not restricted to the Ocean Trap and Line Fishery) does not accrue fairly and that Aboriginal people have been disadvantaged in their participation in the commercial sector. Some people argue that there has been a cumulative loss of rights as licensing requirements have changed.

5. Interaction of the Ocean Trap and Line Fishery and the Indigenous Fisheries Strategy

The Indigenous Fisheries Strategy (IFS) was released in 2002 after consultation with Aboriginal communities at several regional meetings. The Implementation Plan that accompanies the Strategy identified actions for 2003 and 2004, and the progress towards priority actions is monitored by the Indigenous Fisheries Advisory Committee.

The development of mechanisms to maintain and enhance Indigenous participation in the commercial fishing sector generally is a very high priority for the Indigenous Fisheries Advisory Committee, and was the subject of a workshop to develop an action plan during 2003 (see Callaghan and Associates 2003).

Whilst it should not be anticipated that the issue of Aboriginal employment and Aboriginal ownership in the commercial sector can be resolved through the Ocean Trap and Line FMS alone, commercial fishers and the Indigenous community should both participate in discussions about potential changes to the *Fisheries Management Act* and the potential introduction of programs to enhance Indigenous capacity to enjoy their rights to economic independence.

Potential actions, that are still being refined through further consultation within and by the Indigenous Fisheries Advisory Group include:

- filling a number of positions for Indigenous people on Fishery Management Advisory Committees (note for instance that there is currently no Aboriginal person on the Ocean Trap and Line Management Advisory Committee);
- consultation with Aboriginal people about the concept of identification of Indigenous commercial fishers on their licences (and whether Indigenous fishing licences could have special conditions attached to them);
- endorse the goal of retaining Indigenous people in commercial fishing and demonstrate this through investigating options for licence transfers, sub leasing of licences, and assistance with gaining new licences;
- training for Aboriginal fishers, both to enhance employment prospects as crew and to support operations as licensed fishers; and
- consider new structures and any special training for involving Aboriginal people in Management Advisory Committees, potentially using the models described in the Boomanulla Statement.

6. Overall risks to Indigenous values associated with the operation of the commercial Ocean Trap and Line Fishery

Table 1 presents a simple qualitative assessment and ranking of risks to Aboriginal values that are associated with the continued operation of the Ocean Trap and Line Fishery.

Table 1 - Summary of Risks to Indigenous Values, with FMS Strategies in place

Broad issue/value	Risk – existing management	Risk – FMS strategies implemented
Aboriginal sites – the physical evidence of past Aboriginal land use	Low (low probability and low consequence)	Very low/minimal (very low probability and low consequence). It is most unlikely that the Ocean Trap and Line fishery will impact on Aboriginal sites on the deep sea floor.
Aboriginal places – the locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world	Low	Low. Whilst some headlands and islands are known to be places of cultural value, often associated with stories, there is limited potential for Ocean Trap and Line activities to impact on these places. Further involvement of Aboriginal people in the fishery MAC will minimise this risk.

Table 1 - Summary of Risks to Indigenous Values, with FMS Strategies in place (cont)

Broad issue/value	Risk – existing management	Risk – FMS strategies implemented
Aboriginal marine totem species	Moderate	There is limited detailed documentation about Indigenous totem species in the NSW marine environment and the significance of impacts on/risks to these values is therefore difficult to determine. Whilst there can be no doubt that some totem species are target species in the commercial fishery, the extent of concern to Aboriginal people needs further clarification. Initial steps to reduce risk involve further consultation with Aboriginal people, particularly Elders.
Aboriginal cultural landscapes – the places and species in the landscape that are important to Aboriginal people. As a separate issue from Aboriginal places, this refers to the presence and distribution of Aboriginal foods and medicines in the marine landscape	Low to moderate	Low – risk will be reduced as better information about species of concern to communities along the whole coast become better documented and Indigenous participation in fishery management is enhanced.
Aboriginal socioeconomic participation in the commercial fishing sector	Moderate – currently very low participation	Low to moderate – the strategy may facilitate enhanced opportunities for economic participation and skill development, in association with the actions that are priorities in the Indigenous Fisheries Strategy and are further explored in the Indigenous Commercial Fishing Opportunities Action plan. Adoption of key recommendations of the Indigenous Fisheries Advisory Committee will help to open up opportunities and reduce the risk that commercial fishing strategies present to Indigenous rights.

Executive Summary: Historic Heritage

This assessment addresses two specific issues, as required by the DIPNR Environmental Assessment Guideline:

(a) Identify any shipwreck sites or other sites of historic heritage that are affected by fishing activities and outline existing (and proposed) protocols/measures to minimize impacts to these sites.

(b) Summarise the overall risk to European heritage sites from the current and proposed operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

The Nature of Historic Heritage Evidence

Approximately 1100 shipwrecks appear to be located within New South Wales non-estuarine coastal waters. Of these approximately 260 are recorded offshore of the coastlines of the Northern Rivers, Mid North Coast, Illawarra and South East regions of the total New South Wales coastline.

A key constraint to the accurate assessment of risk is that details about the locations and condition of many shipwrecks are poor. It is difficult to pinpoint the locations of these wrecks, or the amount of wreckage that may still remain, with any certainty. For many wrecks, only limited, broadly descriptive information is available, and the extent to which parts of the wreck may be exposed to snagging on nets etc is difficult to determine. The condition of a shipwreck will depend on the nature of the vessel (size and type of construction), depth of water, circumstances that caused the wreck, subsequent disturbance, and marine processes such as waves, currents and sediment transport. For many shipwrecks, little of this information is known directly.

Almost all the shipwrecks along the NSW coast are protected by either the Commonwealth heritage legislation (*Historic Shipwrecks Act*) or by the *NSW Heritage Act*. For example, of the 260 or so shipwrecks identified in the Northern Rivers, Mid North Coast, Illawarra and South East regions of the coast, less than twenty shipwrecks do not have protection under either the Historic Shipwrecks or NSW Heritage Acts.

Potential Risks to Historic Heritage

In broad terms, the potential risks to historic heritage derive from the following aspects of the operation of the fishery:

- direct impacts by vessels on shipwrecks; and

- fishing gear becoming snared or entangled on parts of shipwrecks and affecting the integrity of the heritage structure. In this case, there is also a risk to the safety of licensed fishers and their crew if gear is not easily disentangled from the shipwreck. There are a number of instances of damage to or sinking of vessels after nets became snared on shipwrecks.

These risks are qualitatively assessed in **Table 2**.

Table 2 - Qualitative Risk Assessment Considerations

Aspect	Likelihood	Consequence	Risk
Vessel navigation – collision with shipwrecks	Unlikely to rare	Moderate	Low
Entanglement of lines in shipwrecks	Possible	Very Low	Low

The risk presented to historic shipwrecks by the activities of the ocean trap and line fishery is low. In this context, the types of response that are appropriate in the Fishery Management Strategy relate to procedures for monitoring (for instance locations, frequency and consequence) and reporting incidents.

The draft Fishery Management Strategy requires that fishers respond to new information about heritage resources. Ocean Trap and Line fishers may from time to time encounter shipwreck remains on the sea floor. Although the risk that ocean trap and line activities will detrimentally impact on historic heritage resources is very low, the operation of the ocean trap and line fishery does present an opportunity to further reduce risks in the long term by contributing to improved spatial data about the locations of shipwrecks.

Fishers will report location (GPS co-ordinates, water depth) and any other information they detect about the structure to the NSW Heritage Office and NSW Fisheries. This information will add to the data base, so that fishers can be alerted about potential obstacles on the sea floor (with heritage and safety implications), and the Heritage Office will have more accurate information about the location of shipwrecks.

A second appropriate management response is to provide licence holders with basic information about their responsibilities under the *Heritage Act*, including the provisions relating to damage to structures, exclusion zones and collection of any historic artefacts that may be observed.

The *Heritage Act* requires that relics not be disturbed without obtaining a permit. In rare cases, this would mean that fishing in the vicinity of a structure that has been reported to the Heritage Office should cease until the nature and significance of a relic has been investigated and confirmed.

PART 1

1.0 INTRODUCTION

NSW Fisheries is currently preparing a Fishery Management Strategy for the Ocean Trap and Line sector of the commercial fisheries of NSW. Concurrent with the preparation of the Fishery Management Strategy, NSW Fisheries is required to prepare an environmental impact statement to accompany a Part 5 development application for the continuation of the fisheries.

The Ocean Trap and Line fishery extends from the NSW coastline seaward to the 4,000 metre isobath (approximately 60 to 80 nautical miles offshore). It is a multi-method, multi-species fishery using demersal fish traps and numerous line methods to target demersal and pelagic fish along the NSW coast. The fishery also includes the taking of spanner crabs by nets (dillies) north of Korogoro Point (near Hat Head). Other commercial fisheries and the recreational fishery also target many of the species important to the fishery. Around 200 species are taken in the Ocean Trap and Line fishery with the main species targeted being spanner crab, snapper, yellowfin bream, rubberlip morwong, bonito, yellowtail kingfish, blue-eye, bar cod as well as school and gummy sharks.

At January 2004, NSW Fisheries licensing database showed that 520 fishing businesses held entitlements to operate in the Ocean Trap and Line fishery. The number of operators in the fishery, however, constantly varies due to a number of factors including the transfer and amalgamation of fishing businesses and late payments on renewal of fishing licences.

1.1 SCOPE AND REQUIREMENTS OF THE INDIGENOUS ISSUES ASSESSMENT

This assessment has been conducted to address the requirements of the Department of Infrastructure, Planning and Natural Resources (DIPNR) as set out in Part B, Section 5.3 and Part E, Section 4.3 of the EIS Guideline for the Environmental Assessment of the fishery.

Part B, Section 5.3 requires:

(a) identify the interests of Indigenous people in the resources harvested by the fisheries and in the habitats that may be impacted by the fisheries;

(b) identify any important Aboriginal heritage sites/places likely to be affected by fishers operating within the fisheries and outline any existing protocols/measures that aim to minimise risk of harm to these sites;

(c) outline whether the fisheries affect traditional fishing and access to fisheries resources, and if so, how this occurs;

(d) identify the involvement of Indigenous people in the existing commercial fisheries;

(e) describe NSW government policies and strategies on Indigenous fishing, including the NSW Indigenous Fisheries Strategy; and

(f) summarise the overall risk to Indigenous people from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts.

Part E, Section 4.3 requires:

Identify the impacts of the draft Fishery Management Strategy on:

(a) the interests of Indigenous people in the resource harvested by the fisheries and in habitats that may be impacted by the fisheries;

(b) any important Aboriginal heritage sites/places likely to be affected by fishers operating within the fisheries;

(c) traditional fishing and access to fisheries resources;

(d) involvement of Indigenous people in the existing commercial fisheries;

(e) government policies and strategies on Indigenous fishing, including the NSW Indigenous Fisheries Strategy; and

(f) summarise the overall risk to Indigenous people from the management measures in the draft FMS, taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

1.2 ASSESSMENT METHOD - INDIGENOUS CULTURAL HERITAGE AND COMMUNITY ISSUES

The aim of this assessment is to identify the ways in which the operation of the trap and line fishery in NSW interacts with the values of Indigenous people, and to determine the extent to which the draft Ocean Trap and Line Fishery Management Strategy (FMS) addresses any significant impacts or issues that arise from that interaction.

The Indigenous values that are taken into consideration include:

- Aboriginal sites – the physical evidence of past Aboriginal land use;
- Aboriginal places – the locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world. Aboriginal places may also be associated with historic settlements or events;
- Aboriginal cultural landscapes – the places and species in the landscape that are important to Aboriginal people. As a separate issue from Aboriginal places, this refers to the presence and distribution of Aboriginal foods and medicines in the coastal and marine landscape;
- Aboriginal cultural practices and the maintenance of Traditional Fishing Knowledge (TFK); and
- Aboriginal socioeconomic participation in the commercial fishing sector.

The assessment draws on two principal types of information:

- a review of literature that describes historical and contemporary Indigenous community marine fishing practices, the cultural importance of marine/coastal landscapes and their resources, and Indigenous involvement in the commercial fishery sector; and

- conversations with Indigenous people, including members of coastal Aboriginal communities. Local Aboriginal Land Councils and members of the NSW Fisheries Indigenous Advisory Group about community fishing practices and issues.

Although there have now been several detailed local studies of cultural resources in coastal areas of NSW, the information about the relative and absolute cultural value of Indigenous community fishing is still patchy. The study process commenced with invitations to all Aboriginal communities along the NSW coast to contribute their stories, experience and suggestions for improved management of these ocean fisheries.

Introductory information about the Ocean Trap and Line Fishery was forwarded to each Local Aboriginal Land Council along the coast, together with the invitation to contribute to the project, either as individuals or as a group. A copy of the background information is included in **Appendix 1**. This background information and invitation resulted in minimal community response.

After two follow up phone calls to most Land Councils, the response from Land Councils continued to be minimal.

The members of the Indigenous Fisheries Strategy (IFS) Advisory Committee, including the Chairperson, who come from coastal areas were also contacted. As a result of conversations with the IFS Working Group Chairperson, additional conversations were held with a small number of Indigenous commercial fishers on the north coast. It should be noted that Indigenous people appear to be very poorly represented in the Ocean Trap and Line sector, and the experience of most Indigenous commercial fishers is in the Estuary General, Estuary Prawn Trawl or Beach Haul fishery sectors.

The consultation process used in this project has drawn some important information from Indigenous people with knowledge of the fishing practices and participation. This information confirms that Aboriginal communities value marine habitats and individual fish, bird, whale and dolphin species. However, it appears that community access to marine resources has traditionally and historically been restricted to the beach, rock platforms and nearshore areas (sandy and rocky reefs), with limited experience of offshore areas.

Whilst it is tempting to suggest that the low response rate from Aboriginal communities reflects their focus on nearshore rather than offshore marine resources, this is unlikely to be the full or even the main reason. Other factors that need to be taken into account and that should be addressed in future consultation between NSW Fisheries and the Indigenous community about the management of coastal fishery resources include:

- high demand for Aboriginal communities to participate in diverse ‘consultation’ programs sponsored by many different organisations, but broadly relating to natural resource issues. Members of the Aboriginal community who have offered comments, have indicated that they are over-consulted (in terms of time and events), but rarely in a context where they feel that their comments will make a real difference;

- a strong community preference for face to face discussion (ie verbal presentations and discussion opportunities), where people can share ideas and feedback rather than a more remote, written consultation process. Regional face to face meetings with culturally defined groups should be the minimum level of consultation;

- an ongoing distrust of NSW Fisheries in relation to the management of broader aspects of Indigenous community fishing practices, involvement and exclusion;

- confusion about the different fishery sectors – for instance the difference between the ocean trap and line, and ocean trawl sectors. The experience of individuals who did respond was largely of the nearshore fishery areas; and

- the (as yet) poorly developed feedback mechanisms for input to the assessment process for Fishery Management Strategies generally, so that representatives of local Aboriginal communities can see how the information or ideas that they have provided have been used or adapted in the assessment and management process. Clearer feedback will give communities confidence that their effort in providing input is worthwhile. It is anticipated that the activities of the Indigenous Fisheries Strategy Advisory Committee will greatly improve two way communication and networking about Indigenous issues in fishery management. Nonetheless, a participation program for each Fishery Management Strategy and EIS that allows regional communities to see the outcomes of their input (before the FMS is approved) is desirable.

1.3 STRUCTURE OF THIS REPORT

The assessment report has four main sections:

Section 1 outlines the requirements of the brief and the approach to the assessment process.

Section 2 reviews the literature and community information about Indigenous community fishing in ocean waters, and the values that local Aboriginal communities attribute to places and species. The information in this section highlights the importance of inshore fishing as part of the seasonal round of subsistence and cultural activities within coastal Aboriginal communities. This section also documents the very low level of current Indigenous community participation in the Ocean Trap and Line fishery.

Section 3 considers the existing and proposed frameworks for managing Indigenous community participation in the management of the Ocean Trap and Line fishery, with particular reference to the actions that are proposed in the Indigenous Fisheries Strategy Implementation Plan (NSW Fisheries 2002a) and the Indigenous Fisheries Advisory Group workshop report on 'Developing the Participation of Indigenous People in Commercial Fishing' (2003). This section reviews the objectives and actions proposed in the FMS with those set out in the IFS (and developed in consultation with regional Aboriginal communities). It also considers the relevance of actions from the Draft Plan for Engagement and Retention of Indigenous People in NSW Commercial Fishing Ventures (Indigenous Fisheries Advisory Committee 2003).

Section 4 assesses the risks to Indigenous values associated with the implementation of the Ocean Trap and Line Fishery Management Strategy. This section suggests measures both to further reduce risks to Indigenous community values and to support progress towards the achievement of Indigenous community objectives for further skill development and participation in commercial fisheries.

It is important to note that many of the issues raised by Aboriginal people will be resolved by further implementation of the IFS and further refinement of NSW Fisheries policies for Indigenous participation in the management of commercial fisheries. The Ocean Trap and Line FMS can support and implement measures to address Indigenous community concerns about fishery management generally, but is not the primary policy tool for managing Indigenous participation.

2.0 INDIGENOUS PERSPECTIVES ON THE MANAGEMENT OF THE RESOURCES AND HABITATS USED BY THE COMMERCIAL OCEAN TRAP AND LINE FISHERY

Section 2 reviews the background information about diverse aspects of Indigenous associations with and rights to marine fishery resources. The review considers archaeological, historical and contemporary data about the utilisation of fishery resources, as well as considering the history of commercial Indigenous fishing in NSW and Indigenous community views about the impact of recent new fishery regulations on their traditional cultural fishing rights and practices. Aboriginal people express strong views about the sustainable management of Aboriginal cultural landscapes. They also express concerns about the loss of traditional fishing rights, in terms of regulation and restriction of access to resources, and the loss, lack or recognition or degrading of traditional skills.

Some of the fishery management issues that have been raised by the Aboriginal community in relation to significant changes to fishery structure have been strategically addressed in the Indigenous Fisheries Strategy (NSW Fisheries 2002a). The IFS recognises the economic and skill disadvantage of many Aboriginal communities and proposes measures to reduce the participation imbalance with other sections of the community.

Section 2.1 reviews some key sources of research information about contemporary Indigenous fishing practices and values.

2.1 CONTEMPORARY INDIGENOUS FISHING PRACTICES AND PREFERENCES

2.1.1 Survey of Recreational Fishing in NSW

Documentation of the contemporary fishing practices, catches etc (whether commercial or cultural) of Indigenous people in NSW is patchy, and many questions remain unanswered. Some information is available from the results of a survey of recreational fishing (NSW Fisheries 2002b), in which data about Indigenous fishing practices was analysed separately from the general population. Fishing households were first contacted by telephone (ie a phone survey) and then encouraged to participate in a diary program where monthly information was collected about fish catches, fishing effort and fishing expenditure. Basic information about each household included household structure and demographic character (including ethnicity).

Of 10,300 households who were sampled by the phone survey in NSW (containing 19,600 people over 5 years of age), 1.4% were Indigenous people. Of 1836 households who participated in the diary program, 1.3% of households (140 households), with 1.7% of people (approximately 330 adults and children), were Indigenous. This is a relatively small sample, given the Indigenous population in NSW and the importance of fishing to Indigenous communities. However, the sample does provide a preliminary indication of some of the characteristics of Aboriginal fishing that distinguish it from other groups. Although this was a recreational fishing survey, it should be noted that most Aboriginal fishers who participated would not have considered that they were fishing for recreational purposes. Rather, Indigenous people consistently report that they are fishing for cultural purposes or subsistence purposes, such as for the reasons noted below and in **Sections 2.1.2, 2.2** and **2.3**.

eg '*Grandfather told me that 2-3 hunters used to go out and take some young to teach and they would catch enough for the full tribe. In amongst that group there would be up to 30 people'*.

(Uncle Doug Pearce, Indigenous Fisheries Forum Group, Yamba)

'*Indigenous fishing is cultural. It's about being a part of the land and water to get back to your roots. We don't look at size of bag limits, we look at what needs to be taken home. If an 8 year old goes and gets a feed and doesn't bring enough back for everyone at home, they are going to get their arse kicked*.'

(Aboriginal interviewee (south coast), quoted in Cozens 2003)

Table 2.1 indicates the results of diary records kept by Aboriginal fishing households as part of the Recreational Fishing Survey.

Table 2.1 - Recreational Fishing Survey, Aboriginal Households

Species Common Name	Kept	Released	Total
Bream – unspecified	*32*	*66*	*98*
Carp	37	1	38
Catfish – freshwater	1	2	3
Catfish – unspecified		6	6
Cod - Murray/Murray perch	4	20	24
Cod - red rock/red scorpion/coral perch		2	2
Cod – unspecified		1	1
Fish – other		12	12
Flathead – unspecified	43	79	122
Flounder/sole/flatfish – unspecified		6	6
Garfish – unspecified	30		30
Gurnard	3		3
Leatherjacket	6		6
Lobster – unspecified	12	11	23
Morwong – blue	0		0
Mullet – unspecified	4	7	11
Mulloway/jewfish/kingfish	3		3
Non-Fish – other	1		1
Perch - golden/yellowbelly/callop	42		42
Perch – pearl	1		1
Perch - redfin/English		1	1
Pike – unspecified		1	1
Salmon - Australian east/ west/ kahawai		1	1
Shark – unspecified	1		1
Snapper - pink/southern/squire	2	13	15
Tailor/chopper/jumbo	9	7	15
Trout – brown		1	1

Table 2.1 - Recreational Fishing Survey, Aboriginal Households (cont)

Species Common Name	Kept	Released	Total
Trout – rainbow	10		10
Whiting -unspecified	10	39	49
Yabbies	7		7
Yabbies/nippers/bass yabbies	40		40
Grand Total	**298**	**276**	**574**

The fishing effort by these fishers over the period of the survey is greater than the average across the state, hinting at the broader Aboriginal community consumption of the catches of Aboriginal fishers. Also of interest is the high proportion of fish that are reported to have been released (close to 50%, and in some cases the majority of the reported catch). The reason for this is not clear from the preliminary statistics, and the high release rate is not consistent with the results of the more detailed surveys of Indigenous fishers in northern Australia (see below), where negligible amounts of the catch were not retained by Indigenous fishers. It is of note that some Indigenous people in NSW report that they have a clear cultural practice of returning small fish.

> *'We know when a fish is too small to eat, chuck him back grow up bigger'*.
>
> (Uncle Doug Pearce, Indigenous Fisheries Forum Group, Yamba.)

This view is not however, expressed consistently across the community, as evidenced by the following comment:

> *'Aboriginal people do not go recreational fishing. When the Wallaga Lads go fishing they go fishing to get a feed. Aboriginal people do not catch fish and kiss them and throw them back, they catch them to eat them.'*
>
> (Aboriginal interviewee (south coast), quoted in Cozens 2003)

2.1.2 A Description of Aboriginal Fisheries in NSW

Schnierer and Faulkner (2002) document the results of consultation with Aboriginal people in coastal communities in NSW, about the ways in which they utilise aquatic resources for food, medicines and other parts of their daily lives. The research draws on the results of 150 questionnaires and multiple interviews with individuals, families and communities. Some of the consultation was conducted during the development of the NSW Indigenous Fisheries Strategy.

The results of the consultation enhance the information available from the Recreational Fishing Survey and provide strong community views not only about which species are targeted, when and how, but also the reasons for fishing. It is these reasons, and particularly the cultural identity of Aboriginal fishing, which separate the fishing activities reported by Indigenous people from other fishing in the general community.

Schnierer and Faulkner (2002) also report on comments by Indigenous people about their current participation in the commercial fishery sector, their concerns about the trends that are evident in participation rates, constraints to improved participation and ideas for how the specific cultural character of Indigenous fishing could be incorporated into commercial fishery management. Whilst these issues and suggested solutions generally relate to the broad concepts of commercial and Indigenous fishing, some are directly relevant to the Ocean Trap and Line fishery.

Schnierer and Faulkner provide a comprehensive list of invertebrate and finfish species that are targeted by contemporary Indigenous fishers, demonstrating the diversity of species of interest. Their Tables 1 and 2 are reproduced below as **Tables 2.2** and **2.3**.

Table 2.2 - Aquatic Invertebrates Targeted by Indigenous Communities in Coastal NSW (Schnierer and Faulkner 2002)

(N = Northern, C = Central, S = Southern, M = Marine, E = Estuarine, F = Freshwater, C = Commercial, R = Recreational)

Common name	Scientific name	Region	Habitat	Fishery
Abalone	*Haliotis ruber*	C,S	M	C, R
Beach worm spp.	*various*	All	M	C, R
Bearded mussel	*Trichomya hirsuta*	All	M	
Bimbla cockles spp.	*various*	C,S	E	
Blue swimmer crab	*Portunus pelagicus*	All	M,E	C, R
Cobra	*Teredo navalis*	N	E	
Eastern king prawn	*Penaeus plebejus*	N,C	E	C
Edible mussel	*Mytilus planulatus*	All	M,E	
Freshwater mussel	*various*	All	F	
Greasy back prawn	*Metapenaeus bennettae*	All	E	C, R
Lobster spp.	*various*	All	M	C, R
Mud crab	*Scylla serrata*	All	E	C, R
Mud oysters	*Ostrea angasi*	All	E	
Octopus spp.	*various*	All	M,E	
Pacific oyster	*Crassostrea gigas*	All	M,E	
Periwinkle spp.	*various*	All	M, E	
Pipi	*Donax deltoides*	All	M	C, R
School prawn	*Metapenaeus macleayi*	All	E	C, R
Sea urchin	*various*	All	M	
Shrimp	*Machrobrachium sp*	All	E,F	
Squid spp.	*various*	All	M,E	C, R
Sydney cockle	*Anadara trapezia*	All	E	
Sydney rock oyster	*Saccostrea commercialis*	All	M,E	C, R
Tapestry cockle	*Tapes watlingi*		E	
Yabby	*Cherax destructor*		F	

Table 2.3 - Fish Species Targeted in Indigenous Coastal Fisheries in NSW (Schnierer and Faulkner 2002)

(N = Northern, C = Central, S = Southern, M = Marine, E = Estuarine, F = Freshwater, C = Commercial, R = Recreational)

Common Name	Scientific Name	Region	Habitat	Fishery
Blue groper	*Achoerodus gouldi*		E	
Dusky flathead	*Platycephalus fuscus*	All	E	C, R
Estuary cod	*Epinephelus coioides*	All	E	
Estuary perch	*Macquaria colonorum*	All	E	R
Flat tail mullet	*Liza argentea*	All	E	C, R
Groper	*Epinephelus lanceolatus*	All	E	
River garfish	*Hyporhamphus regularis*	All	E	C, R
Sand mullet	*Myxus elongatus*	All	E	C, R
Pike eel	*Muraenesox bagio*	S	E	
Fork tail catfish	*Arius graffei*	All	E,F	
Longfin river eel	*Anguilla reinhardtii*	C,S	E,F	C
Shortfin river eel	*Anguilla australis*	C,S	E,F	C
Australian bass	*Macquaria novemaculeatus*	All	F	R
Eel tail catfish	*Tandanus tandanus*	All	F	C, R
Freshwater herring	*Potamalosa richmondia*	N	F	
Pink-eye mullet	*Myxus petardi*	N	F	
Rainbow trout	*Salmo gairdnerii*	N	F	R
Dart	*Trachinotus coppingeri*	All	M	R
Sand flathead	*Platycephalus caeruleopunctatus*	All	M	C, R
Sea garfish	*Hyporhamphus australis*	All	M	C, R
Shark spp.	various	All	M	C, R
Tailor	*Pomatomus saltatrix*	All	M	R
Yellow-tail kingfish	*Seriola lalandi*	All	M	C, R
Australian salmon	*Arripis trutta*	C,S	M	C, R
Drummer spp.	various	C,S	M	R
Samson fish	*Seriola hippos*	C,S	M	
Black bream	*Acanthopagrus butcheri*	All	M,E	C, R
Flounder spp.	various	All	M,E	C, R
Leatherjacket spp.	various	All	M,E	C, R
Luderick	*Girella tricuspidata*	All	M,E	C, R
Mulloway	*Argyrosomus hololepidotus*	All	M,E	C, R
Parrot fish	*Labridae*	All	M,E	
Shovel-nose ray	*Aptychotrema rostrata*	All	M,E	
Silver trevally	*Pseudocaranx dentex*	All	M,E	R
Snapper	*Pagrus auratus*	All	M,E	C, R
Sole spp.	various	All	M,E	C, R
Tarwhine	*Rhabdosargus sarba*	All	M,E	C, R

Table 2.3 - Fish Species Targeted in Indigenous Coastal Fisheries in NSW (Schnierer and Faulkner 2002) (cont)

(N = Northern, C = Central, S = Southern, M = Marine, E = Estuarine, F = Freshwater, C = Commercial, R = Recreational)

Common Name	Scientific Name	Region	Habitat	Fishery
Whiting spp.	various	All	M,E	C, R
Yellow fin bream	*Acanthopagrus australis*	All	M,E	C, R
Butter fish	*Monodactylus argenteus*	N,C	M,E	
Pig fish	*Bodianus sp.*	S	M,E	
Sea mullet	*Mugil cephalus*	All	M,E,F	C, R

The species listed are primarily estuarine and near shore species, many of which are also targeted by recreational fishers and commercial fishers (Estuary General, Estuary Prawn Trawl and Beach Haul). Yellow Fin Bream and Yellowtail Kingfish are also species targeted by the Ocean Trap and Line fishery. The fishing methods documented by Schnierer and Faulkner (2002) highlight both the importance of estuarine species and the ongoing use of 'traditional' methods, albeit sometimes adapted to use more modern technology (eg modern nets rather than traditional small handmade nets).

Responses to survey questions about the frequency of fishing events and the destination of the catch both reinforce views expressed in other discussions about the reliance of Indigenous people on fish and shellfish catches as a significant part of their diet, and the importance of sharing catches with the extended family. Eighty-one percent of respondents noted that they fished either to supplement their family's diet or to share with their extended family (especially Elders). However, whilst these subsistence/dietary reasons for fishing are clearly important and continue traditional practices, other reasons for fishing indicate particular characteristics of Indigenous fishing that distinguish it from fishing by other groups in the community. For instance, many fishers from lower income families fish to supplement their family diet, and several ethnic groups are known to target particular species for food or income or to fish seasonally to take advantage of fish breeding or migratory behaviours.

None of these other groups have the cultural ties to the land and water that Aboriginal people express. The quotes noted below reflect both the subsistence/dietary values of fishing and the cultural values of fishing for Aboriginal people.

> *'Fishing has always been in our family and will continue because it is a main meal for us.'*
>
> *'We catch fish for our Elders and for children to help them with their health.'*
>
> *'Limits set by Fisheries don't take into account how we fish and collect for our communities as well as for ourselves.'*
>
> *'Fishing is for relaxation; family outings; getting a feed of fish.'*
>
> *'It's our birthright to collect seafood and freshwater fish even though we eat white fella food, we still eat our traditional foods (kangaroo, possum, spiny ant eater, salt water and fresh water foods).'*

'I feel it's important that we keep fishing regardless of whether we do it traditional or not, we need to pass our methods down to our children so as we can keep the culture going…. Not forget who we are.'

'Fishing is a tradition and a culture throughout Aboriginal people today – letting the younger generation know of what Aboriginal bush food is.'

'How can we continue on with our cultural right of families visiting, camping and sharing stories, obtaining fish and pipis when we have no access to the special place. These are concerns. The fishing co-ops continue to mine pipis, all sizes are collected, not just like Goories only take what is needed.'

'Recognition of Goorie culture which includes fishing as a means of keeping families.'

Schnierer and Faulkner (2002) highlight two important issues associated with Indigenous involvement in the commercial fishery sector.

They note the competition for resources and ongoing conflicts that have been present since the early days of European settlement along the NSW coast. Historical records of nineteenth century resource exploitation (eg Thompson 1993) highlight the depletion of stocks and environmental degradation brought about as European settlement expanded. An example is the harvesting/mining of oyster beds in estuaries such as the Hunter, Port Stephens, Camden Haven and Clarence where extensive natural oyster reefs were removed during the nineteenth century and have never recovered. Apart from the ecological implications of this change to estuary morphology and species abundance, such practices would clearly have had a dramatic impact on the resources available to Indigenous people. Schnierer and Faulkner (2002) argue that despite the evidence of failed management of fishery resources by European fishers, they have maintained control of the resource, largely to the exclusion or 'marginalisation' of Indigenous people.

The second key issue is the recognition of distinctive Indigenous commercial fishing practices that do not necessarily fit with the general commercial fisher concept. It is argued that failure to recognise these practices as valid commercial activities has led to a decrease in the participation of Indigenous people in the commercial sector generally and created barriers to continuing commercial participation (including fee structures, return requirements, licence transfers and access to training to update skills).

The final quote from an Indigenous commercial fisher (in Schnierer and Faulkner (2002)) highlights the frustrations felt by Indigenous fishers about the management of the commercial sector generally. It is important to note however, that the issues raised link back to the focus of Indigenous fishing on estuarine and beach/nearshore species and are not made in the context of the Ocean Trap and Line Strategy in particular.

'I want to continue supplying the community and the elders with pipis and seafood when I can. Pipis and fish have kept the Aboriginal community in this area going for generations since non-Aboriginal people came here and now it's getting harder for Aboriginal people to get licences to fish these days. Fishing is something that is very important to Aboriginal people and their culture and I would like to stay in business so that the community can at least maintain some involvement in the fishing industry.'

2.1.3 National Recreational and Indigenous Fisheries Survey

Henry and Lyle (2003) report the full results of the National Recreational and Indigenous Fishing Survey. This research report provides a separate analysis of the fishing practices of

Indigenous people in northern Australia. Whilst it cannot be assumed that northern Australian communities (across Western Australia, Northern Territory and Queensland) would have the same fishing practices or specific cultural values as those in southern Australia, the survey results do indicate some very clear distinctions in the focus of fishing effort, particularly between offshore and inshore waters in northern Australia.

It is understood and acknowledged that some Indigenous communities have expressed dissatisfaction with the research methods used in this survey (Schnierer pers. comm.). The study does provide useful baseline statistical data, and highlights areas for further consultation with communities to ensure culturally acceptable processes and outcomes.

Table 2.4 shows the relative fishing effort by water type of Indigenous households across the northern Australia survey area, for 370,000 fishing events that were reported in diary records.

Table 2.4 - Annual fishing effort (events) for Indigenous households in northern Australia (fishers aged 5 years and over)

Type of Waters	% of Fishing Events
Offshore	1%
Inshore	55%
Estuary	15%
Rivers	19%
Lakes/dams	9%

These figures show a very strong focus on marine fish resources, but particularly on those marine resources that can be obtained from land or from small boats close to shore. Although there were reported to be regional variations, it is apparent that very little Indigenous fishing in this survey area is conducted in offshore marine waters. This is reinforced by statistics about whether fishing took place from shore or boat. Overall, some 93% of Indigenous fishing in the study area was conducted from the shore, although 21% of fishing households in Queensland reported fishing from boats.

The survey also provided some information about the method of fishing (i.e. the equipment used). The results show that line fishing is by far the most important (53% of all fishing effort), followed by hand collection (26%) (note that the statistics include shellfish), nets (12%), spear (9%) traps (0.5%) and diving (0.1%). The amount of hand gathering by Indigenous fishers is substantially more than the general recreational fishing population. Hand collection was particularly important in the Northern Territory.

Henry and Lyle (2003) also report the species targeted by Indigenous fishers in northern Australia (see **Table 2.5**).

Table 2.5 - Annual harvest of major fishery groupings by Indigenous people in northern Australia

Fishery grouping	Number harvested (x1000)
Finfish	914
Small baitfish	98
Crabs/lobsters	181
Prawns/yabbies	655
Molluscs	1149
Miscellaneous	93

Within the finfish category, the most frequently caught fish were mullet (almost twice as much as the next most numerous catch), catfish, perch/snapper, bream and barramundi. Seventy-eight per cent of mullet were reported to be taken from inshore waters.

As noted above, these results are not necessarily transferable to southern Australia and there are risks in assuming that cultural practices are the same or that Aboriginal people's fishing activities in southern Australia cannot be adequately explained in cultural terms. However, if the results are considered to be *broadly* indicative of Indigenous community fishing behaviour, then several features emerge that are relevant to the current assessment of the impact of the commercial Ocean Trap and Line fishery in NSW. These include:

- Aboriginal fishers who are not commercial licence holders tend to access marine fish and shellfish species almost entirely in inshore areas, and most often from the beach rather than from boats. The deep water areas (3 kilometres offshore) that are the focus of the Ocean Trap and Line fishery are rarely visited by Aboriginal fishers who are not part of the commercial industry.

  Note that the extent of offshore fishing and its relationship to long documented cultural fishing in estuaries, bays and along beaches and headlands, is not well documented in NSW, and informed management would benefit from further consultation/research in this regard.

- The species most often reported to be caught by Indigenous fishers in northern Australia reflect the habitats in which they most frequently fish. The dominance of mullet in northern Australian catches can be linked to the importance of beach and estuary fishing. Similarly, bream is a nearshore family of fish, accessible to people fishing from beaches and in estuaries, rather than deep water fishers.

- Indigenous fishers target a wider variety of fish types and other marine species (particularly shellfish) than other 'recreational' fishers (see also Schnierer and Faulkner 2002). Shellfish are not part of the Ocean Trap and Line fishery.

- There is some overlap in species targeted by the Ocean Trap and Line fishery and those nominated by Indigenous fishers in northern Australia, principally amongst those species whose habitat ranges from the nearshore (including estuaries) to offshore. This includes, snapper (including sea perch), salmon and tuna.

2.2 TRADITIONAL FISHING AND ACCESS TO FISHERIES RESOURCES

This section describes the observations of Indigenous fishing made by early European settlers and the results of several studies that have sought to document wild resource use by Aboriginal communities in coastal areas. These studies relate to practices in the twentieth century, although there is also less well documented continuity back to the late nineteenth century in most cases. The studies provide some insight into the nature of Indigenous ocean fishing and the species targeted. This information is critical to understanding firstly the extent of interactions between Indigenous cultural and subsistence fishing and the Ocean Trap and Line commercial fishery and secondly the extent of impacts of the Ocean Trap and Line fishery on Indigenous community values and practices.

2.2.1 Nineteenth Century Ethnographic Descriptions

There are many nineteenth century references to Aboriginal people fishing in north and south coast estuaries, at estuary mouths, around headlands and along ocean beaches. There are also a few references to people fishing in open ocean waters from canoes. Although there are many references, they tend to be patchy both in terms of their geographic location and temporal continuity. Also, because the observations are reported by European settlers, the description may often involve a degree of personal interpretation of the rationale for the activity, rather than reflecting directly the contextual understanding of the Aboriginal participants.

Some examples of reports from nineteenth century observers, relating particularly (where possible) to fishing in marine waters, are noted below. It is interesting to note that by far the largest number of observations relate to Aboriginal people using estuarine waters for fishing and shellfishing, rather than coastal beaches and offshore waters.

Collins 1798 (quoted in Attenbrow 2002): *'the natives of the sea coast are those with whom we happened to be the most acquainted. Fish is their chief support…. In addition to fish they indulge themselves with a delicacy which I have seen them eager to procure. In the body of a dwarf gum tree are several large works and grubs….'*

Tench 1788 (quoted in Attenbrow 2002): '(they)… *wholly depend for food on the few fruits they gather; the roots they dig up in the swamps; and the fish they pick up along the shore, or contrive to strike from their canoes with spears. Fishing indeed seems to engross nearly the whole of their time, probably from its forming the chief part of their subsistence*.'

Ainsworth (1922): *'the seasons were known to them by the foliage and flowers. They could tell by the natural signs of flowers and fruit when the salmon and mullet were due on the beaches and in the rivers; also when game was likely to be in evidence in particular localities.'*

Ainsworth also describes groups of people moving to the coast in September to take advantage of the huge shoals of salmon (*Arripis trutta*) in the surf (on the NSW north coast) at that time of year. These fish were caught by spearing. Ainsworth also noted the importance of sea mullet in his observations. Although some mullet can be obtained throughout the year, they migrate north along the coast in enormous shoals from late April to early September, and would have been easily obtained by spearing and netting.

Hodgkinson (1845): '*The* (Aboriginal people) *at the Macleay and Nambucca Rivers spear in a few minutes sufficient fish for the whole tribe, on the shallow sand banks and mud flats on that part of the river which rises and falls with the tide.'*

Crown Lands Commissioner (Fry 1843:653): '*the subsistence of the natives of this portion of the colony being determined in a great manner from fishing, the localities which they inhabit are consequently the immediate banks of the rivers Clarence and Richmond*.' Of the coastal Aborigines, Fry says '*their diet is composed almost entirely of fish and honey*.'

Mackaness (1941) – '*fish are abundant and the Aborigines may be termed Icthyophagist…. Their mode of taking fish is by net, spearing and line and hook, the latter ingeniously made from bone. Their canoe a sheet of bark from the straight part of a tree folded at the end*." When fishing, Aboriginal people were noted to '*occupy a kneeling position in the Mudjerre or canoes and may be seen like floating specks off the coast spearing salmon; they are expert fishers*.'

Anderson (1890) also describes canoes and wooden implements used by Aboriginal people on the south coast. The canoes were made of bark strips and were found along beaches as well as estuaries.

There is also some historical evidence that people ate large marine mammals when they were available (Tench 1793, quoted in Attenbrow 2002):

> *'September 1790. On the 7th instant, captain Nepean of the New South Wales corps and Mr White accompanied by little Nanbaree, and a party of men, went in a boat to Manly Cove, intending to land there and walk on to Broken Bay. On drawing near the shore, a dead whale, in the most disgusting state of putrefaction, was seen lying on the beach and at least 200 indians (sic) surrounding it, broiling the flesh on different fires, and feasting on it with the most extravagant marks of greediness and rapture*.'

There is a widespread view in the ethnographic reports that Aboriginal people were generally on the coast through late spring, summer and autumn, living in the hinterland in winter. This view is not wholly supported by the availability of resources, nor is the evidence consistent along the whole coast. Some of the fish species that are known to have been targeted by Aboriginal fishers are far more common (in schools) in winter than in summer. It is possible that early European observers did not note short visits to the coast during winter to access these resources. Sullivan (1982) refers to the observations of Robinson (1844) of the apparently healthy appearance of Aboriginal people both on the uplands (of the Monaro) and right along the south coast between Goalan Head and Gippsland Lakes in mid winter, during late June and July. These observations do not suggest a strongly seasonal pattern of coast and hinterland occupation, and Sullivan suggests that coastal wintering may have been more common in the south than the north.

2.2.2 Studies of wild resource use by Indigenous Communities in Coastal Areas

As part of the liaison with Aboriginal fishers and community groups about a related commercial fishery, and on the advice of the Chair of the NSW Indigenous Fisheries Advisory Group, discussions were held with John Jarrett. John is one of the few Aboriginal people currently holding a commercial fishing licence. John has been at sea since the age of 12 years. During these discussions with John, he also talked about local cultural fishing with his family. As a child, he gathered shellfish with his mother and grandmother, and they also got prawns at Arrawarra. His mother also gathered lobsters at Woody Head, as well as sea urchin eggs and pipi. Every species was targeted at different times and people knew what would be available at different locations throughout the year. This is the same 'circle fishing' concept that was described by south coast communities (Egloff 1981 and Cozens 2003). In addition to the collecting activities of women, John described catching fish in the surf (mullet?). The process involved lots of people, who also shared the catch. People would walk into the surf to surround a large shoal of fish and then gradually walk them into shore.

John Jarrett thought that even though most traditional fishing on the north coast would have been from the beach and close to land, people had canoes and they could have fished further offshore on calm days, both historically and before European settlement. Elsewhere along the NSW coast there is abundant evidence that people took canoes to islands close to the shore (eg Broughton Island in Myall Lakes National Park), so canoes were certainly seaworthy on calm days.

Schnierer and Robinson (1993) in Zann (1996) described the historical and contemporary uses of marine resources, particularly fin-fish and invertebrates in northern NSW. They found that local communities continued to utilise seafood as a food source (for instance, making up 30% of the diet in the lower Clarence valley). They also noted the desire of Indigenous peoples to become more involved in commercial fishing industries based on the assertion that they were the original owners of the coast and its resources, which were never ceded to anyone.

English (2002) reports the results and implications of a detailed study of Aboriginal wild resource use on the NSW mid north coast. The study was conducted with the Gumbaingirr people, based at the Yarrawarra Aboriginal Corporation at Corindi Beach. Gumbaingirr people have lived in camps and villages near Corindi Beach since the 1890s. The project reported by English sought to map the patterns of natural resource use described by the current Indigenous residents of the area. The patterns that are described reflect the changing lifestyles of Aboriginal communities from the 1940s to the present. Whilst these patterns, which draw on the experience of current community elders, do not necessarily represent activities extending to the late nineteenth century or earlier, they do highlight the importance of different types of resources to this community. The study also clearly demonstrates the continuity of attachment to the land. Even though young people in the Yarrawarra community do not use all of the places that were once important for community subsistence, they continue to express an interest in and connection to these places.

With regard to the current assessment, the key issue is the extent to which this coastal community nominates marine resources and marine places as being an important part of their subsistence and cultural activities. The wild resource use that is reported by English clearly demonstrates the diversity of resources that were important, but it also suggests a strong focus on the nearshore, estuary (Corindi Creek and Lake) and terrestrial resources, rather than offshore. This partly reflects the social importance of subsistence activities, with Gumbaingirr Elders reporting how important it was that everyone took their turn and worked together to provide the food and medicines needed for the community.

The places mapped in this project that related to marine or estuarine resources are noted below, (drawing directly on Appendix 2 of English 2002) (**Table 2.6**).

Table 2.6 - Aboriginal Fishing Places, Corindi Area

Place	Activities
Corindi Lake crab spot	Good location for finding crabs in 1950s and 1960s, later became polluted
Headland near old camp	Used from early 1900s to present for abalone and other shellfish
Corindi beach and rock platform	Used '*for thousands of years. Has been the main spot to obtain shellfish for decades and remains important. There is living memory of people singing to whales and dolphins at or near this location*.'
Fishing area on Corindi Beach	Used from 1950s to 1990s, regarded as the best spot to catch Jew Fish. Now within the Marine Park.
Tuny's camp	Aboriginal people lived here in huts. Others used to visit regularly and spend Christmas (good fishing)
Wash away camp	Used by many families throughout the year. Good camp at Christmas time with fresh water, bush tucker and good fishing
Massacre place and sea cave	A plaque at this location commemorates the mid to late nineteenth century killing of Aboriginal people. Some were shot and others jumped off the cliff into the sea. It is believed that some people escaped by going into the sea cave and emerging at another cave. This place is avoided by Gumbaingirr people.
Arrawarra Camp	Used from 1920s as a permanent camp. Freshwater swamp with turtles, eels, good fishing and various plants.
Arrawarra headland and fish trap	Used from distant past to present (although now within Marine Park Sanctuary Zone which inhibits fishing). Headland was a men's area and rain increase site.
Oyster place	Accessed by walking up the beach from the old camp
Corindi Beach	Used by the community for decades and still the main fishing spot for elders and young people. Rock platform is a good place to get shellfish
Fishing spot on Corindi Creek	Used in 1950s. Currently no access and the creek is also polluted
Eel spot on Corindi Creek	As above.

The list of places identified by the Gumbaingirr people provides a great deal of local detail about and differentiation of Corindi Beach, with quite specific locations nominated as the preferred sites along the beach for fishing or other marine resources. Conspicuously absent in this account is any reference to offshore fishing. All the fishing references are to activities conducted from the beach or in the estuarine creek system.

Considerable detail about late nineteenth to mid twentieth century Aboriginal community fishing practices is provided in Egloff (1981) who researched the history of the Aboriginal community at Wreck Bay on the NSW South Coast. These observations clearly indicate that Aboriginal fishers at this time were accessing offshore resources, although the focus of their activities was generally in inshore waters.

Egloff (1981) refers to abundant archaeological evidence of Aboriginal fishing and shellfish gathering along the shorelines at Wreck Bay, with extensive middens containing shellfish, fish hooks (using shell), edge ground axes, bone points and flaked stone implements. Axe grinding grooves, open campsites, bora rings and burial sites are also reported from the Beecroft Peninsula, indicating a well established population with tools and strategies to work with diverse local marine and terrestrial resources.

Egloff describes fishing by men using spears that had hard wood prongs tipped with bone points. These spears were used in Jervis Bay and in the shallow coastal waters over rocky reefs. Women also fished using hook and line. Species represented in the midden sites include snapper and bream, as well as pipi and cockle.

The Aboriginal population on this part of the south coast was decimated after European settlement. Eventually the remaining Aboriginal people were settled at reserves at Roseby Park and Jervis Bay, although a few people had continued to live in these areas throughout the nineteenth century. Egloff (1981) reports that the Office of the Protector of Aborigines provided a boat and fishing gear to Aborigines at Broughton Creek in 1882 and that a boat was also provided to the Jervis Bay people (at Currumbene Creek) the following year.

When the Commonwealth took over the administration of Jervis Bay in 1922, there were 25 Aboriginal people living in a fishing village at Wreck Bay and Aboriginal crews had fished this part of the coast throughout the latter part of the nineteenth century. Egloff's description of the fishing activities at Wreck Bay highlights the following features, which are relevant to the current assessment:

- Net fishing from small boats for mullet, blackfish, jewfish, kingfish, whiting and bream. Two hundred to 300 cases of fish could be caught at a single shot. Aboriginal fishers operated predominantly in Jervis Bay, but as much as 13 kilometres out to sea.
- Snapper were caught off the reefs with hand lines.
- Spotters were stationed at vantage points, including high trees along the beach.
- Fish were carted to the railway station at Bomaderry for transport to markets.
- Each catch was divided into five parts – one part for each crew member and one for the boat and gear which needed constant repair.
- In the 1940s and 1950s there were seven to eight crews of Aboriginal fishermen operating in Wreck Bay, and a rotation system was used to provide equitable access. Each crew had rights for 24 hours in turn.
- Most fishing was done between Christmas and Easter, and at other times men worked at local timber mills or picking vegetables.

- During the Depression, families camped on the southern beaches of the bays and collected pipis, mussels and oysters. People also gathered abalone at this time. It was sun-dried on wire racks and sold to traders in Sydney.

Egloff (1981) also reports that the Office of the Protector of Aborigines also provided fishing boats to reserves and camps along the south coast:

> '*In the Bodalla district, Aborigines were considered by ME Mort to be destitute without a boat. These Aborigines had sold fish for a living until their boat was wrecked while going to the assistance of a sinking vessel… While most white Australians do not realise the extent to which coastal Aborigines quickly adopted European maritime technology and became net fishermen capable of making their own gear and surprisingly enough also pursued large whales. Recently buried at Wreck Bay is one of the great whalers of Twofold Bay, Aden Thomas. Before him were Hadgadi and Adgeree, two coastal Aborigines famous for their whaling exploits.'* (p 23)

These two detailed studies reveal information about two different aspects of Aboriginal community involvement in fishing in marine waters, although it is clear from both studies that coastal Aboriginal people were skilled fishers, with extensive community knowledge of the resources that were available and how to best access them for community needs. From these two examples it could be concluded that the nature of fishing depended somewhat on the access that the community had to European style fishing boats and also to transport (for marketing of fish). The Corindi example shows long continuity of subsistence and cultural fishing from coastal beaches (as well as the estuary) by a community outside the institutional system of missions. In general, this was not commercial fishing, and the community did not refer to the use of ocean going boats.

The Jervis Bay/Wreck Bay example illustrates the adaptation of traditional fishing to the small scale commercial sector, although clearly local subsistence and cultural fishing continued to be practiced. The Wreck Bay case study reinforces comments from the NSW Aboriginal Land Council (pers comm 2002) who note that many of the missions (and other government sponsored settlements) established in the late nineteenth and early twentieth centuries were on estuaries or coastal headlands. Aboriginal people who were placed in these institutions would have been expected to provide a substantial proportion of their food supply by fishing and shellfish gathering, utilising existing skills and traditional practices, augmented by other equipment where it was available.

2.3 ABORIGINAL MARINE 'TOTEMS'

The traditional social structure of Aboriginal communities includes familial or totemic relationships to natural features, plants and animals. Faulkner (2000) notes that a '*general characteristic of Aboriginal totemic relationships was the basic tenant of not consuming one's totem, and taking some degree of responsibility for its survival.*' (p3). In some cases, the relationship was expressed in terms of ceremonies at particular sites (Increase sites) to ensure the continuation of the species. For example, Radcliffe-Brown, in Schnierer and Faulkner (2002), recorded a bream increase site on the lower Clarence River, for the Yaegal people.

Some totems were marine species and many were coastal species, but the full range of totems from the NSW coast, and the variations between groups along the coast, has not been documented. Notwithstanding this, it is apparent that the values associated with totems would have encouraged Aboriginal people to manage their marine resources carefully, to protect both economic and spiritual values.

Rose, James and Watson (2003) discuss Indigenous kinship with natural features in NSW, drawing on case studies from Wallaga Lake (Yuin people) on the south coast, and from the Ngiyampaa people in western NSW. The Yuin people's stories provide some guidance about the spiritual associations and values that Aboriginal people may have with marine species. The black duck is a very important totem species for the Yuin people and many of the other species that are noted as having totem value are terrestrial species from the mountains and forests of the south coast. More relevant to the current assessment of ocean trap and line fishery impacts are stories from the Yuin people about their relationship with dolphins and whales and of the sanctuary value of Little Dromedary Island (Najanuga) and Montague Island (Barunguba). Both islands are off the NSW Far South Coast and are passed by commercial fishing vessels (as well as recreational vessels and other commercial vessels) on a regular basis.

> '*Gulaga was and still is a protection area for all sorts of plants, animals and birds. ….in the video "Sites we want to Keep" the late Guboo Thomas stated that the name Najanuga means "powerful home". The significance of Najanuga as a resource site for birds eggs is documented there as well as by Kelly (1975:4). According to the late Guboo Ted Thomas, birds were protected in the area around Najanuga; only old people gathered eggs from Najanuga and they always took a limited number. Najanuga is thus one of the original bird sanctuaries on the continent*.'
>
> (Rose, James and Watson (2003:47)

The killer whale (Yeerimbine) is identified as a totem south of Twofold Bay. The relationship between some Yuin people and killer whales at Twofold Bay has been widely reported because of the importance of the collaboration to the whaling industry.

> '*A number of Yuin people participated in the industry by calling killer whales to herd smaller whales in toward shore so that they could be harpooned by the ships stationed there. The killer whales were rewarded by being fed the tongues of the harpooned whales. Three people with whom Christine (*Watson*) spoke added that Yuin involvement in the whaling industry was an adaptation to the presence of white people as whales are an important animal in Yuin culture which traditionally should not be killed*.'
>
> (Rose, James and Watson (2003:48))
>
> *'There was also collaboration with dolphins. The late Guboo Ted Thomas, on his tape The Dreamers, recounted an early memory of his grandfather singing songs, hitting the water with a stick and dancing on a beach down on the south coast, calling the dolphin to bring fish in to shore for them to eat……Guboo said that he could still sing the songs and described another time when a dolphin brought a big bream to shore for him.'*
>
> (Rose, James and Watson (2003:48))
>
> *'Yuin women were also able to communicate with dolphins. There is a story that women from Brou Lake would hit on the water, and speak to the dolphins when they swam up, giving them messages to transmit to men on Montague Island.'*
>
> (Rose, James and Watson (2003:48))

This relationship or partnership with dolphins appears to have been quite widespread along the coast. Faulkner (2000) refers to a documented tradition of dolphins assisting Aboriginal people to fish on the beaches in the Yaegl territory at Yamba. Mick Leon (pers.comm.2003), from the mid north coast, noted that dolphins and turtles are considered as ‘brothers’ at that part of the coast, but whales are not.

The Gumbaingirr people on the mid north coast (English 2003) also tell of people calling to the dolphins from the headland at Corindi. Faulkner (2000) refers to a similar relationship in the Moreton Bay region, at Bribie and North Stradbroke Islands.

2.4 THE ARCHAEOLOGICAL RECORD – KNOWN ABORIGINAL SITES

Archaeological sites preserve the physical evidence of past Aboriginal land use and culture. They can be expected to provide some indications of the activities that people were carrying out and how they went about those activities. This information can be interpreted from the organic content of the sites (eg species composite of shell, bone, plant seeds or other remains, presence of charcoal etc), from the implements that are present (different types of flaked or ground stone implements, bone implements etc known to have been used for specific purposes), artefact frequency etc and patterns of site distribution in the landscape (eg continuity, density, spatial and temporal relationship to resources). Unfortunately, for most sites, much of the context and content that would facilitate interpretation has been differentially lost by weathering, decay, erosion or disturbance. For coastal sites, the harsh marine interface environment together with the extent of development, means that many sites have disappeared completely. Where some archaeological evidence or economic and social activity remains, it is frequently very difficult to determine the extent of information that has been lost – ie how indicative of the full record the remaining evidence is likely to be.

In relation to fishing practices, the equipment used by traditional Aboriginal fishers included tools made using a range of plant materials, none of which are preserved in open campsites or middens. These implements include nets, fish traps made of matted brush barriers (rather than stone), look out trees, canoes, fishing lines, spear shafts etc. In this context, much past Indigenous fishing activity is archaeologically invisible.

Some broad observations of archaeological evidence of coastal fishing activity are noted below.

- In excess of 1500 midden sites and similar large numbers of open campsites without shell material have been recorded along the NSW coast, mostly in open contexts, although in some regions (eg the Sydney region), rock shelter sites containing midden deposits are relatively abundant.

- Very large estuarine middens have been recorded from north coast valleys such as the Macleay, Richmond and Clarence, and ethnographic reports link some of these to substantial village settlements at the mouths of estuaries. Middens of equivalent size in open coastal contexts are relatively rare. This is likely to reflect preservation issues in coastal dune fields (aeolian impacts) and back beach areas (wave impacts). Very large middens (dominated by pipi shell) are known to have formerly occurred along Stockton Bight, north of Newcastle, at Dark Point in Myall Lakes National Park, and some mounded coastal sites are also known from the south coast (eg at Pambula).

- Many coastal midden sites are located in close proximity to other resources such as fresh water (creeks or springs) and terrestrial plants and animal resources. This is consistent with the strongly expressed view by the Aboriginal community that fishing and shellfishing were parts of a broader resource access strategy in which stocks of all resources were carefully managed.

- Fish that are reported from coastal midden sites (from bone and ootoliths) include snapper, bream (black and silver), leatherjacket, wrasse, mullet, flathead and mulloway.

- There is a tendency towards increasing variety of fish species in the upper layers of sites. Several authors suggest that this is due to the introduction of new fishing technologies (particularly line fishing) over time. Dates for fish hooks are all less than 1000 years and appear to have been more common on the south coast. In terms of shell species, on the south coast there is a clear change towards hairy mussel and edible mussel over the last 1000 years.

- In addition to economic materials (foods, medicines and tools), some midden sites contain human burials (eg the Dark Point midden in Myall Lakes National Park). Sullivan (1982) suggests that many of these burials, which include males and females (adults) and children, are relatively recent (last 200 years). Wherever they occur and whatever their age, the presence of a burial in a midden deposit is highly significant to the Aboriginal community.

2.5 ABORIGINAL PLACES AND COMMUNITY STORIES

English (2002) discusses the reasons that places associated with 'wild resources' are valued by Aboriginal communities and highlights eight primary factors (based on experience with the Yarrawarra community on the north coast). He notes that these places may be associated with:

1. *'past family, group or individual activities that are remembered by the participants or because they feature in stories passed down through generations;*

2. *a highly valued type of food or medicine that is still highly sought by people today or else remembered as an integral part of people's life and knowledge systems;*

3. *a species that has totemic significance or which features in a story or tradition;*

4. *independence and self reliance in the face of economic and social hardship;*

5. *the concept of past or continuing interaction with the landscape in a way that affirms cultural identity;*

6. *physical remains such as middens, scarred trees, or tin huts that bear witness to people's long term and continuing association with the land;*

7. *enjoyment of the land gained through having access to personal and group space in which to reflect and carry out enjoyable activities such as fishing;*

8. *people's custodial interests in land that are maintained by continuing use and the opportunity to observe change in the landscape's condition.'*

These eight factors highlight the complexity of Indigenous community relationships to fishery resources and their views about appropriate sustainable management practices. Similar patterns of resource relationship are repeated right along the coast, although details clearly change from one social grouping to another and with the specific environmental resources that may be available in different areas (eg the differences between the long sandy beach coasts of the north and the rocky embayments of the south).

Aboriginal people attribute cultural value to some coastal features because of their spiritual associations. Some of these features are listed as Aboriginal Places and have status under the NPW Act (an example of this type of feature is Goanna Headland at Evans Head), but many are not well documented and are not formally identified as Aboriginal Places.

For example Mick Leon (pers. comm. 2003), from the mid north coast of NSW, noted that there was a story that Julian Rocks near Byron Bay were thought to be connected in a spiritual way to Seal Rocks. People could travel spiritually between the two places and come out at either end.

2.6 INDIGENOUS PARTICIPATION IN THE COMMERCIAL OCEAN FISHERIES

Aboriginal participation in the ocean trap and line fisheries is very limited and has been exacerbated by a range of historical circumstances. The removal of many Indigenous people from their traditional territories and lifestyles reduced their capacity to adopt new fishing technologies and methods gradually as they were introduced through the twentieth century. In addition, the low economic status of many Aboriginal families also tended to reduce the financial capacity of Indigenous fishers to subsequently catch up with new technologies (Schnierer pers comm 2004). More importantly, the lack of provisions in the NSW legislation to protect Indigenous fishing rights has discounted the ability of Indigenous people to enter newly developing fisheries or to stay in ones where management strategies squeezed out so called ‘inefficient fishers’ (Schnierer pers comm 2004).

During a discussion with John Jarrett who owns and operates an ocean prawn trawler on the NSW north coast (December 2003 pers comm), John noted that he is the only Aboriginal person on the east coast with a prawn trawl licence (king prawns) for offshore waters (more than 3 nautical miles offshore). John also holds an Estuary General Fishery Licence, which he chooses not to use, as the estuary resources are the basic income for other Indigenous commercial fishers. John noted several important constraints to young Aboriginal people getting involved in the offshore commercial sector, including:

- Licences are expensive and are linked to the boat. So to enter the industry you need the capital to buy the boat and the business.

- People entering the commercial industry need multiple skills. They must not just be skilled fishermen, but be up to date on all the regulations etc, know about mechanics and maintenance, be able to cook etc. Many young Aboriginal people do not have the right mix of skills. As noted in the Indigenous Fishery Strategy (IFS) (see **Section 3.1**) improved skills for Indigenous people to facilitate their entry into the commercial sector is a priority for the IFS Working Group. John Jarrett suggested that the capital needed to buy multiple licences as a commercial venture for the Indigenous community could be as much as $10 million. He suggested that one possibility that could be considered would be a scheme like the CDEP, seeking to provide the right mix of skills and capital to assist Aboriginal employment and business development.

Indigenous fishers comment that over the last twenty years or so, the restructuring of the commercial fisheries to enhance efficiency and provide controls to protect biodiversity has tended to reduce the involvement of Indigenous fishers in the commercial sector. It appears that very few Aboriginal people have been licence holders in the offshore Ocean Trap and Line sector so these factors would have affected this fishery less than the estuary general or beach haul fisheries. However, the general concepts are transferable, and fishers describe Indigenous approaches to commercial fishing in ways that depict an extension of traditional cultural fishing (mixed sectors and diverse species, seasonally opportunistic but also conservationist in approach, community oriented).

At a workshop held in June 2003 to address low participation of Indigenous fishers in commercial fisheries generally, participants identified significant constraints to the commercial viability of Indigenous fishing. In particular, the workshop group, which included licensed Indigenous commercial fishers, and members of the Indigenous Fisheries Advisory Committee, noted five key constraints (Callaghan and Associates 2003, for the IFAG, page 4):

- closures of ocean, beach and estuary fisheries have excluded Aboriginal fishers from traditional fishing areas (commercial and non commercial);

- difficulty in the passing on of licences within families;

- costs of licences, particularly restricted licences, can exclude Aboriginal fishers by making their activity uneconomic;

- the gradual and continuing decline of Aboriginal commercial fishers in the industry means loss of an accessible and appealing employment base for Aboriginal communities. Aboriginal commercial fishers who fish within cultural frameworks as well as for employment and income, may be more successful with additional flexibility in licensing arrangements, such as nominating crew members, subleasing of licences, and assistance with licence fees. In addition, gaps in fishing work due to licence losses etc make it more difficult to maintain or enhance skills – and therefore more difficult to return to commercial fishing; and

- exclusion zones, restructuring more fishers into smaller areas, make commercial survival for Indigenous fishers very difficult.

2.7 INDIGENOUS VIEWS ABOUT SUSTAINABLE NATURAL RESOURCE MANAGEMENT

During interviews about fishery management on the NSW south coast (see Cozens 2003), Aboriginal people referred to 'sea country' – generally encompassing estuary and near shore waters, but rarely offshore waters, to which people were attached and for which they had some responsibility to 'look after'. The Indigenous fishers who were involved in these interviews were licensed Estuary General fishers, and Indigenous representatives on various Fishery Advisory Committees, plus some 'advocates' for Indigenous rights.

Cozens' interviews clearly reveal the nature of Aboriginal fishing (whether or not conducted with a commercial licence) and the intent and framework of that fishing. For instance (p56), she quotes:

> '*Aboriginal fishing is a sustainable fishing practice. We practiced circular fishing. We fished for what was around. We fished for mullet in April and May, prawns in spring and summer and salmon from March to November (as) it's a winter fish. We fished for abalone and lobster in the summer when the water was warmer. We didn't fish them one step to extinction – we didn't have to. We didn't just fish for one species*.'

The views expressed by this interviewee are similar to those noted by Faulkner (2000) that Aboriginal people had specialised ecological knowledge of their local landscape, and that they used this local understanding to guide their fishing practices throughout the year. Traditional ecological knowledge includes knowing when and where a particular species will be present, the most favourable time in its lifecycle for consumption, breeding cycles, relationships between lunar cycles, species mobility in its habitat and favoured fishing and collecting opportunities, medicinal values (Faulkner 2000:6). Faulkner suggests that this traditional ecological knowledge is the feature that makes Indigenous fishing ecologically sustainable and distinguishes Indigenous fishing from other fishing. The teaching and transfer of traditional knowledge is an important aspect of Indigenous fishing.

Whilst the views expressed about the restrained, conservation oriented management of fishery resources by traditional indigenous fishers need to be seen in the context of the relatively small population that was being fed, and the less invasive technologies that were used, there is no doubt that the intent of fishing strategies was not only to feed the community this year, but to ensure they could be fed and meet their obligations next year too.

A broader perspective of the Indigenous concept of sustainable natural resource management is discussed in the 'Boomanulla Statement', which presents the outcomes of the Boomanulla Conference for Country (March 2002). The Conference involved natural resource representatives from Aboriginal communities across NSW. In terms of natural resources, the focus of this conference was the management of terrestrial catchments (land, rivers and vegetation). However, the principles and recommendations endorsed by the Conference are very similar to less formal statements that have been made in relation to Indigenous involvement in the management of coastal fishery resources over the last few years. Some important principles, noted in the Boomanulla Statement and stressed frequently by representatives of Indigenous communities, include:

- *The health and livelihood of Aboriginal communities is related to the health of the river systems and the land* (and in the current case, the coast, estuaries and beaches).

- *Cultural and biological diversity are two sides of the same issue for people who relate to the land and the rivers spiritually*.

- *Consultation with Aboriginal communities means negotiation with them about the meaning of land* (and sea) *management and about what must be done*. Aboriginal representatives must be linked to the community and Elders Councils.

- *The economic future of Aboriginal communities will be tied to natural resources. There must be benefit sharing as a principle for any planning approach*. Aboriginal communities will expect employment, education, and training outcomes from natural resource management plans. Aboriginal people have a traditional custodian's right in relation to natural resources which they have never given up.

2.7.1 Indigenous rights to Coastal Waters and Marine Resources – Implications for participation in Commercial Fishing

Two of the key issues of concern to Indigenous people about the management of commercial fisheries in marine waters is the extent to which commercial fishing activities impact on the conservation of traditional resources and 'country' and also the extent to which Aboriginal people have been able to actively participate in the wealth generating activities of commercial fisheries that operate in waters that they consider to be 'country'.

The Lingiari report on Indigenous Rights to Offshore Waters (2002), and Tsamenyi and Mfodwo (2000), both argue that much of the focus about Indigenous rights to waters so far has focused on customary or cultural rights (ie the right to practice cultural fishing), with little real attention to commercial fishing rights for Indigenous peoples. Tsamenyi and Mfodwo (2000) argue that commercial fishing rights for Indigenous people are an important part of the right to self determination. In Australia, there is no legal recognition (and little policy recognition) of the right of Indigenous people to participate in commercial fishing as a specific group, differentiated from other commercial fishers, although there is clear recognition of the customary rights of Aboriginal people to marine resources. There is also recognition that commercial fishing activities should minimise their impact on customary fishing practices.

Lingiari (2002) and Tsamenyi and Mfodwo (2000) suggest that outcomes of the lack of positive legislation in regard to Indigenous rights to participation in commercial fisheries include:

- Aboriginal people having little direct say in the management of fishery resources (e.g. in setting policy about target species and harvest rates, about appropriate fishing technology and about the management of waste); and

- restricted Aboriginal participation and benefit from the economic values of the commercial sector, either as owners of the resource, or as owners of licences (rather than as employees).

Clearly these are major issues for State and National policy on the management of Australia's coast and seas and their resolution extends well beyond the scope of the NSW Ocean Trap and Line Fishery Management Strategy. However, the apparent low participation of Indigenous people in the trap and line fishery is consistent with the noted National situation, and the issues that have been raised in NSW about access to the commercial sector generally are consistent with those put forward on the national agenda.

In terms of the assessment of the Ocean Trap and Line FMS, a key question is whether the FMS adequately recognises these Indigenous rights to customary fishing and self determination. To a large extent this will depend on broader NSW Fisheries policy development, in consultation with the Indigenous Fisheries Advisory Committee. As a minimum, the Ocean Trap and Line FMS can note the ongoing need to enhance Indigenous participation and foreshadow progressive reviews of actions within the strategy as new positive initiatives are introduced at the broader policy level.

2.8 SUMMARY – INDIGENOUS COMMUNITY OBJECTIVES, VALUES AND ISSUES FOR THE RESOURCES OF THE OCEAN TRAP AND LINE FISHERY

From the above information, the following key values and objectives can be deduced. The information is considered to be indicative of the views of the Indigenous community at the state level. As noted in **Section 1**, these conclusions are based on a small sample of opinion from the Indigenous community in coastal NSW and should not be taken as representing the views of all members of the Indigenous community who participate in fishing. It is anticipated that there will be local and regional differences in emphasis and in detail.

The key values that have been taken forward into the assessment in relation to Indigenous marine fishing are:

1. Communities value access to marine resources close to the beaches and headlands of the NSW coast. The species that occur on rocky headlands, nearshore reefs and islands, along beaches and in the shallow marine waters close to shore are an important part of contemporary Indigenous community diet. Different species are targeted at different times of the year with the aim of providing food for the whole community (or at least an extended family group). Fishing in these areas continues a long tradition of Indigenous dependence on and conservation of marine resources.

2. Fishing by Indigenous people targets some of the species that are also targeted by the commercial ocean trap and line sector, but many of the preferred species are more

common in shallower inshore waters (and are also preferred by recreational fishers). However, Indigenous fishers tend to seek a wider range of species than other groups.

3. Communities value access to fish species or to places for the purpose of teaching younger members of the community about traditional values, particularly respect. In general, these places and species are those that occur on or near to the shore.

4. Indigenous people in coastal areas have ‘totems’ that include marine species. Whilst these vary from one tribal area to another, they are known to include some marine birds, whales, dolphins, turtles and some fish species. The relationship to these totem species may include beliefs about protection, mutual support, environmental or other information. It is not known whether totems include the species targeted by the ocean trap and line fishery as deep ocean species (ie king prawn, silver trevally, whiting, octopus, cuttlefish, gemfish etc).

5. Active participation in the protection of places and habitats that are or have been used by the community as part of the social activity of food gathering.

6. Active participation (ie real influence or control) in the management of any aspect of the fishery that impinges on Indigenous community socio-cultural values (this is distinguished from consultation).

7. Employment or other economic advantage from participation in the activity that will help to support the social and cultural values of the community. Employment and economic gain from marine commercial fisheries is seen as an important pathway to economic self determination.

With these values in mind, the objectives of the Indigenous community in relation to the management of the Ocean Trap and Line fishery could be considered to be as follows:

1. To continue to document the species and places of traditional cultural or spiritual value to the Indigenous community along the coast, so that any potential impacts can be better defined and reversed.

2. To ensure that there is clear and open communication between fishery managers and the Indigenous community about catches, methods, impacts, benefits and opportunities to be involved in management.

3. To enhance the skills and capacity of the Indigenous community to participate in the fishery sector, both as fishers (owners, operators and crew) and in terms of active involvement in the Management Advisory Committee.

4. To provide opportunities for active participation in the Ocean Trap and Line Fishery.

5. To ensure that the commercial Ocean Trap and Line Fishery is managed in a manner that is consistent with sustainable resource use – i.e. that does not result in irreversible damage to habitats, or irreversible decline in the numbers or diversity of fish species.

3.0 DRAFT OCEAN TRAP AND LINE FISHERY MANAGEMENT STRATEGY – ACTIONS TO MANAGE INDIGENOUS ISSUES

This section reviews the existing policy framework for Indigenous fisheries and considers the extent to which the draft Ocean Trap and Line Fishery Management Strategy is consistent with this framework and supports the management concepts and direction that have been agreed.

3.1 INDIGENOUS FISHERIES STRATEGY AND IMPLEMENTATION – INTERACTION AND IMPLICATIONS WITH OCEAN FISHERIES

The Indigenous Fisheries Strategy was released in 2002 after consultation with Aboriginal communities at several regional meetings. The Implementation Plan that accompanies the Strategy identifies actions for 2003 and 2004, and the progress towards priority actions is monitored by the Indigenous Fisheries Advisory Committee. Although there continues to be some regional criticism of the structure and operations of the IFS Advisory Committee (see for instance Cozens 2003), it is a major step forward in terms of Indigenous community involvement in fishery management in NSW. The advisory role of the IFS Advisory Committee extends well beyond the Indigenous Fisheries Strategy itself and includes advice on the development, consultation process and implementation of fishery management strategies in all sectors. It can be anticipated that as the IFS Advisory Committee develops, it will able to provide strong support to Indigenous community representatives on other Fishery Management Committees (eg the Ocean Trap and Line FMAC) and also enhance feedback of information about fishery management to and from regional Indigenous communities.

The management of Indigenous involvement in assessment and ongoing management of the Ocean Trap and Line FMS is not noted as a high priority for the IFS Working Group in implementing the Indigenous Fisheries Strategy, although other priority actions will indirectly benefit Indigenous involvement in the management of ocean resources. For instance, the development of mechanisms to enhance Indigenous participation in the commercial fishing sector generally is a very high priority for the Indigenous fisheries Advisory Committee, and has been the subject of a workshop to develop an action plan during 2003 (see Callaghan and Associates 2003).

Relevant actions from the IFS Implementation Plan, that will help to promote ecologically sustainable and culturally appropriate practices in the Ocean Trap and Line fishery include:

- develop and facilitate a model for community input to fishery management planning (and marine park management) and progressive involvement in fishery management strategies (to be completed in 2004);
- review current Indigenous cultural access to fisheries, review options with IFAC and prepare advice after reviewing input from communities;
- cultural awareness training completed for all existing NSW Fisheries staff, all management advisory committees and new NSW Fisheries staff (as part of Induction);
- project manager to identify strategies to maintain levels of Indigenous involvement in commercial fishing;
- develop an employment strategy for NSW Fisheries in consultation with the IFS Advisory Committee (completed June 2003); and

- review aquaculture and commercial fishing opportunities, consult with IFAC and prepare advice to communities on the skills required to sustain these businesses.

The interaction between these actions and the Ocean Trap and Line FMS is discussed in **Section 3**.**2**.

As noted in **Section 2.6**, the workshop on developing the participation of Indigenous people in commercial fishing resulted in several recommendations that have implications for the Ocean Trap and Line FMS (Callaghan and Associates 2003). These include:

- consultation with Aboriginal people about the concept of identification of Indigenous commercial fishers on their licences (and whether Indigenous fishing licences could have special conditions attached to them);

- endorse the goal of retaining Indigenous people in commercial fishing and demonstrate this through investigating options for licence transfers, sub leasing of licences, and assistance with gaining new licences;

- training for Aboriginal fishers, both to enhance employment prospects as crew and to support operations as licensed fishers; and

- consider new structures and any special training for involving Aboriginal people in Management Advisory Committees, potentially using the models described in the Boomanulla Statement.

3.2 OBJECTIVES OF THE DRAFT OCEAN TRAP AND LINE STRATEGY

The draft Ocean Trap and Line Fishery Management Strategy includes a range of goals and objectives that are intended to respect and protect the interests of Indigenous people in the management and resources of the fishery. In addition to the objectives that are directly relevant to the interests of Indigenous people, a number of objectives also address issues that are of interest to Indigenous people, in relation to sustainable management of the natural resources that are targeted by the fishery, and the sharing of information about the condition of those natural resources.

Goal 4 is the most directly relevant to Indigenous fishing issues. Goal 4 and its objectives are noted and discussed below. **Table 3.1** summarises the relationship of Indigenous community values and objectives, IFS Implementation Plan priorities and Ocean Trap and Line FMS objectives/management responses, based on the matters addressed by Goal 4 of the Fishery Management Strategy. Further information about the objectives under Goal 4 is provided in **Sections 3.3** and **3.4**.

Goal 2 and Goal 3 are also relevant to Indigenous community interests. Goal 2 (Maintain stocks of primary and secondary species harvested by the Ocean Trap and Line fishery), whilst not directed specifically at Indigenous community participation in the fishery, does address issues of broad concern to and widely raised by Aboriginal people. The objectives under Goal 2 relate to the prevention of overfishing by improved monitoring and reporting mechanisms, modifications to minimum size limits, seasonal restrictions to the taking of spanner crab and measures to promote the recovery of species that are already considered to be overfished.

Goal 3 relates to the protection of threatened species, populations and ecological communities. The actions under both Goal 2 and Goal 3 refer broadly to the sustainability outcomes that are discussed by Aboriginal communities along the coast. The interaction between these goals and the Aboriginal community goals derived in this assessment is summarised in **Table 3.2**.

Table 3.1 - Key Aspects of Management Issues, Goals and Objectives

Ocean Trap and Line FMS objective	IFS Implementation Plan Priority actions	Indigenous community values and objectives (Section 2.8)	Recommended Action
GOAL 4: APPROPRIATELY SHARE THE RESOURCE AND CARRY OUT FISHING IN A MANNER THAT MINIMISESNEGATIVE SOCIAL IMPACTS **Objective 4.1: Provide for appropriate access to the fisheries resource by other stakeholders (eg recreational, Indigenous), acknowledging the need for seafood consumers to access quality shellfish and finfish.** **4.1(a) Estimate the total catch of primary and secondary species, taking into account the recorded commercial catch and estimates of recreational, Indigenous and illegal catches.**	Review current Indigenous cultural access to fisheries, review options with IFAC and prepare advice after reviewing input from communities. Note this action is supported by other NSW Fisheries projects to better define Indigenous cultural fishing practices and preferred species (eg through research flowing from the Recreational Fishing Survey) As an example, NSW Fisheries and the Centre for Indigenous Fisheries at SCU have submitted an application to the FRDC for a three year research project aimed at developing a better understanding of all facets of Indigenous fisheries. Current estimates of Indigenous catches are patchy and often qualitative.	Communities value access to marine resources close to the beaches and headlands of the NSW coast for customary or traditional fishing and for community subsistence. The species that occur on rocky headlands, nearshore reefs and islands, along beaches and in the shallow marine waters close to shore are an important part of contemporary Indigenous community diet. Different species are targeted at different times of year with the aim of providing food for the whole community (or at least an extended family group). The Indigenous community fishing targets some of the species that are also targeted by the commercial ocean trap and line sector, but many of the preferred species are more common in shallower inshore waters. Access to fish species or to places for the purpose of teaching younger members of the community about traditional values, particularly respect. In general, these places and species are those that occur on or near to the shore. The Aboriginal community has expressed clear aspirations for developing opportunities for greater direct participation in the commercial sector. The Ocean Trap and Line FMS notes that information in Indigenous fishing is based on the National Recreational and Indigenous Fishing Survey. This is one of the sources used to describe Indigenous fishing activities and values in the current assessment.	Ensure that funds are available to support projects that will clarify and document Indigenous community fishing practices and contexts. The design and implementation of these projects should be culturally appropriate and should be developed in association with the Indigenous Fisheries Strategy Advisory Committee. Although the interaction between Indigenous cultural fishing and the ocean trap and line commercial sector appears to be restricted, this information will help to clarify the extent to which commercial offshore species are also targeted by Indigenous fishers working from the beach or rocky headlands. To enhance access to the resources of the ocean trap and line fishery by commercial Indigenous fishers, a series of actions would be required, including amendments to the *Fisheries Management Act* to recognise Indigenous rights, changes to licensing arrangements, training etc. None of these actions will happen in relation to the Ocean Trap and Line fishery in isolation. Therefore the key action at this stage in relation to access to the Ocean Trap and Line Fishery is to progress consideration of Indigenous fishing rights generally within NSW Fisheries, initially in consultation with the Indigenous Fisheries Advisory Committee.

Table 3.1 - Key Aspects of Management Issues, Goals and Objectives (cont)

Ocean Trap and Line FMS objective	IFS Implementation Plan Priority actions	Indigenous community values and objectives (Section 2.8)	Recommended Action
Objective 4.4: Identify and mitigate any negative impacts of the Ocean Trap and Line Fishery on Aboriginal, cultural or other heritage. **4.4(a) Manage the Ocean Trap and Line fishery in a manner consistent with the Indigenous Fisheries Strategy and Implementation Plan**	Develop and facilitate a model for community input to fishery management planning (and marine park management) and progressive involvement in fishery management strategies (to be completed in 2004); Cultural awareness training completed for all existing NSW Fisheries staff, all management advisory committees and new NSW Fisheries staff (as part of Induction); Project manager to identify strategies to maintain levels of Indigenous involvement in commercial fishing; Develop an employment strategy for NSW Fisheries in consultation with the IFS Advisory Committee (completed June 2003); Review aquaculture and commercial fishing opportunities, consult with IFWG and prepare advice to communities on the skills required to sustain these businesses.	To ensure that there is clear and open communication between fishery managers and the Indigenous community about catches, methods, impacts, benefits and opportunities to be involved in management; To enhance the skills and capacity of the Indigenous community to participate in the fishery sector, both as fishers and in terms of active involvement in the Management Advisory Committee. To ensure that the commercial Ocean Trap and Line Fishery is managed in a manner that is consistent with sustainable resource use – ie that does not result in irreversible damage to habitats, or irreversible decline in the numbers or diversity of fish species	Provide awareness training for ocean Trap and Line licence holders (and other commercial fishers) and encourage discussion about Indigenous rights and how they can be accommodated in the commercial sector. Maintain liaison with the IFAC about the community input model for ongoing management of the fishery (eg in terms of support for an Indigenous community representative on the Ocean Trap and Line MAC). Consider whether the Boomanulla model or other models would enhance Indigenous input to fishery planning In overall fishery management planning (not restricted to the Ocean Trap and Line FMS) identify the most appropriate opportunities for community capacity building and investment support, in terms of generating employment and income. Further progress the actions identified in the Discussion Document and Action Plan for Enhancing the Participation of Indigenous People in Commercial Fishing (2003), with particular attention to additional consultation requirements and review of Fisheries policy.

Table 3.1 - Key Aspects of Management Issues, Goals and Objectives (cont)

Ocean Trap and Line FMS objective	IFS Implementation Plan Priority actions	Indigenous community values and objectives (Section 2.8)	Recommended Action
4.4(b) Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from ocean trap and line fishing activities.	Cultural awareness training completed for all existing NSW Fisheries staff, all management advisory committees and new NSW Fisheries staff (as part of Induction);	To ensure that there is clear and open communication between fishery managers and the Indigenous community about catches, methods, impacts, benefits and opportunities to be involved in management	Further consultation with elders in all regions along the coast to clarify how any impacts that have been identified can be managed to minimise risks to Indigenous community values
4.5 To promote harmony between the commercial sector and other resource users, including recreational fishers, Indigenous fishers and local communities, through fair and equitable sharing of the resource. **4.5(a) In consultation with the Ocean Trap and Line MAC, identify areas of high interaction between the Ocean Trap and Line fishery and other resource users and respond appropriately to resolve any conflicts.**	Improved documentation of the species targeted by Aboriginal people, and of places that are preferred locations for family based cultural fishing. Promote recognition of the concept of "Indigenous fisher" with NSW Fisheries. Review catch allocations for Indigenous fishers. Review licence allocation process and catch history requirements in relation to Indigenous commercial fishers, to encourage retention of Indigenous fishers in the commercial sector. As noted above, cultural awareness training has been completed for NSW Fisheries staff and MACs.	There is limited detailed information about "high usage" areas for Indigenous fishers practicing cultural fishing, although in general, communities on the north and south coasts (ie not metropolitan) tend to report a higher dependence on fishing as a subsistence/dietary activity and a cultural activity. One detailed study of fishing places is available for the Yarrawarra people. Total Indigenous fishing catches are also not well documented, although existing studies do demonstrate some overlap in targeted species. Indigenous participation in the commercial sector	From the Indigenous community perspective, the key action is recognition of "Indigenous fisher" as a group to be considered when assessing resource allocation. Further consultation with aboriginal communities about constraints to access and specific cultural processes that need to be respected in managing access to the resource. The concept of "harmony" between resource users is a major issue for the Indigenous community and will affect all FMS.

3.3 GOAL 4, OBJECTIVE 4.1

GOAL 4:

'Appropriately share the resource and carry out fishing in a manner that minimises negative social impacts.'

Objective 4.1:

'Provide for appropriate access to the fisheries resource by other stakeholders (eg recreational, Indigenous), acknowledging the need for seafood consumers to access quality shellfish and finfish'.

4.1(a):

'Estimate the total catch of primary and secondary species, taking into account the recorded commercial catch and estimates of recreational, Indigenous and illegal catches.'

These objectives and actions are relevant to Values 1, 2 and 3, and Objective 1 noted above (in **Section 2.8**).

A fundamental precursor to FMS Objective 4.1 is a sound understanding of the harvesting rates and trends in harvesting rates for fishing effort by all sectors – commercial, Indigenous, recreational and other. In relation to Indigenous catch of the species that are targeted by the Ocean Trap and Line fishery, some information is currently available from the results of the National Recreational and Indigenous Fishing Survey and work by Schnierer and Faulkner in NSW.

Although the National survey has provided valuable baseline data on Indigenous fishing in northern Australia, as noted above the detail of the statistics available for NSW is not great, and the sample size reported in the Interim Report is small. The work by Schnierer and Faulkner demonstrates that there is a great deal of contemporary community information available on species, methods and on fishing purpose and value.

One of the priority actions of the Indigenous Fisheries Strategy is to improve the documentation of Indigenous fishery practices, including species, locations, methods, effort and community socio-cultural associations. This is essential information if Objective 4.1 of the Ocean Trap and Line FMS is to be realised.

Action: Ensure that funds are available to support projects that will clarify and document Indigenous community fishing practices and contexts. The design and implementation of these projects should be culturally appropriate and should be developed in association with the Indigenous Fisheries Strategy Advisory Committee. Although the interaction between Indigenous cultural fishing and the Ocean Trap and Line commercial sector appears to be relatively restricted, this information will help to clarify the extent to which commercial offshore species are also targeted by Indigenous fishers working from the beach or rocky headlands.

Sharing the fishery resource requires consideration of commercial fishery participation as well as minimising impacts on traditional or cultural fishing practices. As noted in **Section 2** and **Table 3.1**, the NSW Fisheries legislation does not provide for 'affirmative action' type strategies or regulations in relation to Indigenous access to and participation in the Ocean Trap and Line or any other commercial fishery. This situation cannot be remedied only in relation to Ocean Trap and Line fishing.

The recommendations arising from the 2003 workshop on enhancing Indigenous participation in commercial fishing (Indigenous Fisheries Advisory Committee) provide a basis for continuing research, consultation and advice about how opportunities for Aboriginal people to participate in commercial fishing, generating employment and economic benefits for regional communities, can be enhanced. It is appropriate that representatives of the Ocean Trap and Line fishery sector are involved in these ongoing discussions and that the Ocean Trap and Line FMS is reviewed as new initiatives are adopted. It is likely that the first step in the process would be consideration of changes to the *Fisheries Management Act* to specifically identify Indigenous fishing rights and practices.

Action: Ocean Trap and Line fishers and Indigenous community representatives (from the Indigenous Fisheries Advisory Committee) contribute to further research and consultation about options for amending the *Fisheries Management Act* and other affirmative action strategies to enhance opportunities for successful Indigenous participation in the commercial fishery sector.

3.4 GOAL 4, OBJECTIVE 4.4

Objective 4.4:

'*Identify and mitigate any negative impacts of the Ocean Trap and Line Fishery on Aboriginal, cultural or other heritage.'*

4.4(a):

'Manage the Ocean Trap and Line fishery in a manner consistent with the Indigenous Fisheries Strategy and Implementation Plan.'

4.4(b):

'Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from ocean trap and line fishing activitie'.

This objective and actions are relevant to Values 1 to 7 and Objectives 2, 3 and 4 noted above in **Section 2.8**.

The Indigenous Fisheries Strategy and Implementation Plan were released in December 2002, and NSW Fisheries consider that there will be limited opportunities for the Ocean Trap and Line activities to impact detrimentally on the implementation of the Indigenous Fisheries Strategy. This appears to be a reasonable conclusion in relation to traditional fishing rights, where most fishing that is part of community culture takes place in estuaries, nearshore bays and along beaches and headlands. As noted above, there appears to be limited overlap in the species targeted by the commercial ocean trap and line sector and Indigenous cultural fishers. Any potential negative impacts in terms of species access for Indigenous fishers can be resolved using the results of studies with regional communities described in relation to **Objective 4.1**. In this sense, there is also a relatively limited scope for Ocean Trap and Line fish catches to seriously reduce stocks of species that are targeted by Indigenous cultural fishers.

At this stage, the Ocean Trap and Line FMS does not provide particular benefits or opportunities for Indigenous commercial fishers. There is potential for the FMS to encourage greater participation of Indigenous fishers in commercial fishing. The key actions to achieve this objective are outside the scope of individual FMS. They are a primary focus of discussions between the Indigenous Fisheries Advisory Committee and NSW Fisheries.

As agreement on new initiatives is reached, the Ocean Trap and Line FMS and other commercial FMS should be reviewed to ensure that they reflect emerging policy and statutory positions.

Although it is possible that some Aboriginal sites (i.e. physical evidence of past Aboriginal occupation) remain in deep water on the continental shelf, perhaps associated with the remnants of former late Pleistocene shorelines, it is most probable that any artefactual material has either been reworked by ocean waves/currents or has been buried by sedimentation since the post glacial sea level rise 6000 years ago. Ocean Trap and Line gear sometimes disturbs sea bed sediments, and has the potential to snag on submerged rocks etc. However, overall there is a very low potential for Ocean Trap and Line fishing to directly impact on Aboriginal sites.

It is more possible that ocean trap and line activities could occur in areas that are the habitat of totem species or could involve catches of totem species. There is very limited published information about totem species for all Aboriginal people along the coast (noting as an exception the importance of dolphins that has been stated by a number of people). Given the poor documentation of the species, it is difficult to assess the extent of potential risks and impacts.

Objective 4.4(a) provides an opportunity to clarify these spiritual aspects of cultural values of marine species and marine places for the entire coast. The task would involve consultation with elders groups in all regional communities, to document the species that are important and any places that are linked to stories about those species. This information would form the basis for any negotiation about the management of critical species or places in any region. These negotiations are the focus of **Objective 4.4(b**). The action noted in **Table 3.1** in relation to improved documentation of Aboriginal cultural practices and values along the coast (as proposed in the NSW Fisheries and Schnierer/SCU research project) will provide information to underpin refined management of the Ocean Trap and Line fishery, to respect important Indigenous community values.

3.5 GOAL 4, OBJECTIVE 4.5

Objective 4.5:

'To promote harmony between the commercial sector and other resource users, including recreational fishers, Indigenous fishers and local communities, through fair and equitable sharing of the resource.'

4.5(a):

'In consultation with the Ocean Trap and Line MAC, identify areas of high interaction between the Ocean Trap and Line fishery and other resource users and respond appropriately to resolve any conflicts.'

As noted above, the extent of interaction between the species and places targeted by Indigenous fishers and commercial fishers in the Ocean Trap and Line fishery is poorly documented. A key gap is the documentation of traditional knowledge about fishing – species, methods, locations and equipment etc. Whilst it is apparent from conversation with Indigenous people in non metropolitan regions that there is detailed knowledge of fishery ecology in local areas, little of the traditional understanding is written down. Traditional knowledge has therefore been given relatively low profile in planning for fishery management.

In general, aboriginal fishers describe cultural fishing principally as a shoreline based activity, partly because of the capital required to acquire and maintain vessels suitable for offshore fishing by groups of Aboriginal fishers. It is likely therefore that there is limited direct spatial overlap between the Ocean Trap and Line commercial sector and Indigenous fishing places, although there is some overlap in the species that are targeted (this will vary throughout the year).

In terms of fair and equitable sharing of the fishery resource, it is important that fishery managers have a clear understanding of the extent of Indigenous fishing and its cultural and economic importance to the Aboriginal community. A second priority is to review the constraints to ongoing Indigenous access to commercial licences and measures to maintain or restore commercial fishery skills in the Aboriginal community.

3.6 OTHER RELEVANT GOALS AND OBJECTIVES

As noted in **Section 3.1**, the Indigenous Fisheries Strategy Implementation Plan includes two actions relating to capacity building and skill development in the Indigenous community to enhance their ability to participate as licensed fishers in the commercial sector. This issue was also raised by John Jarrett in discussions about the commercial ocean fisheries.

The Indigenous community objectives noted in **Section 2.8** relate to sharing of cultural and resource management information, but also to Indigenous community participation in the management of conservation issues and in the economic benefits accruing from the fishery, by enhancing the community's capacity to be constructively involved.

The draft FMS does include some objectives outside Goal 4 that relate to these matters, although they are not worded to highlight the Indigenous community as a specific stakeholder. Additional goals, objectives and actions that have relevance to the values and objectives expressed by the Indigenous community are noted in **Table 3.2**.

Table 3.2 - Indirect Management Objectives and Measures

Indigenous community objective	IFS Implementation priority	Ocean Trap and Line FMS objective
To ensure that there is clear and open communication between fishery managers and the Indigenous community about catches, methods, impacts, benefits and opportunities to be involved in management and fishing	Develop and facilitate a model for community input to fishery management planning (and marine park management) and progressive involvement in fishery management strategies (to be completed in 2004).	Apart from the Objectives listed under **Goal 4**, there are several objectives relating to monitoring information, consultation about specific issues and notification of stakeholders about management decisions that have been made for the fishery (eg **Objective 2.1**, **Objective 5.2**). These may be of indirect relevance to Indigenous stakeholders.
To enhance the skills and capacity of the Indigenous community to participate in the fishery sector, both as fishers and in terms of active involvement in the Management Advisory Committee	Project manager to identify strategies to encourage and maintain levels of Indigenous involvement in commercial fishing, following up the recommendations of the June 2003 workshop on measures to enhance Indigenous participation in the commercial sector. Develop an employment strategy for NSW Fisheries in consultation with the IFS Working Group (completed June 2003). Review aquaculture and commercial fishing opportunities, consult with IFWG and prepare advice to communities on the skills required to sustain these businesses.	None of the objectives in the FMS deal specifically with these issues. However, some of the objectives noted under **Goal 7**, which relate to surveys, research and improved fishery data collection and management systems may assist with the identification of opportunities for Indigenous participation and appropriate skill development programs.
To ensure that the commercial Ocean Trap and Line Fishery is managed in a manner that is consistent with sustainable resource use – i.e. that does not result in irreversible damage to habitats, or irreversible decline in the numbers or diversity of fish species		Apart from the Objectives listed under **Goal 4**, the Objectives under **Goal 1** (eg Objective 1.3- Mitigate the impact within the fishery on ocean habitats) and **Goal 2** (Prevent overfishing of the stocks of primary and key secondary species by ocean trap and line fishers), will help to address this community aspiration. Some objectives under **Goal 3** will also be of relevance to Aboriginal community values eg **Objective 3.1 (c)** and **3.1 (d)** which deal with the management of protected and threatened species. **Objective 6.5** also deals with broader resource sustainability issues.

4.0 IMPACT EVALUATION AND RECOMMENDATIONS

Although Indigenous communities along the NSW coast have a long standing and important relationship with marine resources, the currently available information suggests that the most important habitats and species are those along the beaches and rocky headlands and in shallow nearshore waters. Some species that are targeted by commercial Ocean Trap and Line fishers also use these habitats. Certainly, some non fishery species that appear to have important cultural associations for the Indigenous community (such as dolphins, whales and turtles) occur both in inshore and offshore waters. The Fishery Management Strategy includes measures to ensure that these species are not impacted by commercial Ocean Trap and Line fishing activities.

The Planning guidelines for this assessment require that the **risks** to indigenous people's values are noted, both for the current situation and with the strategies nominated in the FMS in place. The impact assessment has addressed four key issues about the relationship of commercial ocean trap and line fishing activities and the fishery practices and values of the Indigenous community. These issues are noted in **Table 4.1**, together with a summary statement about the anticipated risk to Indigenous values with current management and with the strategies noted in the FMS in place.

The concept of risk incorporates both a probability factor (how likely an impact is to occur) and a consequence or magnitude factor (how severe the impact would be). A standard risk assessment approach is difficult to apply with the type of information that is available about Indigenous fishery and marine habitat values. **Table 4.1** therefore presents a simple qualitative assessment and ranking of risk.

Table 4.1 - Summary of Risks to Indigenous Values, with FMS Strategies in place

Broad issue/value	Risk – existing management	Risk – FMS strategies implemented
Aboriginal sites – the physical evidence of past Aboriginal land use	Low (low probability and low consequence)	Very low/minimal (very low probability and low consequence). It is most unlikely that the ocean trap and line fishery will impact on Aboriginal sites on the deep sea floor.
Aboriginal places – the locations that are associated with stories about the landscape or with personal and community totemic associations with the natural world	Low	Low. Whilst some headlands and islands are known to be places of cultural value, often associated with stories, there is limited potential for ocean trap and line activities to impact on these places. Further involvement of Aboriginal people in the fishery MAC will minimise this risk.
Aboriginal marine totem species	Moderate	There is limited detailed documentation about Indigenous totem species in the NSW marine environment and the significance of impacts on/risks to these values is therefore difficult to determine. Whilst there can be no doubt that some totem species are target species in the commercial fishery, the extent of concern to Aboriginal people needs further clarification. Initial steps to reduce risk involve further consultation with Aboriginal people, particularly Elders.

Table 4.1 - Summary of Risks to Indigenous Values, with FMS Strategies in place (cont)

Broad issue/value	Risk – existing management	Risk – FMS strategies implemented
Aboriginal cultural landscapes – the places and species in the landscape that are important to Aboriginal people. As a separate issue from Aboriginal places, this refers to the presence and distribution of Aboriginal foods and medicines in the marine landscape	Low to moderate	Low – risk will be reduced as better information about species of concern to communities along the whole coast become better documented and Indigenous participation in fishery management is enhanced.
Aboriginal socioeconomic participation in the commercial fishing sector	Moderate – currently very low participation	Low to moderate – the strategy may facilitate enhanced opportunities for economic participation and skill development, in association with the actions that are priorities in the Indigenous Fisheries Strategy and are further explored in the Indigenous Commercial fishing opportunities action plan. Adoption of key recommendations of the Indigenous fisheries Advisory Committee will help to open up opportunities and reduce the risk that commercial fishing strategies present to Indigenous rights.

Table 4.1 indicates the objectives and actions proposed in the Ocean Trap and Line FMS present generally low risks to Indigenous values. The FMS will not result in additional impacts on Aboriginal sites or places, and the measures proposed are expected to further reduce any small existing impacts. Two areas would benefit from further research and consultation and the information arising from these studies would greatly enhance the certainty tat risks are being effectively managed.

The first key issue for further research is to obtain more information about traditional cultural fishing practices in all regions of the NSW coast. This should include fishing practices, fishing purpose, participation, locations, links to totems, places and other objects of value to local Aboriginal communities.

The second issue is to further explore measures to encourage and maintain Aboriginal participation in the commercial sector, including the Ocean Trap and Line fishery. It should not be anticipated that this issue can be resolved through the Ocean Trap and Line FMS alone. However, Ocean Trap and Line fishers and the Indigenous community should both participate in discussions about potential changes to the *Fisheries Management Act* and the potential introduction of affirmative action programs to enhance Indigenous capacity to enjoy their rights to economic independence.

The implementation and review of the Ocean Trap and Line FMS, in association with the Indigenous Fisheries Strategy, is likely to have some benefits for Indigenous stakeholders.

5.0 REFERENCES

Ainsworth J. Reminiscences 1847-1922. Richmond River Historical Society.

Anderson W (1890). Notes on the shell heaps, or kitchen middens accumulated by the Aborigines of the southern coastal district. *Records of the Geological Survey of New South Wales*, **2**, 52-60.

Attenbrow V (2002). Sydney's Aboriginal Past: Investigating the archaeological and historical records. University of NSW Press.

Callaghan B and Associates Pty Ltd, for NSW Indigenous Fisheries Advisory Committee (2003). A Draft discussion Document and Action Plan. Developing the Participation of Indigenous People in Commercial Fishing. Report of a workshop in June 2003.

Colley S M (1987). Fishing for facts: Can we reconstruct fishing methods from archaeological evidence? *Australian Archaeology* **24**, 16-25.

Cozens Z (2003). Involving Kooris in Fisheries Management – NSW Far South Coast. Paper presented at the 12th NSW coastal Management Conference, Port Macquarie, pp 53-62

Egloff B J (1981). Wreck Bay: An Aboriginal Fishing Community. Australian Institute of Aboriginal Studies, Canberra.

English A (2002). The Sea and the Rock Gives Us a Feed. Mapping and Managing Gumbaingirr wild Resource Use Places. NPWS.

Faulkner A (2000). Aboriginal Fisheries in NSW. Paper presented at the 10th NSW Coastal Management Conference, Yamba, pp 1-13

Fry C (1843). Report on the Aborigines of the Clarence District. *Historical Records of Australia, Series 1*, 22:652.

Gunjil Jindabah Centre (1996). Aboriginal sites of Significance. Regional Report of upper North Coast NSW, Volume 6, Heritage, Aboriginal and Social Issues. Resource Conservation and Assessment Council, Sydney.

Henry GW and Lyle JM (2003). The National Recreational and Indigenous Fishing Survey. FRDC Project 99/158. NSW Fisheries Final Report Series No. 48. Fisheries Research and Development Corporation.

Hodgkinson C (1845). Australia from Port Macquarie to Moreton Bay with descriptions of the natives, their manners and customs; the geology, natural productions, fertility and resources of that region. T and W Boone, London.

Hughes P and Sullivan ME (1974). The redeposition of midden material by storm waves. *J. Proc. Royal Society NSW*. **107**, 6-10.

Lingiari Foundation (2002) Indigenous Rights to Water Report: Lingiari Report to ATSIC (Volume 1 and Offshore Water Rights Discussion Papers).

Mackaness G (1941). George Augustus Robinson's journey into south Eastern Australia, 1844, with George Henry Haydon's narrative of part of the same journey. Australian historical Monographs 19. Ford, Sydney.

NSW Aboriginal Land Council (2002). Indigenous Fisheries Consultations: Central Coast Regional Aboriginal Land Council and Far North Coast Regional Aboriginal Land Council (Report of workshops at Tweed Heads and Forster).

NSW Fisheries (2002a). Indigenous Fisheries Strategy and Implementation Plan.

NSW Fisheries (2002b). Survey of Recreational Fishing in NSW. Interim Report by NSW Fisheries.

Robinson G A (1844). *Journals*, Volume 19, Mitchell Library Sydney.

Rose D, James D and Watson C (2003). Indigenous Kinship with the Natural World in New South Wales. NPWS (project funded by NPWS and the NSW Biodiversity Strategy).

Schnierer S and Robinson S (1993). Coastal Environmental Uses and Issues in Aboriginal Communities: A case history from northern NSW. Chapter 21 in the State of the Marine Environment Report for Australia, Technical Summary. (Compiled by Zann, Great Barrier Reef Marine Park Authority), Townsville Queensland.

Schnierer S and Faulker A (2002). A Description of the Aboriginal Fisheries of NSW. Report funded by the Fisheries Action Program, Natural Heritage Trust and prepared by the Centre for Indigenous Fisheries, School of Environmental Sciences, Southern Cross University.

Sullivan M E (1982). Aboriginal shell middens in the coastal landscape of New South Wales. Thesis submitted for PhD, Australian National University.

Tsamenyi M and Mfodwo K (2000). Towards Greater Indigenous Participation in Australian Commercial Fisheries: Some Policy Issues. Centre for Marine Policy, University of Wollongong and Law School, University of Tasmania, for ATSIC.

PART 2

6.0 HISTORIC HERITAGE

This part of the assessment addresses the issues identified in Part B 5.4 (a) and (b) and Part E 4.4 (a) and (b) of the EIS Guidelines for the Ocean Trap and Line Fishery, issued by DIPNR in February 2003. These requirements are noted below:

Part B 5.4

(c) Identify any shipwreck sites or other sites of historic heritage that are affected by fishing activities and outline existing protocols/measures to minimize impacts to these sites.

(d) Summarise the overall risk to European heritage sites from the current operational arrangements taking into consideration the likelihood/frequency of impacts and the consequence of the impacts occurring.

Part E 4.4

Identify the impacts of the draft FMS on:

(a) Any shipwreck sites or other sites of historic heritage that are/were affected by fishing activities;

(b) Summarise the overall risk to European heritage sites from the management measures identified in the Draft FMS taking into consideration the likelihood/frequency of impacts and the consequence of the impact occurring.

The key issue arising from these requirements is an assessment of the relative risks presented to historic heritage sites and values (but principally shipwreck sites) by the current management strategies for the ocean trap and line fishery and by the proposed management of the fishery.

In broad terms, the potential risks to historic heritage derive from the following aspects of the operation of the fishery:

- direct impacts by vessels on shipwrecks; and
- fishing gear becoming snared or entangled on parts of shipwrecks and affecting the integrity of the heritage structure. In this case, there is also a risk to the safety of licensed fishers and their crew if gear is not easily disentangled from the shipwreck. There are a number of instances of damage to or sinking of fishing vessels after nets became snared on shipwrecks.

As noted in the DIPNR Director's Requirements, risk comprises a combination of probability and consequence. Risk assessment concepts and methods are defined in Australian Standard (AS) 4360:1990. Risk assessment processes can vary from qualitative preliminary considerations which use broad consequences and likelihoods to give an understanding of comparative risk, to highly quantified assessments that provide detailed ranking of the risks associated with all aspects of a proposal or operation. For the purposes of this assessment, detailed quantification and ranking of risks is not considered necessary and risk has been considered in qualitative terms.

6.1 STRUCTURE OF THIS ASSESSMENT

The assessment reports the results of a review of the historic heritage that is located off the NSW coastline. The review of historic heritage has defined those elements of the resource that are, or appear to be, located in such a position that either ocean trap and line fishing commercial operation might have some impact on an element or vice versa.

For the purposes of this report, historic heritage has been confined to the transport context having regard to the location of the study area. It is considered highly unlikely that other types of historic heritage (buildings, wharves etc) will have any interaction with the trap and line fishery. The transport context is specifically represented in the record of shipwrecks.

This assessment therefore addresses shipwrecks that have been recorded in offshore NSW and Australian waters. It is heavily based on data contained in the 'Maritime Heritage Online – NSW' database (the database), which is maintained by the NSW Heritage Office. Only a sample of the information from the database has been analysed, for the waters off the coastlines of the Northern Rivers, Mid North Coast, Illawarra and South East regions. These areas have a strong maritime history and high concentration of offshore shipwrecks and are recognised ocean trap and line fishing grounds. The analysis that is presented demonstrates that shipwrecks are common right along the NSW coast in waters used by ocean trap and line fishers.

Section 2 of the assessment identifies the sources of information that have been used to provide guidance on the nature and location of shipwrecks in NSW coastal waters. This section also reviews the statutory controls that must be taken into account by fishery managers where there is potential for trap and line activities to interact with shipwreck sites.

Section 3 of the assessment describes the results of data base searches, with particular reference to the accuracy and reliability of entries. This section also provides information about the concept of significance. The significance of a site is an important factor when considering the risks associated with the interaction of the fishery and the cultural heritage resource.

Section 4 reviews the objectives and actions that are identified in the draft Fishery Management Strategy, and considers whether these actions adequately reduce or manage the potential risks to heritage values.

7.0 METHOD – DATA COMPILATION AND ASSESSMENT

For this component of the study, the sources of data were the database with additional source material obtained from:

- *The Register of British Shipping;*
- Annual reports of government departments, particularly in the latter quarter of the 19th Century;
- The Register of the National Estate, maintained by Environment Australia;
- The (NSW) State Heritage Register, maintained by the NSW Heritage Office;
- The (NSW) State Heritage Inventory, maintained by the NSW Heritage Office;
- *Bar Dangerous: A Maritime History of Newcastle* (Callan 1986) and *Bar Safe* (Callan 1994);
- Index of shipwrecks on the NSW Coast Between the Hawkesbury and Manning Rivers, 1788-1970 (Fletcher nd);
- *Australian Shipwrecks* (Loney 1980);
- *Wrecks on the New South Wales Coast* (Loney 1993);
- *Shipwreck Atlas of New South Wales* (NSW Heritage Office 1996);
- *Centenary: NSW Steamship Wrecks* (Parsons 1995);
- *Scuttled and Abandoned Ships in Australian Waters* (Parsons & Plunkett 1998);
- Navigational charts of the coastline and estuaries; and
- Information from statewide and local newspapers.

The sources of data are collectively referred to as ‘the marine archaeological record’.

Search of the marine archaeological record indicated that more than 250 shipwrecks have been recorded within the sectors of the study area that have been examined in detail. Within the Hunter, Central Coast and Sydney sectors of the study area, at least that number again of shipwrecks has been recorded offshore. One of the difficulties posed by the database, and by the marine archaeological record generally, was that the location of many shipwrecks could not be specified with any degree of accuracy, particularly regarding shipwrecks of the 19th Century. The judgment involved in differentiating offshore from onshore and estuarine shipwrecks was guided by the following criteria:

1. Detail of the geographical location of the wreck and/or precision in description of geographical features relevant to the wreck. For example, while a wreck described as located east of Green Cape is relatively definitive, one that refers to the wreck location as being simply ‘Port Stephens’ may refer to the estuary, or offshore or inshore but a reference to ‘Hannah ([sic: Anna] Bay’ will probably place the wreck in inshore waters.
2. The nature of the vessel’s voyage, e.g. international, inter-colonial, coastal intra-state, or port service. Thus, a vessel described only as having been wrecked ‘east of Green

Cape' in transit from Clarence River to Melbourne with sawn hardwood will have been unlikely to have been inshore at that stage of the voyage.

3. The circumstances of the loss, e.g. navigation error, failure of equipment, condition of wind and/or weather. The examples of such causes are boundless and need to be read in conjunction with criteria 1 and 2 above.

Greater precision in describing the disposition of shipwrecks might only be achieved by an exhaustive research of primary sources and is not considered necessary at this stage.

Appendix 2 tabulates the shipwrecks that are recorded in the marine archaeological record for the regions studied.

7.1 STATUTORY FRAMEWORK

This section outlines the historic heritage protection that is required by State, Federal and local legislation and indicates specific statutory constraints that may affect proper management of heritage resources in the context of the use of NSW offshore waters for commercial fishing.

The seventh column, headed 'Protection', in the data base presented in **Appendix 2**, indicates against each shipwreck recorded, the level at which protection is/or is not afforded by Commonwealth or State legislation. The level of protection is explained in the following **Sections 7.1.1** and **7.1.2**.

7.1.1 National Constraints

Apart from general heritage and planning legislation at Commonwealth and State levels, shipwrecks may be protected under the *Historic Shipwrecks Act* 1976. The Act applies within Commonwealth waters and, upon the declaration by a State that the Commonwealth Act so applies, to the waters of a State. New South Wales has made such a declaration. The seventh column of **Appendix 2** indicates to which shipwrecks the *Historic Shipwrecks Act* 1976 applies**.** The *Historic Shipwrecks Act*, s4A, sets out the base criteria for consideration of a shipwreck as historic as being that the shipwreck be:

(a) situated in Australian waters, or waters above the continental shelf of Australia, adjacent to the coast of a Territory; and

(b) at least 75 years old.

The Act further provides that:

- the Minister may declare historic the remains of disturbed or fragmented shipwrecks and artefacts related to shipwrecks (s4A(5), –(6), –(7));
- whether or not within the base criteria, the Minister may declare historic individual shipwrecks, the individual remains of disturbed or fragmented shipwrecks and individual artefacts related to shipwrecks (s5);
- whether or not within the base criteria, the Minister may make a provisional declaration of a shipwreck or of artefacts associated with a shipwreck pending determination (s6);
- the Minister may declare a 'protected zone' not exceeding 200 hectares as the curtilage of a shipwreck (s7);

- upon publication in the Gazette of a notice declaration a shipwreck and/or site and/or article historic, a person holding an artefact related to the declaration must give it to the Minister (s9) and the minister is empowered to demand the surrender of such an article by notice (s10);
- the Minister may give directions as to the custody of material the subject of declaration (s11);
- it is an offence to destroy, damage, disturb or interfere with an historic shipwreck or artefact or to attempt to dispose of any material to which a declaration applies (s13);
- it is an offence to enter a protected zone with tools, explosives, equipment for diving and/or conducting any prohibited activities; to trawl, dive or undertake any other underwater activity; or to moor (s14);
- the Minister is empowered to issue permits to allow the exploration or recovery of a shipwreck or artefacts associated with a shipwreck (s15); and
- any person discovering a shipwreck or artefacts from a shipwreck must report the find to the Minister (s17).

The Act also provides penalties for offenders against its provisions.

7.1.2 State Constraints

The seventh column of **Appendix 2** indicates shipwrecks that are listed on the NSW State heritage registers. The requirements of the (NSW) *Heritage Act* 1977 must therefore be taken into account by any management planning that affects those resources. The *Heritage Act* established measures for the protection of heritage resources. Heritage sensitivity may be indicated by historical research and/or by various on-site archaeological surface surveys. The basic unit for the assessment of heritage significance pursuant to the *Heritage Act* is the ‘relic’. The *Heritage Act* defines a relic as:

> *Any deposit, object or material evidence –*
>
> *(a) which relates to the settlement of the area that comprises NSW, not being Aboriginal settlements; and*
>
> *(b) which is 50 or more years old.*

The Act further provides that:

- sites and relics in a range of descriptions are protected from disturbance and damage (ss. 24-34, 35A-55B, 130, 136-7, 139) and ss. 47-52 inclusive apply specifically to ‘Protection of Historic Shipwrecks’;
- relics may be the subject of conservation orders (ss. 26(2)(b), 35A,36,37, 44, 48);
- relics in shipwrecks are protected in situ on all sites (ss. 26(2)(a), 35A36, 37, 44, 51);

- if a site or relic is listed on the NSW Heritage Register no activity may proceed that will disturb, or for the discovery of, relics except with an Excavation Permit (ss. 57, 60);

- no activity may proceed that will disturb, or for the discovery of, relics (not subject to a conservation instrument) except with an Excavation Permit (ss. 47, 139, 140);

- location of relics must be reported to the Heritage Council (s. 146); and

- recovery of relics from excavation must be reported to the Heritage Council (s. 146A).

The Act provides penalties for offenders against its provisions (s. 157).

8.0 RESULTS

By an application of the judgment criteria to the raw results of researching the marine archaeological record, approximately 1100 shipwrecks appear to be located within New South Wales non-estuarine coastal waters. Of these approximately 260 are recorded offshore of the coastlines of the Northern Rivers, Mid North Coast, Illawarra and South East regions of the total New South Wales coastline.

It is clear from **Appendix 2** that it is difficult to pinpoint the locations of these wrecks, or the amount of wreckage that may still remain, with any certainty. For many wrecks, only limited, broadly descriptive information is available, and the extent to which parts of the wreck may be exposed to snagging on nets etc is difficult to determine. The condition of a shipwreck will depend on the nature of the vessel (size and type of construction), depth of water, the circumstances that caused the wreck, subsequent disturbance, and marine processes such as waves, currents and sediment transport. For many shipwrecks, little of this information is known directly.

As discussed in **Section 2** and noted in **Appendix 2**, almost all the shipwrecks along the NSW coast are protected by either the Commonwealth heritage legislation (*Historic Shipwrecks Act*) or by the *NSW Heritage Act*. For example, of the 260 or so shipwrecks identified in the Northern Rivers, Mid North Coast, Illawarra and South East regions of the coast, less than twenty shipwrecks do not have protection under either the Historic Shipwrecks or NSW Heritage Acts.

8.1 THE CONCEPT OF SIGNIFICANCE

The extent to which an item of historic heritage may be a constraint to the operation of the Ocean Trap and Line fishery is strongly influenced by the assessment of its significance. This section explains the concept of cultural significance and the following section notes the significance that has been attributed to various heritage resources. The protection afforded by Commonwealth and State heritage and planning legislation is also noted.

The *Heritage Act* 1977 (NSW) defines items of environmental heritage to be:

> *Those buildings, works, relics or places of historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance for the state of New South Wales.*

In the context of this report, significance is the measure of the value and importance of elements of the archaeological record to cultural heritage. While the fabric of the archaeological record is the subject of the assessment of heritage significance, the assessment itself is conditioned by the environmental and historic context of the site. Furthermore, an evaluation of heritage significance is not static but evolutionary, as a function of evolving community perspectives and cultural values.

The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter) classifies the *nature* of cultural significance in terms of historical, aesthetic, scientific and social criteria. The implications of these classifications are as follows:

- Aesthetic significance addresses the scenic and architectural values of an item and/or the creative achievement that it evidences. Thus, an item achieves aesthetic significance if it has visual or sensory appeal and/or landmark qualities and/or creative or technical excellence.

- Historical significance considers the evolutionary or associative qualities of an item with aesthetics, science and society, identifying significance in the connection between an item and cultural development and change.

- Scientific significance involves the evaluation of an item in technical and/or research terms, considering the archaeological, industrial, educational and/or research potential. Within this classification, items have significance value in terms of their ability to contribute to the better understanding of cultural history or environment and their ability to communicate, particularly to a broad audience within a community.

- Social significance is perhaps the most overtly evolutionary of all classifications in that it rests upon the contemporary community appreciation of the cultural record. Evaluation within this classification depends upon the social spiritual or cultural relationship of the item with a recognisable community. (Marquis-Kyle & Walker 1992, 21-23).

Historical study looks to the documentary record of human development and achievement, as interpreted by the authors of the documents that comprise the primary and secondary resources. In parallel, historical archaeology is concerned not only with the documentary record but also with material evidence. The archaeological record may provide information not available from historical sources. An archaeological study focuses on the identification and interpretation of material evidence to explain how and where people lived, what they did and the events that influenced their lives. Considerations material to archaeological study include:

- whether a site, or the fabric contained within a site, contributes knowledge or has the potential to do so (perhaps, whether the archaeological record validates or contradicts the historical). If a site can contribute knowledge within the *nature* criteria above, the availability of comparative sites and the extent of the historical record should be considered in assessing the strategies that are appropriate for the management of the site; and

- the level at which material evidence contributes knowledge in terms of current research themes in historical archaeology and related disciplines.

The ‘level of contribution’ is thus a critical determinant and is assessed according to the same protocols as is cultural significance, that is, in terms of representativeness/rarity and local/regional/state associations.

In relation to “research themes and historical archaeology and related disciplines”, the direction of historical archaeology implies, and is conditioned by, consideration of historic, scientific, cultural, social, architectural, aesthetic and natural values. It is a convenient method of classifying the values of material evidence, within the Nature criteria above, in terms of the following broad model:

- *Historical* value lies at the root of many of the other values by providing a temporal context and continuity, thereby providing an integrating medium for the assessment of social, cultural and archaeological significance;

- *Scientific* value depends upon the ability of an item to provide knowledge contributing to research in a particular subject or a range of different subjects;

- *Cultural* value attaches to artefacts which embody or reflect the beliefs, customs and values of a society or a component of a society and/or have the potential to contribute to an understanding of the nature and process of change and its motivation;

- *Social* value derives from the way people work(ed) and live(d) and from an ability to understand the nature, process of change and its motivation. Social significance is closely related to cultural significance, in its concern with the practicalities of socio-cultural identification;

- *Architectural* value depends on considerations of technical design (architectural style, age, layout, interior design and detail), the personal consideration (i.e. the work of a particular architect, engineer, designer or builder) and technical achievement (construction material, construction technique, finish);

- *Aesthetic* value addresses the manner in which an item comprises or represents creative achievement, epitomising or challenging accepted concepts or standards; and

- *Natural* value attaches to items that either support or manifest existing natural processes and/or systems or which provide insights into natural processes and/or systems.

Within this general framework, the assessment of significance is made in the light of two distinct measures: the degree of significance and the level of significance.

- The *degree of significance* of heritage material is evaluated as being either representative or *rare*. *Representative* items are those which are fine distinctive, characteristic and/or illustrative examples of an important class of significant item or a significant aspect of the environment. *Rare* items are those which singularly represent or represent an endangered, discrete, or uncommon aspect of, history or cultural environment. By derivation, items considered within the context of broader investigation as being insignificant may be dismissed by an evaluation of *little or none.*

- The *level of significance* of heritage material is assessable in five classifications depending upon the breadth of its identifiable contemporary community or historical or geographical context. Thus –

  - a *local* classification recognises an item as being significant within a local historical/geographical context or to an identifiable contemporary local community;

  - a *regional* level of significance recognises the item as significant within a similar regional historical/geographical context or identifiable contemporary regional community; and

  - a *state* level of significance identifies that item as significant in a statewide historical/geographical context or to an identifiable contemporary statewide community (Heritage Office 1996, 4-7).

  and by derivation:

  - a *national* level of significance attaches to an item that is significant in a nationwide historical/geographical context or to an identifiable contemporary nationwide community; and

  - an *international* level of significance has the appropriate connection to international context or the international community.

9.0 RISKS TO HISTORIC HERITAGE VALUES

9.1 THE INTERACTION OF COMMERCIAL FISHING WITH HISTORIC HERITAGE RESOURCES

The activities associated with commercial ocean trap and line fishing are limited to associated boating, boat management, and the use of a variety of gear.

The physical and spatial presence of heritage resources along ocean floors and associated submarine landforms is likely to have only a marginal effect on commercial fishing operations. It is possible for wreckage to pose a hazard to navigation and to fishing activities by representing a potential snag for nets or other gear.

While navigation of boats is unlikely to pose a significant threat to shipwrecks and associated maritime relics, snagging of nets on the ocean floor has the potential to cause disturbance, damage or destruction to submarine relics. Submarine relics are by their nature fragile while their *in situ* preservation is most frequently either precarious or on/or within a horizon of fine silt or sand. Disturbance of a relic in either of these environments can not only modify, damage or destroy a relic but alternatively or concurrently modify the environment in which it is located by moving, exposing or burying the relic.

9.2 MANAGEMENT OBJECTIVES OF THE DRAFT OCEAN TRAP AND LINE FISHERY MANAGEMENT STRATEGY

Goal 4 of the draft FMS incorporates broad direction for the management of historic heritage:

'Appropriately share the resource and carry out fishing in a manner that minimizes negative social impacts.'

Objective 4.4(b) refers directly to historic heritage values.

'Modify the activity, where relevant, in response to new information about areas or objects of cultural significance in order to minimise the risk from ocean trap and line fishing activities'.

The background provided to this objective notes particularly the lists of historic shipwrecks and the role of the Heritage Office in relation to approvals for damage to these shipwrecks.

Objective 4.5 can also be considered to refer indirectly to the protection of historic heritage sites, by noting the intent of the FMS to resolve conflicts between ocean trap and line fishers and the interests of other members of the community. The background to this objective mentions resolution of some conflicts by small temporal or spatial closures to trap and line activities. Whilst this strategy will address conflicts with other waterway users in confined spaces (the example given is for Coffs Harbour), small closures is unlikely to be a practical response to potential conflicts with the protection of historic shipwrecks whose location and condition is not well defined.

9.3 RISK CONSIDERATIONS

Guidance on concepts for a qualitative risk assessment is provided in AS 4360. **Tables 9.1** and **9.2** summarise qualitative descriptions of likelihood and consequence. These concepts have been used in considering potential risks to historic heritage associated with the operation of the ocean trap and line fishery. It is stressed that the assessment presented here is preliminary and qualitative in scope.

Table 9.1 - Qualitative Description of Likelihood

Almost certain	May occur at least several times a year
Likely	May arise about once a year
Possible	May arise at least once in a ten year period
Unlikely	Likely to occur at some time during the next ten to twenty five years
Rare	Very unlikely to occur within the next twenty five years

Table 9.2 – Indicative Consequence Scales

Catastrophic	Long term harm – significant, extensive and irreparable damage to highly valued structures or locations of cultural significance
Major	Major damage to highly valued locations or structures of cultural significance
Moderate	Damage to valued structures or places of cultural significance (not likely to be permanent or irreparable)
Minor	Minor damage to places or structures of cultural value
Insignificant	Negligible damage to structures or locations of cultural value

Even with a qualitative risk assessment, it is possible to grade the risk that results, in terms of the urgency of action to reduce risk to the environment, cultural places or safety. Descriptors and indicative responses are noted in **Table 9.3**.

Table 9.3 - Qualitative Risk Descriptors

Extreme risk	Immediate action required to reduce risk
High	Urgent action required to reduce risk
Medium	Manage risk by monitoring or improving procedural guidelines etc
Low	Manage by routine procedures, unlikely to need specific additional resources

Table 9.4 presents consideration of two aspects of ocean trap and line fishing that have the potential to interact with historic heritage places (shipwrecks), and provides a preliminary evaluation of risks to historic heritage values. In an assessment conducted strictly in accordance with the National Standard, this assessment process would be conducted by a panel of people involved in the activities in question. The use of a panel ensures that all aspects of activities and risks are taken into consideration. For this process, which is

intended only to provide an indication of the scope of risks to historic heritage items/sites, the assessment has referred to the data base information rather than an expert panel.

Table 9.4 - Qualitative Risk Assessment Considerations

Aspect	Likelihood	Consequence	Risk
Boat navigation – collision with shipwrecks	Unlikely to rare	Moderate	Low
Entanglement/impact of gear on shipwrecks	Possible	Moderate	Low to medium

The risk presented to historic shipwrecks by the activities of the ocean trap and line fishery is generally low, extending to medium for snagging in some cases. In this context, the types of response that would be appropriate in the Fishery Management Strategy relate to procedures for monitoring (for instance locations, frequency and consequence) and reporting incidents.

The draft Fishery Management Strategy requires that fishers respond to new information about heritage resources. Although the risk that ocean trap and line activities will detrimentally impact on historic heritage resources is generally low, the operation of the ocean trap and line fishery does present an opportunity to further reduce risks in the long term by contributing to improved spatial data about the locations of shipwrecks.

A key constraint to the accurate assessment of risk is that details about the locations and condition of many shipwrecks are poor. Ocean Trap and Line fishers may from time to time encounter shipwreck remains on the sea floor. When this occurs, fishers could report location (GPS co-ordinates, water depth) and any other information they detect about the structure to the NSW Heritage Office and NSW Fisheries. This information will add to the data base, so that fishers can be alerted about potential obstacles on the sea floor (with heritage and safety implications), and the Heritage Office will have more accurate information about the location of shipwrecks.

Implementation of routine reporting of potential shipwreck sites to the Heritage Office will contribute to the demonstration of due diligence (by showing that fishers are aware of potential risks and are taking steps to reduce them), as well as refining the available information.

A second appropriate management response is to provide licence holders with basic information about their responsibilities under the *Heritage Act*, including the provisions relating to damage to structures, exclusion zones and collection of any historic artefacts that may be observed.

Note that the *Heritage Act* requires notification of the Heritage Office if a relic is found (or suspected) and also requires that relics not be disturbed without obtaining a permit. In rare cases, this would mean that fishing in the vicinity of a structure that has been reported to the Heritage Office should cease until the nature and significance of a relic has been investigated and confirmed.

9.4 RECOMMENDATIONS

These recommendations are made on the basis of:

- the review of the heritage assets in offshore precincts of the study area contained in this report in **Appendix 2**;
- the limited descriptions of the fabric and the precise locations of some of the material evidence offshore relating to shipwrecks;
- synthesis of the archaeological and historical contexts that is available from the review;
- the appreciation of the significance of the heritage resources; and
- consideration of the management issues and potential impacts of the proposed use.

It is recommended that in general in connection with the operation of the commercial ocean trap and line fishery, the attention of all authorities and agencies has been, and that of all commercial fishers, their contractors and employees will be, directed to:

a) the provisions of the Commonwealth *Historic Shipwrecks Act* 1976 and in particular to:

   i) the definition of shipwreck under that Act (s.4A);

   ii) the provisions of ss.4A, 5, 7, 9, 10, 11, 13, 14, 15 and 17 of that Act;

b) the provisions of the NSW *Heritage Act* 1977:

   i) the definition of relic under the Act (s.4);

   ii) the provisions of sections 24-34, 35A-55B, 57, 60, 130, 136-7, 139 and 140 of that Act;

c) submarine shipwrecks and/or relics may be exposed or covered from time to time as the result of current fluctuations and movement of ocean floor sediments. If an item suspected of being part of an historic shipwreck or other shipwreck becomes visible as a result of water conditions or inadvertent disturbance it should be reported in the first instance to the Minister pursuant to the *Historic Shipwrecks Act* 1976 and/or to the NSW Heritage Office pursuant to the *Heritage Act* 1977;

d) if any activity is proposed that will, or may, cause the disturbance of a shipwreck/relic that is registered on the SHR, an application should be made pursuant to s.57 of the *Heritage Act* for issue of an excavation permit pursuant to s.60 of the Act;

e) if any activity is proposed that will, or may, cause the disturbance of a shipwreck/relic that is not registered on the SHR, an application should be made pursuant to s.139 of the *Heritage Act* for issue of an excavation permit pursuant to s.140 of the Act;

f) the basic requirements that, in relation to any commercial fishing activity, if:

   - a shipwreck or relic is suspected or if there are reasonable grounds to suspect a relic that is likely to be disturbed, damaged or destroyed by commercial fishing activity; and/or

   - any relic is discovered in the course of commercial fishing activity that will be disturbed, damaged or destroyed by further such activity;

the NSW Heritage Office must be informed forthwith and commercial fishing activities suspended that might have the effect of disturbing, damaging or destroying such relic, until the requirements of the Heritage Office have been satisfied.

10.0 REFERENCES

Annual reports of government departments, particularly in the latter quarter of the 19th Century.

Callan (1994). *Bar Dangerous: A Maritime History of Newcastle* (Callan 1986) and *Bar Safe*

Fletcher (nd). Index of shipwrecks on the NSW Coast between the Hawkesbury and Manning Rivers, 1788-1970

Loney (1980). *Australian Shipwrecks*

Loney (1993). *Wrecks on the New South Wales Coast*

NSW Heritage Office (1996). *Shipwreck Atlas of New South Wales*

NSW State Heritage Register, maintained by the NSW Heritage Office

NSW State Heritage Inventory, maintained by the NSW Heritage Office

Parsons (1995). *Centenary: NSW Steamship Wrecks*

Parsons & Plunkett (1998). *Scuttled and Abandoned Ships in Australian Waters*

Register of the National Estate, maintained by Environment Australia

Standards Association of Australia, Australian and New Zealand Standard AS/NZS/4360: Risk Management. 1999

The Register of British Shipping

APPENDIX 1

Background Information

NSW Fisheries

Environmental Impact Assessment for Ocean Trawling and Ocean Trap and Line Fisheries

Information for local Aboriginal community organisations

An invitation to contribute to the development of a plan for sustainable Ocean Trawl and Ocean Trap and Line Fishing

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Background

The NSW Fisheries Management Act requires that a management strategy is developed for all major fisheries in NSW. NSW Fisheries is also required to assess the environmental impact of each fishery.

NSW Fisheries has been progressively preparing new management strategies for the fisheries of NSW over the last three years. The Indigenous Fisheries Strategy (IFS) was produced in 2002, following five years of discussion with Aboriginal communities. The IFS provides a new framework for the participation of Aboriginal people in all other aspects of fishery management in NSW.

Fishery Management Strategies have also been prepared for the Estuary General, Estuary Prawn Trawl, Ocean Haul and Fish Stocking components of the State's fisheries. An Environmental Impact Statement has been prepared in association with each of the Fishery Management Strategies to evaluate how the strategy will interact with, benefit or impact on the environment and on other people who may have an interest in the fish resources.

Work has now commenced on the preparation of a Fishery Management Strategy and Environmental Impact Statement for the ocean trawl and ocean trap and line fisheries.

What activities are involved in Ocean Trawl Fishing?

Ocean Trawl fishing occurs in ocean waters along the NSW coast, extending seaward to the margin of the continental shelf. Ocean Trawl operators work in diverse marine habitats. The nature and distribution of these habitats is poorly understood.

Ocean Trawl fishing can target fin fish or prawns. NSW Fisheries has identified 21 species and groups of species that are targeted by ocean trawl fishing in NSW. These include cuttlefish, octopus, school whiting, silver trevally, king prawns, school prawns, redfish and gemfish. Several of the species that are targeted by Ocean Trawl fishing are also important to other fisheries in NSW, such as estuary general and ocean haul.

Currently fish trawl nets are prohibited north of Smokey Cape (South West Rocks) where prawn trawling is most important. Prawn trawlers may operate south of South West Rocks, but may only retain finfish that meet minimum size requirements. There are also closures in other areas to protect fish stocks.

Bycatch reduction devices are mandatory on all ocean trawl prawn nets to minimize the incidental catch of finfish in prawn nets. In the past, incidental bycatch has been a significant impact of trawl fishing on fish stocks.

Goals of the Fishery Management Strategies

The Fishery Management Strategy that is in preparation has multiple management goals that will guide sustainable ocean trawling and trap and line operations.

An important objective of the draft Ocean Trawl Fishery Management Strategy is to manage the fishery in a way that is consistent with the Indigenous Fisheries Strategy and Implementation Plan. This is reinforced by an objective that highlights the importance of providing appropriate access to the fishery resources by Indigenous people.

The draft strategy also includes objectives that will address environmental management issues such as:

- a Code of Conduct for fishers;
- closures around river mouths at times of high river discharge (to reduce bycatch of juvenile fish and prawns and help to maintain fish stocks);
- ongoing introduction and upgrade of environmentally friendly trawl gear;
- improved research on species and habitats;
- species recovery programs and special closures;
- there is some potential for ocean trawl fishing to interact with threatened marine species such as the Grey Nurse Shark, turtles, seals etc. Awareness training, exclusion devices and revive and release strategies are being introduced across the fishery to better protect these species; and
- better integration of fishery management along the NSW coast by the Commonwealth and NSW Governments.

Opportunities for Indigenous communities to participate in planning and management of the Ocean Trawling and Ocean Trap and Line Fisheries

The Department of Infrastructure, Planning and Natural Resources has issued guidelines for the preparation of the Fishery Management Strategies and Environmental Impacts. The EIS for ocean trawl fishing must address the following issues:

- identify the interests of Indigenous people in the resources harvested by the Ocean Trawling Fishery;
- identify the interests of Indigenous people in the habitats of fish that are targeted by the fishery;
- outline whether the fishery affects traditional fishing and how this occurs;
- describe how Indigenous people are currently involved in the fishery;
- identify any Aboriginal cultural heritage sites that are likely to be affected by the fishery activities;
- describe how the Indigenous Fisheries Strategy provides guidance about the management of the Ocean Trawling and Ocean Trap and Line fisheries; and
- describe the risks that the operation of these fisheries presents to Indigenous community values.

How you can contribute now

An effective strategy for the sustainable management of Ocean Trawling and Ocean Trap and Line Fishing in NSW depends on good information from the people who are involved in the fishery or who are affected by its activities. Any comments you might like to contribute will be welcome.

Some issues to consider include:

- Do Indigenous people in your community fish for the species that are targeted by these commercial fisheries?
- Do you fish primarily from the beach, or do you also fish offshore from boats?
- Are there any locations along the coast or offshore in your community area that have special values for your community? These might be places associated with special community stories, and are places that commercial fishers would not want to damage in any way.
- Are any members of your community actively involved in these fisheries as commercial operators?
- Would you like more information about these fisheries?

Who to contact for more information

We welcome your information and ideas about how Aboriginal people can contribute to sustainable management of the Ocean Trawling and Ocean Trap and Line Fisheries in NSW.

Here's how to contact us.

For more information about the Ocean Trawling and Ocean Trap and Line Fishery Management Strategies or to provide written comments on how Indigenous people are involved or affected by these fisheries, please contact Pam Dean-Jones at Umwelt.

Phone	02 4950 5322
Fax	02 4950 5737
Email	pdeanjones@umwelt.com.au
Mail	Umwelt (Australia) Pty Limited Attn: Pam Dean-Jones PO Box 838 Toronto NSW 2283

If you would prefer, you can also contact Tom Smith or Phil Duncan at NSW Fisheries. Tom and Phil can provide more information about how NSW Fisheries is implementing the Indigenous Fisheries Strategy, and how your community can get involved.

APPENDIX 2

Shipwrecks recorded in the Regions Studied

The database hereunder has been prepared from source(s) that sometimes provide incomplete information. The database seeks to indicate sites that lie within the Ocean Trawl, Trap and Line Fishery however specification of the location of some wrecks has required subjective judgment of the site of the event based on evidence of the activities of a vessel at the time of loss, the nature of its voyage and on the nature of rescue and reporting of the loss. Where shown below, "HSA, Federal" in the Protection" column indicates a wreck subject to the Historic Shipwrecks Act 1976, Commonwealth legislation: "NSW HA, State" indicates a wreck subject to the (NSW) Heritage Act 1977.

Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
Northern Rivers	Agnes: Wood Carvel Schooner	12/3/1890	6 miles North of Brunswick River Heads	Lost sails, foundered in gale that claimed Anne Moore, Bannockburn, Fawn, Hastings, Spurwing, Jessie Matilda and Mallagate	80 tons, 23.62x6.156m, Built 1875 Brisbane Water, Voyage/cargo unknown, 8 lost	HSA, Federal
Northern Rivers	Alberta: Steel Steamer, Screw	19/10/1890	Sutherland Reef off Tweed Heads, Lat28.253783 Long153.592217	Aground on reef, pilot error.	3398 tonnes gross, 103.6x12.86m, built 1888 Newcastle UK, voyage Japan-Melbourne, cargo coal, none lost	HSA, Federal
Northern Rivers	Alert: Wooden Schooner	_/6/1854	L-spit of Richmond River	Unknown	66 tonnes, 18.8x4.5m, built 1851 Pyrmont, voyage/cargo unknown	HSA, Federal
Northern Rivers	Anne Moore: Wooden Brigantine	3/7/1889	1 mile south of Sandon River, Solitary Islands	Aground on Anne Moore reef in gale that claimed Agnes, Bannockburn, Fawn, Hastings, Spurwing, Jessie Matilda and Mallagate (in Northern Rivers). Vessel broke up and portion of the hull later seen floating between Ballina and Byron Bay, final resting place unknown.	90 tonnes, 26.2x6.7m, built 1865, Table Cape, voyage Newcastle to Richmond River, cargo coal	HSA, Federal
Northern Rivers	Annie C Lynn: Wooden Schooner	_/_/1891	Rocks off North Head of Brunswick River	Struck rocks	54 tonnes, 21.8x5.6m, built 1876 Stockton, voyage Byron Bay-Brunswick River, cargo unknown	HSA, Federal
Northern Rivers	Annie D: Wooden Brigantine	_/7/1868 (last seen 11/7/1868)	Off Richmond River	Stranded in gale	76 tonnes, 24.99x5.882m, built 1868 Manning River, voyage to Richmond River, cargo alcohol and general cargo, nil lost.	HSA, Federal
Northern Rivers	Arrow: Wood Carvel Brigantine	3/7/1859	Tweed River bar	Foundered in easterly gale	124 tonnes, 24.14x6.52m, built unknown, voyage/cargo unknown, none lost	HSA, Federal
Northern Rivers	Atalanta: Schooner	28/2/1868	Outbound on Tweed River bar	Struck bar	Vessel details unknown, voyage from Tweed River, cargo cedar timber, none lost	HSA, Federal
Northern Rivers	Atalanta: Wooden Steamer, Paddle	_/_/1878-79	Off Clarence River	Unknown	21 tonnes, 23.9x3.2m, built 1867 Balmain, voyage/cargo unknown	HSA, Federal
Northern Rivers	Beaver: Wooden Dropsail Schooner	23/9/1851	Solitary Islands Group	Struck shore or rocks when wind failed	77 tonnes, 20.3x5.03m, built 1849 Clarence River, voyage Sydney-Moreton Bay, cargo unknown	HSA, Federal
Northern Rivers	Bramble: Wooden Schooner	28/9/1850	6 miles south of Long Point, between Richmond and Clarence River mouths	Foundered in squal	53 tonnes, 17.6x4.9m, built 1840 Moruya, voyage Richmond River-Sydney, cargo cedar timber, more than 2 lost	HSA, Federal
Northern Rivers	Cahors: Steel Steamer, Screw	10/6/1885	Evans Reef off Evans Head	Struck reef	1254 tonnes gross, 76.4x9.6m, built 1883 Fife UK, voyage Sydney-Brisbane with passengers and general cargo, 1 lost	HSA, Federal
Northern Rivers	Callender: Wooden Brig	6/6/1871	Rocks north of the Richmond River Entrance	Wind failed	139 tonnes, 27.4x7.8m, built 1846 Newport USA, voyage Melbourne-Richmond River, cargo unknown	HSA, Federal
Northern Rivers	City of Sydney: Wooden Brigantine	9/11/1868	North spit of Clarence River Heads	Struck North Spit	88 tonnes, 21.1x5.6m, built 1841 Sydney, voyage Clarence River-Geelong, cargo 1100 bags of maize	HSA, Federal
Northern Rivers	Clara: Ketch	_/_/1869	Between Richmond River and Tweed River	Lost, foundered?	40 tonnes, 19.5x4.937m, built 1867 Brisbane Water, voyage/cargo unknown	HSA, Federal
Northern Rivers	Clarence: Dredge	12/3/1890	Off Clarence River	Moored offshore during flood, broke moorings in gale	Displacement unknown, 31.39x8.534m, built 1877 place unknown, voyage Clarence River-Clarence River	HSA, Federal
Northern Rivers	Collector: Wooden Steamer, Screw	_/7/1887	Off Tweed River bar	Lost at sea, foundered?	24 tonnes, 17.6x3.4m, built 1866 Grafton, voyage/cargo unknown, apparently no loss of life	HSA, Federal
Northern Rivers	Comet: Wooden Schooner	30/3/1851	Northside of Tweed River entrance	Attempting to cross bar	34 tonnes, 14.5x4.2m, built 1843 Williams River, voyage/cargo unknown	HSA, Federal

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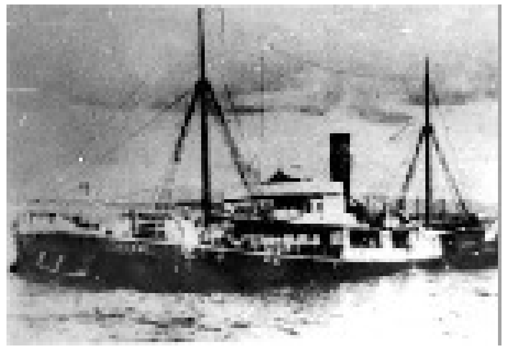
Northern Rivers	Comet: Wooden Steamer, Screw	19/3/1890	Off Richmond at mouth	Struck sand spit	82 tonnes, 29.65x5.09m, built 1883 Stockton, voyage to Broadwater with empty molasses casks	HSA, Federal
Northern Rivers	Favourite: Iron Steamer, Screw	10/6/1896	Off the North Spit, Clarence River	Foundered	29 tonnes, 23.2x4.0m, built 1870 Pyrmont, voyage Clarence River-Clarence River, in ballast, fishing	HSA, Federal
Northern Rivers	Fido: Steel Steamer, Screw	19/07/1907	Fido Reef', near Cook Island, off lighthouse, Tweed Heads, Lat28.199217 Long153.590367	Struck reef	1433 tons, 70.53x10.696m, Built 1904 Tvdestrund Norway, Voyage Nauru-Sydney with phosphate and mail	HSA, Federal

Contemporary depiction of the wreck of ss Fido



Source: Maritime Heritage Online, NSW Heritage Office

Part of the residual wreck of ss Fido

The remains of the boiler of ss Fido

Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
Northern Rivers	Frederick Davis: Wood Carvel Steamer, Screw	26/12/1908	In 6 fathoms off Bear Point Solitary Islands	Sprang a leak and sank at anchor	61 tonnes, 26.21x5.669m, built 1907 Coraki, voyage Ballina-Melbourne, cargo unknown, none lost	HSA, Federal
Northern Rivers	Friar's Craig:	_/9/1893	Near Clarence River	Lost at sea, foundered?	No details known, voyage Newcastle-Iquique, built West Coast South America, cargo unknown	HSA, Federal
Northern Rivers	Friendship: Wood Carvel Steamer, Screw	28/11/1912	Rocks at the end of Tweed River head	Unknown, presumably struck rocks	192 tonnes gross, 30.8x8.2m, built 1897 Brisbane Water, voyage from Tweed River, cargo tallow etc, no losses	HSA, Federal
Northern Rivers	Golden Fleece: Wooden Barquentine	_/4/1847	South Spit of Richmond River mouth	Drifted after wind failed	123 tonnes, 25.9x5.8m, built 1845 Sydney, voyage from Richmond River with 100,000 ft of cedar timber	HSA, Federal
Northern Rivers	Goodiron: Wooden Lighter	_/_/1895	Off entrance to Richmond River	Broke moorings	40 tonnes, 18.98x5.486m, built 1886 Balmain, voyage from Richmond River, cargo unknown, no losses	HSA, Federal
Northern Rivers	Helen Macgregor: Iron Steamer, Screw	_/_/1875 (probably 13-14/3/1875)	Reef off South Head, Clarence River	Struck reef	251 tonnes, 46.5x6.3m, built 1866 Whiteinch UK, voyage Grafton-Sydney with general cargo, passengers and prisoners, 8 lost (6 of 18 crew and 2 of 11 passengers)	HSA, Federal
Northern Rivers	Henry: Wood Carvel Brigantine	6/3/1861	North Spit Richmond River mouth	Drifted after wind failed	101 tonnes, 22.68x6.49m, built USA, voyage Ballina-Sydney with cedar timber	HSA, Federal
Northern Rivers	Hilander: Wood Carvel Brigantine	7/10/1872	North Spit of Richmond River Heads	Unknown	93 tonnes, 20.8x6m, built 1850 Tabishuifack near Brunswick Canada, voyage/cargo unknown	HSA, Federal
Northern Rivers	J and T Fenwick: Wooden Steamer, Screw	1/4/1883	Off entrance, Richmond River	Fouled towing hawser	26 tonnes, 17.9x4m, built 1871 Pyrmont, voyage Richmond River-Richmond River as tug	HSA, Federal
Northern Rivers	Jane: Wooden Schooner	_/7/1848	Tweed River or off Tweed River	Unknown	41 tonnes, 14.26x4.541m, built 1836 Manning River, voyage and cargo unknown, no losses	HSA, Federal
Northern Rivers	Jane: Wooden Schooner	_/_/1862	Richmond River or off Richmond River	Unknown	188 tonnes, 26.6x7.5m, built 1852 Cape Elizabeth (Maine) USA, voyage and cargo unknown, no losses	HSA, Federal
Northern Rivers	Jane Scott: Wooden Cutter	6/5/1849	Off Tweed River	Struck reef in SW gale, hull broke up half sinking north and half sinking south of the river mouth	36 tonnes, 14.6x4.3m, built 1842 Port Macquarie, voyage Tweed River-Sydney with cedar timber, no losses	HSA, Federal

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Northern Rivers	Jessie Matilda: Wooden Brigantine	21/7/1889	Evans Reef ~18 miles south of Ballina	Struck reef in the gale which caused the loss of the Agnes, Anne Moore, Bannockburn, Hawn, Hastings, Spurwing and Mallagate	88 tonnes, 26.4x6.3m, built 1877 Cape Hawk, voyage Sydney-Richmond River with general cargo, no losses	HSA, Federal
Northern Rivers	Kalara: Iron Steamer, Paddle	8/11/1886	2 miles off Point Danger, Tweed	Unknown	166 tonnes, 39.62x6.111m, built 1881 Brisbane, voyage Tweed River-Brisbane with passengers and general cargo, no losses	HSA, Federal
Northern Rivers	La Perouse: Wood Carvel Schooner	27/12/1878	Off Clarence River	Unknown	113 tonnes, 27.3x7.1m, built 1878 Jervis Bay, voyage Clarence River-Lyttelton, NZ, with ironbark girders, no losses	HSA, Federal
Northern Rivers	Liffy: Wood Carvel Brigantine	18/7/1898	Off North Head, Richmond River	Tow rope parted, struck rocks	102 tonnes, 29.32x6.705m, built 1885 Brisbane Water, voyage Wollongong-Richmond River with coal	HSA, Federal
Northern Rivers	Limerick: Steel Steamer, Screw	26/04/1943	35 km northeast of Cape Byron	Either torpedoed	8724 tonnes, 140.3x19.11m, built 1925 Port Glasgow UK, voyage/cargo unknown, 2 lost	Not protected
Northern Rivers	Lismore: Wood Carvel Schooner	1/11/1891	Off Clarence River	Collision with Eurimbla	181 tonnes, 30.57x7.01m, built 1878 Port Stephens, voyage Richmond River-Clarence River, cargo unknown, 2 lost	HSA, Federal
Northern Rivers	Mabel White: Wood Carvel Topsail Schooner	20/3/1894	~8 miles off Richmond River	Sprang a leak	84 tonnes, 24.84x6.278m, built 1881 Cape Hawk, voyage Newcastle-Townsville with coal, no losses	HSA, Federal
Northern Rivers	Madge Wildfire: Wooden Schooner	28/3/1851	Off Richmond River bar	Easterly gale	26 tonnes, 14.72x4.206m, built 1850 Broulee, voyage Richmond River-Richmond River, in ballast, 5 lost	HSA, Federal
Northern Rivers	Mary Ann: Wood Carvel Brigantine	13/1/1874	Off Clarence Head	Wind failed drifted onto northern spit	134 tonnes, 26.06x5.334m, built 1851 Sorel Canada, voyage Newcastle-Clarence River with coal, no losses	HSA, Federal
Northern Rivers	Mary Jane: Wood Carvel Schooner	_/7/1861	Between Sydney and Tweed River	Unknown	46 tonnes, 18.47x4.846m, built 1861 Bellinger River, voyage Tweed River-Sydney, cargo unknown	HSA, Federal
Northern Rivers	Matilda Ann: Wooden Schooner	6/5/1849	Off North Head, Richmond River	Wrecked in the gale that also wrecked the Jane Scott, Tweed, Louisa, Swift and capsized the Helen	48 tonnes, 18.11x4.3m, built 1847 Broulee, voyage/cargo unknown, no losses	HSA, Federal
Northern Rivers	Nautilus: Wooden Schooner	3/3/1844	Off Richmond River mouth	Wind failed drifted onto southern spit	43 tonnes, 14.17x4.27m, built 1837 Brisbane Water, voyage Richmond River-Sydney with cedar timber, unknown losses	NSW HA, State
Northern Rivers	No name: Launch	8/06/1938	Off Tweed Heads	Burnt	Unknown	NSW HA, State
Northern Rivers	Northumberland: Wooden Schooner	17/1/1845	South Spit of Richmond River entrance	Slow crew response	43 tonnes, 12.8x4.57m, built 1841 Hawkesbury River, voyage Sydney-Richmond River, cargo unknown	HSA, Federal
Northern Rivers	Panic of 66: Wooden Topsail Schooner	20/5/1870	Rocks off North Head of Tweed River	Wind failed, drifted onto rocks	52 tonnes, 19.96x6.573m, built 1866 Brisbane Water, voyage Sydney-Tweed River with flour and general cargo	HSA, Federal
Northern Rivers	Pioneer: Wood Carvel Ketch	13/1/1877	Rocks at the entrance of Tweed River	Wind changed	73 tonnes, 23.59x6.065m, built 1874 Manning River, voyage unknown, cargo general	HSA, Federal
Northern Rivers	Reliance: Wood Carvel Schooner	12/7/1887	East of Mt Warning	Sprang a leak	74 tonnes, 23.95x6.035m, built 1876 Macleay River, voyage Sydney-Normanton with general cargo	HSA, Federal
Northern Rivers	Restless: Wood Carvel Brig	24/8/1872	20 miles off North Solitary Island	Sprang leak in a gale	258 tonnes, 35.78x7.985m, built 1862 Maine USA, voyage Solomon Islands-Brisbane, cargo unknown	HSA, Federal
Northern Rivers	River Chief: Wooden Brig	25/11/1865	At or off Richmond River heads	Unknown	159 tonnes, 21.91x6.858m, built 1845 Murray River, voyage/cargo unknown	HSA, Federal
Northern Rivers	Rose: Wood Carvel Cutter	_/1/1847	Off Tweed Heads	Unknown	28 tonnes, 11.64x4.21m, built 1841 Brisbane Water, voyage/cargo unknown	HSA, Federal

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Northern Rivers	Samuel Merritt: Wood Carvel Barquentine	13/1/1877	Richmond River entrance	Struck north spit	259 tonnes, 39.47x8.473m, built 1854 Bath (Maine) USA, voyage unknown, in ballast	HSA, Federal
Northern Rivers	Sarah: Wooden Schooner	22/5/1848	Richmond River entrance	Wind failed, drifted onto rocks at North Head	50 tonnes, 20.73x4.54m, built 1842 Balmain, voyage to Richmond River, cargo unknown	HSA, Federal
Northern Rivers	Settlers Friend: Woodec Carvel Schooner	17/8/1877	Off Tweed River entrance	Stranded	65 tonnes, 22.18x5.882m, built 1867 Brisbane Water, voyage Sydney-Tweed River, in ballast	HSA, Federal
Northern Rivers	Sisters: Wood Carvel Schooner	5/5/1880	Off North Spit, Richmond River entrance	Broached in heavy sea	37 tonnes, 17.55x5.12m, built 1873 Brisbane Water, voyage from Richmond River with hardwood timber	HSA, Federal
Northern Rivers	Sophia Ann: Wood carvel Steamer, Screw	9/04/1908	Southern sand spit at Richmond River entrance	Unknown	165 tonnes, 36.97x6.583m, voyage/cargo unknown	HSA, Federal
Northern Rivers	St Leonard: Wooden Schooner	_/_/1849	At or off Tweed Heads	Unknown	56 tonnes, 16.52x5.33m, built 1847 Brisbane Water, voyage/cargo unknown	HSA, Federal
Northern Rivers	Star of the Sea: Wood Carvel Schooner	22/2/1878	South Spit of Brunswick River entrance	Wind failed, drifted onto spit	59 tonnes, 23.25x5.486m, built 1867 Macleay River, voyage to Brunswick River ind ballast	HSA, Federal
Northern Rivers	Sussex: Wood Carvel Schooner	_1-2/1890	Last seen off Richmond River	Unknown - left Trial Bay in company of Schooner Kent - neither vessel seen again - vessels may have collided in foul weather and sunk	87 tonnes, 28.7x6.7m, built 1885 Brisbane Water, voyage Port Stephens-Tweed River, cargo unknown	HSA, Federal
Northern Rivers	Sylvanus: Wood Carvel Schooner	13/4/1871	Rocks off North Head, Richmond River entrance	Unknown	50 tonnes, 19.29x5.181m, built 1861 Brisbane Water, voyage Sydney-Richmond River, cargo unknown	HSA, Federal
Northern Rivers	Titania: Wood Carvel Ketch	_6-7/1879	Entrance to Brunswick River	Wind shift	51 tonnes, 15.78x4.663m, built 1855 Shoalhaven, voyage Sydney-Brunswick River in ballast	HSA, Federal
Northern Rivers	True Blue: Wood Carvel Ketch	_9-10/1881	Rocks off North Head of Tweed River entrance	Unknown	49 tonnes, 21.03x5.547m, built 1876 Batemans Bay, voyage from Tweed River, cargo unknown	HSA, Federal
Northern Rivers	Tweed: Wooden Vessel (type unknown)	_/_/1858	Near Tweed River	Capsized?	Details unknown, built nd Tweed River, voyage/cargo unknown	HSA, Federal
Northern Rivers	Tweed: Steel Steamer, Screw	19/4/1888	At or off Tweed River entrance	Unknown	240 tonnes, 39.07x6.918m, built 1885 Newcastle-on-Tyne UK, voyage/cargo unknown	HSA, Federal
Northern Rivers	Urara: Wooden Steamer, Paddle	2/5/1866	At or off Clarence River entrance, loss illustrated below:	Struck South Reef	382 tons gross, 55.01xBuilt 1859 Birkenhead UK, 7.376m, Voyage Sydney-Grafton via Newcastle with passengers and general cargo	HAS, Federal

Source: Maritime Heritage Online, NSW Heritage Office

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Northern Rivers	Vesta: Iron Steamer, Paddle	26/3/1873	Richmond River entrance	Inbound at night, struck south spit	93 tonnes, 28.04x4.45m, built 1842 Melbourne, voyage Richmond River-Richmond River in ballast	HSA, Federal
Northern Rivers	Waimea: Iron Steamer, Screw	10/1/1872	Off northside Richmond River entrance	Caught in break, capsized?	229 tonnes gross, 39.92x6.309m, built 1868 Sydney, voyage Richmond River-Sydney with maize and timber	HSA, Federal
Northern Rivers	Wallaby: Wood Carvel Schooner	14/5/1874	Richmond River entrance	Wind failed, drifted to north spit	78 tonnes, 22.61x6.278m, built 1864 Brisbane Water, voyage Richmond River-Sydney with iron timber	HSA, Federal
Northern Rivers	Wanganui: Iron Steamer, Screw	20/6/1880	1 mile off Clarence River entrance	Struck reef	221 tonnes gross, 44.166x6.37m, built 1863 Dundee UK, voyage Newcastle-Clarence River with general cargo, 2 lost	HSA, Federal
Northern Rivers	West Hartley No. 1: Iron Schooner	11/2/1874	Off Brunswick River entrance	Wind failed	69 tonnes, 27.21x5.364m, built 1863 Blackball UK, voyage to Brunswick River in ballast	HSA, Federal
Northern Rivers	William and James: Wooden Schooner	15/7/1856	At or off Richmond River	Unknown	75 tonnes, 18.1x5.7m, built 1849 Brisbane Water, voyage/cargo unknown	HSA, Federal
Northern Rivers	William Buchanan: Wood Carvel Barque	8/12/1864	Offshore reef 10 miles south of Clarence River entrance	Struck reef, subsequent explosion and fire	155 tonnes gross, 28.25x7.38m, built 1848 Maine USA, voyage from Sydney with 14 carboys of acid	HSA, Federal
Mid North Coast	Abbey:	15/2/1868	3 miles north, Crowdy Head	Foundered in gale	90 tonnes, 22.6x5.7m, built 1853 Newcastle UK, voyage Sydney-Newcastle in ballast	HSA, Federal
Mid North Coast	Adonis: Wood Brigantine	22/12/__	~15 miles south, Crowdy Head	Sprang leak, foundered	108 tonnes gross, 28.166x6.309m, built 1874 Jervis Bay, voyage Wollongong-Richmond River with coal	HSA, Federal
Mid North Coast	Agnes Irving: Iron Side Paddle Steamer	28/12/1879	Off South Spit old entrance to the Macleay River, Trial Bay	Struck and foundered	431 tonnes gross, 62.02x7.467m, built 1862 Deptford Green Kent UK, voyage Sydney-Macleay River with passengers and freight	HSA, Federal
Mid North Coast	Albany: Iron Steamer Screw	26/03/1905	2 miles north and 3/4-1 mile off Nambucca Heads	Aground, wreck	889 tonnes gross, 70.5x8.7m, built 1862 Northumberland UK	HSA, Federal
Mid North Coast	Aleda: Wood Carvel Schooner	17/06/1914	At Big Hill north of Point Plummer, Port Macquarie	Foundered in gale	83 tonnes gross, 28.7x7.3m, built 1897 Whangaroa NZ, voyage Sydney-Nambucca River in ballast, Master and 5 crew lost	HSA, Federal
Mid North Coast	Alert: Wood Steamer Screw	21/02/1901	Nambucca Heads, off	Wrecked, cause unknown	27 tonnes gross, 18.3x4.2m, built 1882 Sydney, voyage and cargo unknown	HSA, Federal
Mid North Coast	Alfred Fenning: Wood Ketch	_/6/1914	2 km south, Crescent Head	Lost at sea, cause unknown	74 tonnes, 24.38x6.522m+F101	
Mid North Coast	Alice: Wood Ketch	5/7/1877	Off North Spit Camden Haven	Aground after wind failed	24 tonnes, 16.2x4.5m, built 1865 Brisbane Water, voyage Camden Haven-Sydney with timber	HSA, Federal
Mid North Coast	Alpha: Wood Schooner	21/2/1897	Off Nambucca Heads	Struck rocks	82 tonnes, 26.9x6.3m, built 1867 Port Stephens, voyage Sydney-Nambucca River in ballast	HSA, Federal
Mid North Coast	Amity: Wood Ketch	12/3/1870	Off Manning River	Foundered in gale	29 tonnes, 15.1x4.7m, built 1866 Hawkesbury River, Captain and 4 crew lost	HSA, Federal
Mid North Coast	Annandale: Wood Carvel Ketch	12/03/1907	20 miles SE, Smokey Cape	Sprang leak, foundered	108 tonnes gross, 29.4x7.3m, built 1899 Tomakin, voyage Sydney-Bellinger River with coal	HSA, Federal
Mid North Coast	Annie Ogle: Wood Carvel Brig	_/2/1875	5 miles south, Smokey Cape	Foundered in gale	210 tonnes, 35.48x7.74m, built 1874 Balmain, voyage Grafton-Sydney in ballast, Master and 8 crew lost	HSA, Federal
Mid North Coast	Barwon: Wood Brigantine	15/2/1868	Off Crowdy Head	Foundered in gale	56 tonnes, 20.5x5.5m, built 1865 Macleay River, voyage Sydney-Newcastle in ballast, Master and 4 crew lost	HSA, Federal
Mid North Coast	Bertha: Wood Schooner	26/7/1891	Off Nambucca Heads	Foundered in southerly gale	87 tonnes, 23.5x6.8m, built 1885 Brisbane Water, voyage and cargo unknown	HSA, Federal
Mid North Coast	Black Jack: Wood Schooner	_/_/1823	Off the bar, Port Macquarie, lat31.434-31.4005, long152.93.	Pilot's neglect: presumably foundered	28 tonnes, dimensions unknown, built 1820 Sydney Harbour, voyage Sydney-Port Macquarie in ballast ?	HSA, Federal
Mid North Coast	Britannica: Wood Carvel Ketch	22/8/1878	Top entrance Nambucca River	Steering gear failed	50 tonnes gross, 22.31x5.638m, built 1877 Cape Hawk, voyage Sydney-Nambucca River in ballast	HSA, Federal
Mid North Coast	Candidate: Wood Carvel Ketch	_/5/1912	South of Camden Haven	Foundered in gale	86 tonnes, 26.82x7.42m, built 1885 Brisbane Water, voyage Camden Haven-Sydney, cargo unknown, at least 1 lost	HSA, Federal

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Mid North Coast	Caroline: Wood Schooner	9/12/1835	Off, near Trial Bay, Macleay River	Unknown	69 tonnes, 16.3x5.5m, built 1827 Sydney Harbour	HSA, Federal
Mid North Coast	Challenger: Wood Cutter	_/8/1845	Off Manning River	Unknown	31 tonnes, 12.66x3.9m, built 1840 Williams River	HSA, Federal
Mid North Coast	Chance: Wood Ketch	12/6/1874	Manning River, off	Capsized in gale	41 tonnes, 17.9x5.2m, built 1870 Brisbane Water, 3 lost	HSA, Federal
Mid North Coast	Daphne: Wood Launch	11/04/1933	5 miles SE South West Rocks	Foundered after catching fire	Displacement unknown, 12.19x4.267m, built details unknown, presumed Manning River, presumed 1933, 1 lost	NSW HA, State
Mid North Coast	Dart: Wood Cutter	13/3/1832	Outside Port Macquarie bar	Struck rocks	21 tonnes, 12.19x3.657m, built 1826 Sydney Harbour, voyage Port Macquarie-Sydney with cedar timber and maize	HSA, Federal
Mid North Coast	Deva: Wood Brig	4/12/1870	25 miles off Smokey Cape	Sprang a leak, foundered	244 tonnes, 25.2x6.9m, built 1838 Hylton Durham UK, voyage New Calidonia-Newcastle in ballast, 0 lost	HSA, Federal
Mid North Coast	Deveron: Wood Barquentine	16/7/1833	Off Port Macquarie-Trial Bay	Sprang a leak and foundered in gale	Built 1814 Monkwearmouth Durham UK, voyage unknown - whaler, 0 lost	HSA, Federal
Mid North Coast	Dredge Punt: Details unknown		Camden Haven or off Camden Haven, minimum lat31.600667, long153.117833-152.8	Struck rock, foundered	Voyage details unknown - information from MSB unsourced list of vessels wrecked on or near the coast of NSW	Not protected
Mid North Coast	Ellen: Wood Topsail Schooner	24/6/1879	Off Trial Bay	Foundered in gale	Built 1877 Oxley Island Manning River, voyage Sydney-Richmond River in ballast, 5 lost	HSA, Federal
Mid North Coast	Emily Anne: Wood Schooner	27/12/1864	Off Crowdy Head (after having been sunk at Manning River bar)	Capsized in high sea	Built 1864 Balmain, 20.29x5.029m, voyage Sydney-Manning River with sawmill machinery and provisions, 4 lost	HSA, Federal
Mid North Coast	Emma: Wood Ketch	_/_/1853	Off Manning River	Unknown	31 tonnes, 14x4m, built 1846 Brisbane Water, voyage and cargo unknown	HSA, Federal
Mid North Coast	Emmeline: Wood Ketch	19/6/1880	Between Camden Haven and Port Macquarie	Wind failed?	43 tonnes gross, 19.3x5.6m, built 1877 Brisbane Water, voyage Camden Haven to unknown destination with timber	HSA, Federal
Mid North Coast	Euphemia: Wood Schooner	_/_/1863	Off Macleay River	Unknown	25 tonnes, 17.7x4.6m, built 1857 Macleay River, voyage and cargo unknown	HSA, Federal
Mid North Coast	Fairy: Wood Schooner	_/5/1839		Unknown	25 tonnes, 11.2x4.2m, built 1838 Manning River, voyage and cargo unknown	HSA, Federal
Mid North Coast	Fingal: Steel Steamer Screw	5/05/1943	Off Nambucca Heads	Torpedoed	2137 tonnes gross, 84.12x13.31m, built 1923 Moss, Norway, voyage Sydney-Darwin with military cargo, 12 lost	NSW HA, State
Mid North Coast			Off Camden Haven, max lat31.683. Max long163.366.	Capsized	48 tonnes, 15.164x4.52m, built 1836 Clarencetown, more than 4 lost	HSA, Federal
Mid North Coast	Glossariel: Wood Topsail Schooner	_/_/1886	5-6 miles east Manning River heads	Sprang a leak, foundered	86 tonnes gross, 24.9x6.3m, built 1876 Shoalhaven, voyage Sydney-Richmond River with coal and general cargo	HSA, Federal
Mid North Coast	Gloucester: Wood Barquentine	29/7/1877	31 miles off Smokey Cape	Sprang a leak, foundered	591 tonnes gross, 42.06x8.656m, built 1852 Sunderland UK, voyage Newcastle-Japan with 526 tonnes coal, 0 lo+F102st	HSA, Federal
Mid North Coast	Guiding Star: Wood Schooner	_/9/1864	Off Point Plummer, Port Macquarie	Foundered in gale?	39 tonnes, 17.3x4.8m, built 1859 Hawkesbury River, voyage Manning River-Sydney (?), cargo unknown	HSA, Federal
Mid North Coast	Henne De Fraine: Wood Carvel Topsail Schooner	4/05/1900	Off Camden Haven	Sprang a leak, foundered	96 tonnes gross, 27.98x7.437m, built 1899 Kincumber, voyage Camden Haven to unknown destination, cargo unknown	HSA, Federal
Mid North Coast	Isabella: Wood Schooner	20/9/1824	Off Port Macquarie	Stolen, presume foundered	37 tonnes, 10.363x3.658m, built 1822 Sydney Harbour, seized by Port Macquarie pilot crew (convicts), pilot and crew set adrift, voyage Port Macquarie to unknown port, cargo unknown	HSA, Federal
Mid North Coast	Janet: Wood Schooner	_/_/1867	Off Macleay River, Trial Bay	Unknown	39 tonnes, 18.4x4.8m, built 1858 Shoalhaven, voyage and cargo unknown	HSA, Federal
Mid North Coast	Jolly Rambler: Wooden Sloop	_/12/1836	Off Macleay River	Unknown	37 tonnes, 14.2x4.7m, built 1813 Broadstairs Kent UK, voyage and cargo unknown	HSA, Federal

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Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
Mid North Coast	Just-in-Time: Wood Topsail Schooner	4/4/1893	Off Charlotte Bay, 15 miles north Smokey Cape	Sprang a leak, foundered	109 tonnes gross, 27.9x6.3m, built 1884 Stavanger/Havenger Norway, voyage Sydney-Tweed River with iron and general cargo	HSA, Federal
Mid North Coast	Kooroongaba: Steel Steamer Screw	~9/1/1972	Off Crowdy Head	Tow line parted, foundered	313 tonnes gross, 47.7x12.62m, built 1921 Newcastle NSW, former Sydney ferry under tow to breakers, voyage Sydney-destination not recorded: Japan (?)	HSA, Federal
Mid North Coast	Laura: Wood Carvel Ketch	9/6/1878	15 miles south Manning Heads	Sprang a leak, foundered	30 tonnes, 18.1x5.12m, built 1874 Cape Hawk, voyage Camden Haven-Sydney with timber	HSA, Federal
Mid North Coast	Lizzie Coleson: Wood Carvel Schooner	_/6/1870	North of Macleay River	Foundered in gale	61 tonnes, 23.1x5.76m, built 1868 Brisbane Water, voyage Clarence River-Sydney with timber, more than 2 lost	HSA, Federal
Mid North Coast	Lombard: Unknown construction material, Barquentine	_/5/1867(?)	Off Nambucca Heads	Unknown	208 tonnes, 32.88x7.863m, built 1856 Essex Massachusetts USA, voyage Gladstone-New Zealand with cattle	HSA, Federal
Mid North Coast	Lorenzo Sabine: Wood Carvel Barquentine	10/4/1869	In 21 feet of water in Trial Bay	Sprang a leak, foundered	157 tonnes, 27.61x6.4m, built 1852 Robertstown USA, voyage Newcastle-Brisbane with coal and hay	HSA, Federal
Mid North Coast	Macksville: construction material unknown, Tug	2/01/1924	Off Scotts Head	Foundered under tow	Details of construction, building and voyage unknown.	HSA, Federal
Mid North Coast	Madjus: Iron Steamer Screw	6/10/1884	Off Port Macquarie	Sprang a leak, foundered	400 tonnes gross, 48.768x8.534m, built 1884 Sunderland UK, voyage England-Sydney, "almost" in ballast (?)	HSA, Federal
Mid North Coast	Manurewa: Iron Barquentine	9(?)/04/1922	Between Camden Haven and Clarence River	Presumed foundered, loss not explained	371 tonnes gross, 43.61x7.955m, built 1884 Glasgow UK, voyage Newcastle-Clarence River with 167 tonnes coal, 14 lost	HSA, Federal
Mid North Coast	Martha: Wood Ketch	12/2/1871	Near Nambucca River	Unknown	42 tonnes, 16.46x4.63m, built 1854 Brisbane Water, voyage and cargo unknown	HSA, Federal
Mid North Coast	Mary: Wood Carvel Schooner	25/2/1866	Bellinger River, off	Unknown	47 tonnes	HSA, Federal
Mid North Coast	Metaris: Wood Carvel Barquentine	29/7/1881	50 miles east off Port Macquarie	Sprang a leak, foundered in a gale	244 tonnes, 31.54x7.498m, built 1857 Sunderland UK, voyage Newcastle-Honolulu with 393 tonnes coal	HSA, Federal
Mid North Coast	Mikado: Construction unknown Tug	25/7/1897	Trial Bay	Foundered in gale	No details known of dimensions, voyage or cargo	HSA, Federal
Mid North Coast	Minnie Lowe: Wood Carvel Schooner	27(?)/9/1880	Off Port Macquarie	Foundered in gale (?)	75 tonnes, 24.8x5.8m, built 1877 Cape Hawk, voyage unknown in ballast, 6 lost	HSA, Federal
Mid North Coast	Mousam: Wood Barquentine	3/6/1860	Between 16 and 13 miles SE of Port Macquarie	Sprang a leak, foundered	197 tonnes, 30.51x7.315m, built 1846 Kennebunk Maine USA, voyage Newcastle-Melbourne with coal	HSA, Federal
Mid North Coast	Naomi: Unknown material, Schooner	26/9/1880	Lost at sea after being seen near Port Macquarie	Presumably foundered	72 tonnes, 22.25x6.1m, built 1872 Brisbane Water, voyage Sydney-Port Macquarie in ballast, 6 lost (vessel also referred to in various papers as "Namoi" and "Meomi")	HSA, Federal
Mid North Coast	Narara: Wood Schooner	_/5/1849	Off (south?) Solitary Island	Foundered in gale	24 tonnes, 13.32x3.75m, built 1842 Brisbane Water	HSA, Federal
Mid North Coast	Noongah: Steel Motor Vessel	25/08/1969	8 miles off Crescent Head	Foundered in gale	1464 tonnes gross, 71.63mx11.31m, built 1952 Port Glasgow UK, voyage Newcastle-Townsville with 100 tonnes of steel, 20 lost	Not protected
Mid North Coast	Oceana: Wood Carvel Steamer Screw	7/10/1903	Off Manning River bar	Unknown	34 tonnes, 18.77x4.785m, built 1886 Lavender Bay, voyage Sydney-Marshall Islands with general cargo	HSA, Federal
Mid North Coast	Octoroon: Wood Carvel Top Sail Schooner	22/2/1878	Crowdy Head, off (12 miles off Port Macquarie)	Sprang a leak and foundered	52 tonnes, 20.72x5.638m, built 1865 Brisbane Water, voyage Port Macquarie-Sydney with timber	HSA, Federal
Mid North Coast	Orara: Wood Carvel Steamer Screw	30/12/1895	Off Woolgoolga (Solitary Islands)	Screw shaft broke, struck rocks, foundered	66 tonnes gross, 21.54x5.547m, built 1894 Brisbane Water, voyage Clarence River-Sydney in ballast	HSA, Federal
Mid North Coast	Pelican: Composite Steamer Paddle	_/4/1888	3 miles north of Nambucca Heads	Sprang a leak, foundered	69 tonnes gross, 27.79x4.511m, built 1854 Sydney Harbour, voyage Nambucca Heads-Bellinger River with stores and timber	HSA, Federal

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Mid North Coast	Portmar: Iron Steamer Screw	16/06/1943	Off Smokey Cape	Torpedoed	5551 tonnes gross, 124.9x16.52m, built 1919 Portland Oregan USA, voyage Sydney-Brisbane, cargo unknown, 2 lost	HSA, Federal
Mid North Coast	Premier: Wood Carvel Ketch	24/05/1916	Off Nambucca Heads, Wellington Rock	Unknown	135 tonnes gross, 32.09x8.686m, built 1896 Port Macquarie, voyage Newcastle-Nambucca River, cargo unknown	HSA, Federal
Mid North Coast	Ranger: Wood Carvel Steamer Screw	13/2/1887	1 mile south Trial Bay/Macleay River	Foundered in easterly gale	40 tonnes gross, 17.12x4.724m, built 1885 Long Nose Point Balmain, voyage Macleay River-Macleay River, tug, 2 lost	HSA, Federal
Mid North Coast	Richmond: Wood Schooner	_/3/1837	Trial Bay, Macleay River	Possibly struck bar?	41 tonnes, 14.32x4.57m, built 1834 Tamar River TAS, voyage and cargo unknown	HSA, Federal
Mid North Coast	Rosedale: Iron Steamer Screw	_/9/1911	Off Smokey Cape	Presumed foundered in southerly gale	274 tonnes gross, 42.7x6.431m, built 1877 Dundee UK, voyage Nambucca River-Sydney, cargo unknown but with ~11 passengers and 18 crew, ~29 lost	HSA, Federal
Mid North Coast	Samson: Wood Carvel Steamer Paddle (Drogher)	_/12/1908	Off Manning River Heads	Sprang a leak, foundered	101 tonnes gross, 27.43x6.096m, built 1885 Myall River Port Stephens, voyage unknown (cargo possibly timber, otherwise unknown)	HSA, Federal
Mid North Coast	Sarah Nicholl: Wood Carvel Schooner	25/3/1875	5 miles north of Bellinger River	Presumed foundered	68 tonnes, 25.05x5.364m, built 1866 Brisbane Water, voyage Sydney-Port Macquarie-Macleay River with timber, 3 passengers, 5 lost	HSA, Federal
Mid North Coast	Sea Bird: Unknown material, type	12/02/1916	Off Laurieton between Crowdy Head and Port Macquarie	Capsized	Nothing known of description, origin, voyage or cargo, 3 lost	HSA, Federal
Mid North Coast	Shamrock: Wood Carvel Steamer Screw	19/02/1911	Off Camden Haven	Fire, foundered	30 tonnes gross, 20.81x3.749m, built 1895, Tweed River, voyage and cargo unknown	HSA, Federal
Mid North Coast	Shelbourne: Wood Carvel Ketch	14/2/1893	At sea off Crowdy Head	Sprang a leak, foundered	61 tonnes, 24.1x5m, built 1887 Clarencetown, Williams River, voyage Camden Haven-Sydney with 40,000 timber shingles. Vessel had been converted from a steamer to a sailing vessel in 1890.	HSA, Federal
Mid North Coast	Sir George: Wood Carvel Ketch	12/11/1903	2 miles north, Smokey Cape	Foundered in gale	94 tonnes, 28.37x7.071m, built 1892 Brisbane Water, voyage Port Macquarie-Sydney with 40,000 SFT hardwood timber, 2 lost	HSA, Federal
Mid North Coast	Somaki: Wood Motor Vessel	12/12/1946	At or off Port Macquarie	Fire, foundered	11 tonnes gross, 9.966x3.2m, built 1933 Coffs Harbour, voyage and cargo unknown	HSA, Federal
Mid North Coast	Sumatra: Steel Steamer Screw	26/06/1923	Between Port Macquarie and Crescent Head	Missing presumed foundered	584 tonnes gross, 52.24x8.29m, built 1889 Keel Germany (seized by Commonwealth Government during WWI and transferred to New Guinea administration), crew of 31 New Guineans, 6 Chinese, 7 others and included Mrs Bell (the Captain's mother), voyage Sydney-Rabaul with supplies, 45 lost	HSA, Federal
Mid North Coast	Sun Beam: Wood Carvel Ketch	_/10/1896	North of Camden Haven	Lost at sea, presumed foundered	33 tonnes, 17.19x5.12m, built 1879 Brisbane Water, voyage Sydney-Brisbane-Rockhampton with 170 cases of explosives, 3 lost	HSA, Federal
Mid North Coast	Tam O'shanter: Wood Cutter	22/2/1846	Off Manning River entrance	Capsized	12 tonnes, 9.14x3.26m, built 1844 Brisbane Water, voyage Sydney-Manning River with general cargo including flour, 1 lost	HSA, Federal
Mid North Coast	Telegraph: Iron Steamer Paddle	9/10/1867	Off Perpendicular Point Camden Haven	Struck rock, foundered	521 tonnes gross, 67.36x7.223m, built 1854 Glasgow UK, voyage Sydney-Brisbane with passengers, general cargo and sheep	HSA, Federal
Mid North Coast	The Queen: Wood Schooner	_/2/1892	Off Camden Haven	Unknown	71 tonnes, 23.3x6.6m, built 1879, Tomaga Moruya, voyage unknown origin to Port Macquarie, cargo unknown, 5 lost	HSA, Federal
Mid North Coast	Titan: Steel Barge (Crane)	29/12/1992	Off Smokey Cape lat31.665833 long152.872333	Capsized	Gross tonnage unknown, 53.58x24.29m, built 1919 Cockatoo Island Sydney Harbour, voyage Sydney-unknown destination port, under tow	Not Protected

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Mid North Coast	Trial: Wood Brig	_/9/1816	3 miles NW of Smokey Cape, Trial Bay, lat30.884667-30.834833, long153.083667-153.000667	Capsized	Structural details unknown, voyage Sydney-unknown destination (vessel was sezied at …… Pigs Reef in Sydney by escaping convicts and the crew put ashore off Newcastle), all hands lost, number not known	HSA, Federal
Mid North Coast	Trial: Wood Ketch	_/10/1824(?)	Off Manning River	Unknown	23 tonnes, other details unknown, voyage and cargo unknown	HSA, Federal
Mid North Coast	Triumph: Wood Carvel Ketch	13/02/1903	5 miles south Attacking Point, Port Macquarie	Struck bar, sprang a leak and foundered	83 tonnes, 23.83x7.559m, built 1894 Brisbane Water, voyage Camden Haven-Sydney with timber	HSA, Federal
Mid North Coast	Trusty: Wood Carvel Schooner	6/5/1885	Manning River, off	Unknown	61 tonnes, 21.27x5.455m, built 1877 New Haven Philip Island, voyage unknown origin-Manning River, cargo unknown	HSA, Federal
Mid North Coast	Unidentified vessel: no description	No date	Trial Bay	Unknown	No particulars of vessel, voyage or cargo	Unknown
Mid North Coast	Unidentified vessel: no description	No date	Off Laurieton	Unknown	No particulars of vessel, voyage or cargo	Unknown
Mid North Coast	Urana: Steel Steamer Screw	31/08/1937	Off Manning River	Struck reef, split in two and foundered	119 tonnes gross, 46.63x10.54m, built 1924 Glasgow UK, voyage Newcastle-Macleay River with coal	HSA, Federal
Mid North Coast	Violet Doepal: Wood Carvel Top sail Schooner	24/01/1905	4 miles north and 1.5 miles off Bellinger River	Sprang a leak, foundered	127 tonnes, 32.43x8.29m, built 1898 Bellinger River, voyage Sydney-Bellinger River with coal, 0 lost	HSA, Federal
Mid North Coast	Wanderer: Wood Topsail Schooner	15/11/1851	Off Jail Point, Port Macquarie	Unknown	84 tonnes, other details unknown, built UK, voyage Guadal Canal Solomon Islands-Port Macquarie with general cargo	HSA, Federal
Mid North Coast	Wollongbar: Steel Steamer Screw	29/04/1943	Between Port Macquarie and Crescent Head	Sunk by enemy action (torpedoed)	2239 tonnes gross, 86.89x12.83m, built 1922 Glasgow UK, voyage unknown, cargo unknown, 32 lost	NSW HA, State
Mid North Coast	Wotonga: Iron Steamer Screw	2/1/1882	Off Tacking Point, Port Macquarie	Struck rock	997 tonnes gross, 70.01x8.039m, built 1876 Dunbarton UK, voyage Sydney-Brisbane with passengers and general cargo	HSA, Federal
Mid North Coast	Yvonne: Wood Launch	12/02/1937	Off Smokey Cape	Foundered in gale	Details unknown, voyage Taree-Northerly with a cargo of fish	HSA, Federal
Illawarra	Agnes: Wood Carvel Ketch	_/_/1883	Off Jervis Bay	Foundered?	38 tons, 22.95x4.328m, Built 1877 Williams River, Voyage/cargo unknown	HSA*, Federal~
Illawarra	Annie Powell: Wood Carvel Schooner	5/8/1886	About 5-6 miles off Five Islands, Wollongong	Sprang leak, foundered	122 tons, 30.48x7.437m, Built 1884 Macleay River, Voyage Kiama-Botany Bay	HSA, Federal
Illawarra	Botany: Dredge	9/10/1936	Off Jervis Bay	Foundered under tow	Voyage Newcastle-Bermagui	Not protected
Illawarra	Buonaparte: Wooden Schooner	17/10/1864	8 miles north of Bellambi, 10 miles offshore	Sprang leak, foundered	119 tons, 25.2x6.7m, Voyage Bellambi-Invercargill, cargo 100 tons coal	HSA, Federal
Illawarra	Christopher George: Wooden Schooner	_/2/1869	Off or near Wollongong	Foundered in gale	57 tons, 18.9x4.8m, Built 1849 Macleay River, Voyage Sydney-Wollongong, Cargo unknown, 5 lost	HSA, Federal
Illawarra	Clio: Wood Carvel Ketch	12/2/1869	Off Wollongong	Foundered?	42 tons, 19.14x5.516m, Built 1868 Port Stephens, voyage/cargo unknown	HSA, Federal
Illawarra	Coast Farmer: Iron Steamer, Screw	20/07/1942	Off Jervis Bay	Torpedoed	3290 tons gross, 98.75x14.08m, Built 1920 Newark USA, 1 lost	Not protected
Illawarra	Colac, HMAS: Steel Steamer, Screw	17/02/1987	Off Jervis Bay	Scuttled after use as gunnery target by HMAS Ovens	Built 1941, Morts Dock	Not protected
Illawarra	Comboyne: Wooden, Steamer, Screw	27/11/1920	1 mile off Bass Point	Struck object	Timber carrier, 281 tons, 42.42x9.052m, built 1911 at Tuncurry NSW	HSA, Federal
Illawarra	Corio: Iron, Steamer, Screw	12/7/1866	Off Wollongong	Wrecked in gale	170 tons, 39.8x5.5m, built 1854 Greenock Scotland, voyage unknown, 10 lost	HSA, Federal
Illawarra	Dandenong: Iron Steamer, Screw	_/9/1876?	Off Jervis Bay	Sprang leak, foundered during the 'Dandenong' gale	743 tons, 61.3x8.6m, built 1865 Howden Northumberland, Voyage with passengers Hobsons Bay -Sydney, 40 lost	HSA, Federal

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Illawarra	Duke of Wellington: Wooden Brigantine	14 June 1863	Off Bellambi	Capsized while standing off Bellambi in a storm, in ballast	88 tons, 21.5x.6.2m, Build unknown but former Brazil trade slaver, Voyage to Bellambi in ballast, 5 lost	HSA, Federal
Illawarra	Echo: Wood Carvel Schooner	21/3/1863	Near Long Point, Shellharbour	Struck rock	21 tons, 11.3x3.444m, built Sydney 1843. In Voyage Shoalhaven-Sydney: cargo wheat, maize, potatoes	HSA, Federal
Illawarra	Elizabeth: Wooden Schooner	_/10/1868	Off Bulli	Capsized in squall	46 tons, 21.0x5.1m, built 1862 Doughboy Creek, Qld,	HSA, Federal
Illawarra	Esther Maria: Wooden Ketch	29/2/1882	6 miles north of Beecroft Point	Collision with 'Kameruka	52 tons, 21.2x5.7, Built 1867 Hawkesbury River, Voyage Sydney-Jervis Bay, 1 lost	HSA, Federal
Illawarra	Fairey Firefly: naval aircraft	Not advised	Not advised	Not advised	Not advised	
Illawarra	Franz: Wooden Schooner	9/9/1879	Off Shellharbour, north of Lake Illawarra, near Five Islands	Foundered in gale	148 tons gross, 25.2x6.5m, Built Hamburg Germany, Voyage Sydney-Kiama in ballast	HSA, Federal
Illawarra	Free Selector: Wooden Ketch	13/2/1869	Off Wollongong	Foundered	47 tons, 18.9x5.56, Built 1867 Brisbane Water, Voyage/Cargo unknown	HSA, Federal
Illawarra	Frolic: Wooden Ketch	nk	Kiama	Wrecked	26 tons, 13.9xs4.24m, Built 1853 Brisbane Water, Voyage/cargo unknown	HSA, Federal
Illawarra	Gabriella: Steel Motor Vessel	10/12/1986	Dutch heavy lift vessel, capsized and sank at mooring Port Kembla 14/8/1986, 2 lost. Vessel refloated upside down, declared total loss, towed out to sea 30 miles off Port Kembla and…	...Scuttled	Built 1974 Netherlands,	Not protected
Illawarra	George: Wood carvel Schooner	_/7/1867	Off? Bulli	Wrecked	98 tons, 21.39x5.76m, Built 1846 Sunderland UK	HSA, Federal
Illawarra	George s [or M] Livanos: Steel Steamer, Screw	20/7/11942	15 miles off Jervis Bay,	Torpedoed	4835 tons, 134.4x17.58m, Built 1938 Hartlepool UK, Voyage/cargo unknown	Not protected
Illawarra	Henrietta: Wooden Schooner	4/2/1880	Crookhaven Reef, off Shoalhaven Head	Foundered	29 tons, 18.3x 4.6m, Built 1871 Brisbane Water, Voyage Sydney-Shoalhaven in ballast	HSA, Federal
Illawarra	Julie Heyn: Wood Carvel Barque	_/5/1865	Off Cape St George, Jervis Bay	Sprang leak, foundered	318 tons, 33.92x7.99m, Built 1848 Stettin? New Britain?Pomerania Germany, Voyage to Adelaide with coal	HSA, Federal
Illawarra	Koraaga: Steel Steamer, Screw	9/09/1931	5 miles east of Black Head, Gerringong	Struck reef	221 tons, 34.93x6.644m, Built 1915 Middlesborough UK, Fishing out of Sydney	Not protected
Illawarra	Lady of the Lake: Wooden Schooner	31/7/1879	7 miles offshore, Shoalhaven Bight	Wrecked	41 tons, 16.45x4.876m, Built unknown, Voyage unknown, in ballast	HSA, Federal
Illawarra	Little Pet: Wood Carvel Schooner	13/6/1885	Bellambi Reef, Wollongong	Struck reef	78 tons, 20.02x5.608m, Built 1851 North Shields UK, Voyage/cargo unknown	HSA, Federal
Illawarra	Lucy: Wooden Schooner	_/7/1847	Off Wollongong	Foundered	47 tons, 14.93x 4.785m, Built 1845 Ulladulla, Voyage Sydney-Port Phillip with wheat, timber	HSA, Federal
Illawarra	Maggie Scott: Wood Carvel Ketch	14/6/1889	Off Black Point, Shoalhaven Bight	Sprang leak, foundered30 tons, 18.1x	30 tons, 18.1x5.09m, Built 1868 Brisbane Water, Voyage Tomkin Creek-Sydney with sawn hardwood	HSA, Federal
Illawarra	Malcolm: Wood carvel Brigantine	_/2/1898	In the vicinity of Bulli	Foundered in gale	182 tons, 32.06x7.162m, Built 1862 Prince Edward Island Canada, Voyage Wollongong-Sydney with coal, 7 lost	HSA, Federal
Illawarra	Margaret: Wooden clinker Ketch	28/12/1879	Off Black Point, near Gerringong	Lost rudder, foundered	25 tons, 15.84x3.931, Built 1867 Durham UK, Voyage Shoalhaven-Sydney with timber	HSA, Federal
Illawarra	Marvel: Wood Carvel Steamer Screw	24/11/1892	4 miles off Pilot Station, Shoalhaven Bight	Sprang leak, foundered	71 tons, 22.98x5.547m Built 1891 Jervis Bay, Voyage Jervis Bay-Sydney with timber logs	HSA, Federal
Illawarra	Mary Warner: Wood Carvel Top-sail Schooner	20/4/1894	Off Kiola	Sprang leak, abandoned	65 tons, 23.65x6.4m, Built 1873 Lake Macquarie, Voyage Beagle Bay-Sydney with timber	HSA, Federal
Illawarra	Unnamed steel launch	15/06/1939	Off Shellharbour	Caught fire	Details unknown, reported by fishermen	Not protected
Illawarra	Norman: Wood Carvel Schooner	28/8/1895	Bellambi Reef, Wollongong	Struck reef	51 tons, 20.6x6.3, Built 1880 Lake Macquarie, Voyage Wollongong-Sydney with 81 tons of coal	HSA, Federal
Illawarra	North Briton: Wooden Sloop	17/12/1828	Off Wollongong	Wrecked	Details, voyage and cargo unknown	HSA, Federal
Illawarra	Northern Firth: Steel Steamer, Screw	22/02/1932	Off Brush Island, Ulladulla	Struck submerged object	1954 tons, 85.4x12.77m, Built 1922 Grangemouth UK, Voyage Melbourne-Sydney with general cargo	Not protected

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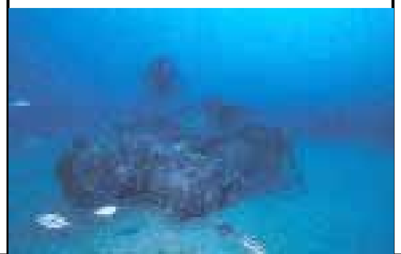
Illawarra	Palmerston: Iron Steamer, Screw	29/05/1929	18 miles south of Jervis Bay	Collision	463 tons, 53.43x7.62m, Built 1878 Glasgow UK, Voyage unknown, cargo fish	Not protected
Illawarra	Perseverance: Wooden, Type unknown	_/1/1842	Illawarra region	Cause not known	Details not known	HSA, Federal
Illawarra	Petrel: Wooden Schooner	_/1/1850	Between Wollongong-Sydney	Cause not known	7 tons, 8.11x2.74, Built 1838 Sydney, Voyage Wollongong-Sydney, Cargo unknown	HSA, Federal
Illawarra	Phoebe: Barquentine	_/5/1876?	Offshore north of Jervis Bay?	Sprang leak?	Details unknown, said to be transit Hong Kong-Newcastle, Cargo unknown - information derived from message in bottle	HSA, Federal
Illawarra	Prince Alfred: Wooden clinker Ketch	_/6/1891	Off Five Islands, Wollongong	Supposedly foundered	56 tons, 22.82x5.577m, Built 1868 Balmain, Voyage Sydney-Mosquito Bay in ballast	HSA, Federal
Illawarra	Resolute: Wooden Steamer, Screw	12/07/1907	1 mile offshore, Bellambi Reef, Wollongong	Struck sand/reef	211 tons, 39.92x7.101m, Built Auckland, Voyage Sydney-Kiama in ballast1880	HSA, Federal
Illawarra	Result: Wood Carvel Schooner	30/9/1893	Near Abrahams Bosom, Shoalhaven Bight	Missed stays	56 tons, 25.23x5.699, Built 1882 Wangaroa NZ, Voyage Sydney-St Georges Basin in ballast	HSA, Federal
Illawarra	Ruby: Wood Carvel Fishing boat	9/12/1895	Sir John Young Banks off Beecroft Head	Sprang leak	8 tons, 9.174x2.164, Built 1872 Balmain, Voyage Sydney-Beecroft Head with fish	HSA, Federal
Illawarra	Saxonia: Iron Steamer, Screw	17/5/1898	Bellambi Reef, off Wollongong	Struck reef (navigation error), in 'Maitland' gale	257 tons gross, 49.49x7.406m, Built 1856 Hull UK, Voyage Wollongong-Bulli with coal	HSA, Federal
Illawarra	Spec: Wood Carvel Schooner	17/10/1865	1.5 miles off Black Head near Gerringong	Heeled over, foundered in squall	17 tons, 13.13,x3.535m, Built 1856 Sydney, Voyage/cargo unknown, 2 lost	HSA, Federal
Illawarra	Spray: Wood Carvel Brig	24/4/1870	Near the Bulli jetty at Coal Cliff	Cause not known	142 tons, 23.89x6.522m, Built 1850 Launceston, Wollongong, Cargo unknown	HSA, Federal
Illawarra	Taramung: Iron Steamer, Screw	_/5 or 6/1891	In or near Wreck Bay	Foundered in gale	1281 tons gross, 75.07x10.24m, Built 1880 Port Glasgow UK, Voyage Newcastle-Melbourne with 1647 tons coal, 30 lost	HSA, Federal
Illawarra	Tiger: Wood Carvel Schooner	11/7/1866			76 tons, 18.1x5.303m, Built 1821 Barrington Nova Scotia, Voyage to Wollongong, cargo unknown, 3 lost	HSA, Federal
Illawarra	Unidentified wreck	nd	Approximately 5 miles off Shellharbour	Unknown	Details unknown; wooden wreckage reported by fishermen - nd	Not protected
Illawarra	Unique: Wooden Steamer, Screw	4/03/1934	Off Shoalhaven Heads	Sprang leak	84 tons, 23.1x5.547m, Built 1902 Blackwall Brisbane, Voyage Sydney-Port Kembla with fish,	Not protected
Illawarra	Wandra: Wooden Steamer, Screw	15/12/1915	Off Drum& Drumsticks, Jervis Bay [found at Lat35.044833-Long 50.839, in 26 m water]. Deck winch pictured below (Source: Maritime Heritage Online, NSW Heritage Office)… 	Swamped by heavy seas	164 tons gross, 36.72x7.924m, Built 1907 Coopernook, Voyage Moruya-Sydney with full cargo	HSA, Federal
Illawarra	William Combe: Wooden Steamer, Screw	16/04/1931	Off Drum & Drumsticks, Jervis Bay	Hit rock, foundered	39 tons, 18.28x6.035m, Built 1929 Drummoyne, Voyage unknown, Cargo fish,	Not protected
South-east	Alice Jane: Wood Carvel Schooner	11/1/1888	Off Tomakin, Batemans Bay	Unknown	80 tons, 25.2x5.73m, Built 1873 Cape Hawke, Voyage unknown, Cargo timber	HSA, Federal
South-east	Almeda: Wooden Brigantine	9/7/1863	7 miles NE Cape Howe	Sprang leak, foundered	210 tons, 28.9x7.3m, Built Connecticut USA, Voyage Sydney-Melbourne with maize/general cargo	HSA, Federal
South-east	Ann and Maria: Wooden Brig	5/7/1869	9-10 miles south Green Cape	Unknown	236 tons, 28.3x8.0m, Built 1849 Sunderland UK, Voyage Newcastle-Melbourne, Cargo unknown	HSA, Federal

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Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
South-east	Arthur: Wooden Ketch	_/_/1883	Off Wagonga Head, Narooma	Unknown	61 tons, 23.4x5.7m, Built 1879 Manning River, Voyage/cargo unknown,	Not protected
South-east	Bega: Iron Steamer, Twin-screw	5/04/1908	Off Tanja Beach, between Tathra and Bermagui	Capsized	567 tons gross, 57.7x7.5m, Built 1883 Greenock UK, Voyage Tathra-Sydney with passengers and cargo, 1 lost (heart attack during rescue)	HSA, Federal
South-east	Carrick: Iron Barque	16/12/1896	Off Cape Howe	Unknown	998 tons nett, other details unknown, Voyage Newcastle-Valparaiso with coal,	HSA, Federal
South-east	Conjola: Wooden Steamer, Paddle	221/7/1927	Batemans Bay-Sussex Inlet	Foundered	35 tons, 18.28x6.096m, Built 1920 Balmain, Voyage/cargo unknown	Not protected
South-east	Cumberland: Steel Steamer, Screw	11/08/1917	5 miles SE Green Cape	Sank under tow after struck mine or torpedoed	8993 tons gross, 144.4x18.28m, Built 1915 Glasgow UK, Voyage Townsville-Eden with frozen meat	HSA, Federal
South-east	Dunkeld: Wood Carvel Barquentine	27/6/1870	Off Twofold Bay	Lost at sea	390 tons, 40.14x5.974m, Built 1852 Nova Scotia Canada, Voyage Newcastle-Melbourne with coal, 2+ lost	HSA, Federal
South-east	Favorite: Wooden Ketch	17/5/1852	Cape Howe area, could be in Victorian waters	Unknown	15 tons, 13.1xm, Built Brisbane Water, Voyage Melbourne-Sydney with 2000 oz gold dust and 8+ passengers, 8+ lost	HSA, Federal
South-east	Glimpse: Wooden Barque	20/10/1881	240 miles off Cape Howe	Bows opened in gale	347 tons gross, 40.08x9.2m, Built 1856 Newbury NY USA, Voyage Burrards Islet BC-Melbourne with timber, 3 lost	HSA, Federal
South-east	Henry Bolte: Steel Motor Vessel, Tug	_/8/1988	South Red Point off Twofold Bay [located at Lat37.114 Long 149.962333in 25m water. Gangway on Henry Bolte depicted below (Source: Maritime Heritage Online, NSW Heritage Office): 	Scuttled as dive site	393 tons gross, 40.72x10.21m, Built 1966 Newcastle,	Not protected
South-east	Indus: Wooden Barque	17/3/1872	100 miles off Mt Dromedary	Lost at sea	368 tons, 33.1x8.49m, Built 1839 Dumbarton UK, Voyage unknown, with coal	HSA, Federal
South-east	Industry: Wooden clinker Sloop	_/6/1845	Off Broulee	Unknown	14 tons, 9.144x3.505m, Built 1834 Hawkesbury River, Voyage/cargo unknown	HSA, Federal
South-east	Iron Knight: Steel Steamer, Screw	8/02/1943	30 kms off Montague Island	Torpedoed	4812 tons gross, 123.2x17.12m, Voyage Whyalla-Newcastle with iron ore, Built 1937 Glasgow UK, 36 lost	Not protected
South-east	Julius Vogel: Wood Carvel Schooner	16/4/1890	Off Tomakin, Batemans Bay	Foundered in gale	56 tons, 20.23x5.882m, Built 1873 Auckland, Voyage/cargo unknown	HSA, Federal
South-east	Kali: Wooden Motor Vessel	_/9/1986	12 miles South Bermagui	Unknown	42.5 tons, 16.46x5.03m, Built 1958 Ulladulla	Not protected

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Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
South-east	Kameruka: Steel Steamer, Screw	16/10/1897	Pedro Reef, Moruya [cf former collision with 'Esther Marie' 1882 above]	Unknown	515 tons gross, 54.74x7.467m, Built 1880 Greenock UK, Voyage Twofold Bay-Sydney with passengers and cargo	HSA, Federal
South-east	Kedumba: Wooden Steamer, Screw [Vehicular Ferry]	21/12/1932	25 miles NW Montague Island	Sprang leak, foundered	291 tons, 40.08x11.06m, Built 1913 Sydney, Voyage Sydney-Melbourne in ballast	Not protected
South-east	Lady Darling: Iron Steamer, Screw	_/11/1880	Approximately 4 miles SW Montague Island, in 15 fathoms. Located Lat36.318333 Long150.168333. View of stem to Engine Room below (Source: Maritime Heritage Online, NSW Heritage Office): 	Struck submerged object in gale	895 tons gross, 73.03x8.564m, Built Liverpool UK, Voyage Newcastle-Melbourne with coal	HSA, Federal
South-east	Lillian: Wooden Ketch	20/6/1882	Grasshopper Island, Batemans Bay	Unknown	33 tons, 18.71x5.059m, Built 1865 Balmain, Voyage to Newcastle, Cargo unknown	HSA, Federal
South-east	Malaita: Motor Vessel	28/05/1948	Off Narooma	Unknown	Details unknown	Not protected
South-east	Mary: Wooden Schooner	26/5/1821	Twofold Bay, Range Lat37.101-37.034333, Lon149.950667-149.850667	Anchor cables parted	Details unknown, Voyage Sydney-Port Dalrymple with spirits	HSA, Federal
South-east	Mimmie Dyke: Wood Carvel Schooner	16/7/1887	South of Twofold Bay	Unknown	87 tons, 23.77x5.76m, Built 1854 Dundee UK, Voyage Melbourne-Sydney, Cargo unknown	HSA, Federal
South-east	Mimosa: Iron Steamer, Paddle	9/9/1863	Off Bulga Head, north of Tathra. Located Lat 36.58295 Long150.05755. View of the Mimosa's boiler below (Source: Maritime Heritage Online, NSW Heritage Office): 	Struck submerged rock	153 tons gross, 49.65x5.455m, Built 1854 Renfrew UK, Voyage Merimbula-Sydney with passengers and coastal cargo, 2 lost	HSA, Federal
South-east	Mina, Wood Carvel Brig	23/6/1888	East of Green Cape	Sprang leak, foundered	265 tons, 32.88x7.65m, Built 1867 Rounebeck Germany, Voyage Clarence River-Melbourne with sawn hardwood	HSA, Federal
South-east	Motor Gem: Wooden Motor Vessel	15/03/1917	Off Tathra Head	Unknown	57 tons gross, 24.78x5.425m, Built 1907 Sydney, Voyage/cargo unknown,	HSA, Federal
South-east	Olivia: Wooden Schooner	19/11/1827	South of Twofold Bay	Unknown	60 tons, other details unknown, Built 1826 Port Dalrymple, Voyage/cargo unknown	HSA, Federal
South-east	Picard: Wood carvel Schooner	8/10/1867	15 miles East of Cape Dromedary	Lost Stern post	165 tons, 27.92x6.86m, Built 1846 Portsmouth New Hampshire USA, Voyage Launceston -unknown, Cargo unknown	HSA, Federal
South-east	Porpoise: Wooden Schooner	16/5/1866	Off Wagonga Heads, Narooma	Unknown	39 tons, 14.11x4.54m, Built 1851 Shoalhaven, Voyage/cargo unknown,	HSA, Federal

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Region	Vessel: Type	Date Lost	Location	How Lost	Detail	Protection
South-east	Provincial Trader: Steel Motor Vessel	24/03/1995	Off Twofold Bay	Scuttled after sinking at moorings	419 tons, 42.367xm Built 1959 Brisbane as a fire-fighting tug, converted to fishery9.957, Voyage from Twofold Bay	Not protected
South-east	Recina: Steel Steamer, Screw	11/04/1943	32 km North of Cape Howe	Unknown	4732 tons gross, 122.1x16.52m, Built 1930 Sunderland UK as 'Lady Plymouth', Voyage Whyalla-Newcastle with iron ore	Not protected
South-east	Riptide: Wooden Motor Vessel	5/06/1949	Near Tathra	Unknown	26 tons, 14.52xm, Built 1948 Gladesville, Voyage/cargo unknown	Not protected
South-east	Robert J Walker: Steel Steamer, Screw	26/12/1944	East of Bermagui	Torpedoed	7180 tons, 128.8x17.37m, Built 1943 Portland Oregon USA, Voyage Fremantle-Sydney, Cargo unknown	Not protected
South-east	Tasman Hauler: Steel Motor Vessel	1/10/1988	Off Twofold Bay, Located Lat36.112 Long149.962	Scuttled as dive site after running aground	418 tons, 42.4x9.96m, Built 1959 Brisbane as firefighting tug 'BP Cockburn', Voyage from Twofold Bay, No cargo	Not protected
South-east	Tea Tephi: Wooden Schooner	27/8/1894	Off Twofold Bay	Collided with whale	23 tons, 14.99x3.474m, Built 1884 Eden, Voyage/cargo unknown	HSA, Federal
South-east	Teazer: Wooden carvel Brigantine	11/10/1854	Off Twofold Bay	Abandoned in gale	58 tons, 14.99x4.572m, Built Melbourne, Voyage Launceston-Melbourne in ballast	HSA, Federal
South-east	Victory: Wood Carvel Brigantine	6/11/1893	Near Cape Howe	Abandoned after sprang leak	142 tons, 27.79x7.376m, Built 1873 Jervis Bay, Voyage Warrnambool-Newcastle in ballast	HSA, Federal
South-east	Wear: Steel Steamer, Screw	8/09/1944	15 kms off Montague Island	Collision	1892 tons, 81.68x11.55m, Built 1911 Sunderland UK, Voyage/cargo unknown, 1 lost	Not protected
South-east	William Dawes: Steel Steamer, Screw	22/07/1942	Off Tathra Head	Torpedoed	7176 tons, 126.97x17.343m, Built 1942 Portland Oregon USA, Voyage/cargo unknown, 5 lost	Not protected
South-east	Zvir: Steel Steamer, Screw	15/11/1942	150 kms South of Port Kembla	Collision	5607 tons, 118.9x16.45m, Built 1926 Glasgow UK, Voyage Whyalla-Newcastle with iron ore	Not protected

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