
Abalone Fishery

Environmental Impact Statement

Public Consultation Document

**This is the First of Three Volumes of the Environmental Impact
Statement on the NSW Abalone Fishery**

VOLUME 1

Executive Summary

Review of the Existing Abalone Fishery

September 2005

Environmental Impact Statement prepared by:

The Ecology Lab Pty Ltd

On behalf of:

**NSW Department of Primary Industries and
Shareholders of the NSW Commercial Abalone Fishery**



Details of the public consultation process and contact information are included on page 26 in Chapter A (Volume 1)



**Environmental Impact Statement on the Abalone Fishery in NSW
Public Consultation Document**

The Ecology Lab Pty Ltd, September 2005

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DECLARATION

For the purpose of section 115K (4) of the *Environmental Planning and Assessment Act 1979*, The Ecology Lab Pty. Ltd. is responsible for the preparation of this Environmental Impact Statement (EIS) for the Abalone Fishery. The Ecology Lab worked with stakeholders in the fishery and staff from The NSW Department of Primary Industries (formally NSW Fisheries) with expertise and qualifications in fisheries management and environmental science to prepare the EIS. Where expertise was not available within The Ecology Lab or The Department of Primary Industries, external experts were consulted.

The EIS has been prepared, under instruction from The Department of Primary Industries, on behalf of the persons with harvesting rights in the Abalone Fishery (the shareholders). A list of the shareholders is contained in Appendix A1 of the EIS.

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The location of the proposed activity is described in Chapter D Section 2.2.1. 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 is presented in the EIS in Chapter E. The 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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MEMBERSHIP ON ADVISORY BOARDS

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CHAPTER A EXECUTIVE SUMMARY

Introduction

The Abalone Fishery is a quota managed fishery which targets the blacklip abalone (*Haliotis rubra*) along coastal reefs of NSW. It is a highly specialised fishery which provides a valuable seafood product, most of which is exported. The fishery is intensively managed with a history of pro-active administrative, research and compliance programs. Moreover, participants in the fishery have been closely involved in the development of many of the management arrangements.

The operation of the current activity causes some environmental, social or economic risks. The recent effects of some external factors have combined to exacerbate some risks. In particular, there is risk to the economic viability of operators in the fishery. These risks must be addressed for the activity to proceed sustainably and for the necessary approvals to be granted. A number of actions have been proposed to address the risks, including the framework for a more efficient harvesting strategy measures to minimise the impact of external factors affecting the fishery and measures that allow the capacity of the commercial fishery and individual fishing businesses to adjust according to economic conditions. The actions proposed represent a balanced approach to securing the objectives sought for commercial abalone fishing and sustainable fisheries.

The Environmental Impact Statement (EIS) for the Abalone Fishery presents a thorough, frank and transparent assessment of the risks associated with the current activity and the measures proposed to address the risks.

This summary provides an introduction to the environmental assessment process. It briefly outlines the context within which the fishery currently operates, the management arrangements proposed for the fishery (i.e. the draft fishery management strategy), and the findings of the environmental impact assessment.

Public exhibition of the EIS provides an opportunity for the community to review the environmental performance of the activity of commercial abalone 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 NSW are managed in an ecologically sustainable way. The changes require the development and implementation of fisheries management strategies and associated environmental assessments for each major fishing activity, including the Abalone Fishery. The draft fishery management strategy (FMS) and environmental impact assessment for each fishing activity are combined within an EIS. Their structures are based on guidelines issued by the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR).

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 FMS), it has re-evaluated the level of risk that would eventuate if the management strategy were to be implemented.

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

Development of the Draft Fishery Management Strategy

Proposed management arrangements in the draft FMS were developed in a consultative process between shareholders in the commercial fishery for abalone and the NSW Department of Primary Industries (DPI), wherein industry representatives were assigned the lead role for the project. Consultation was facilitated through the Joint Abalone Working Group (JAWG), which comprised two representatives from Industry (one nominated by ABMAC and the other by the Abalone Development Company) and representatives from DPI. Input was also sought from the Abalone Management Advisory Committee (ABMAC), shareholders in the fishery directly (through a specifically designed summary paper and industry open day), the Ministerial Advisory Council's on the Seafood Industry (which includes representatives from other NSW commercial fisheries) and Recreational Fishing, the Total Allowable Catch Setting and Review Committee, the NSW Nature Conservation

Council, the cross sector and expert based FMS Working Group and the Indigenous Fisheries Working Group.

The draft FMS contains the proposed rules for management of the Commercial Abalone Fishery. It also contains the objectives for the fishery, a detailed description of the way the fishery operates, and describes the long term management framework for the fishery. It 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 Draft Environmental Impact Assessment

The environmental impact assessment and the strategy have been developed in stages. The draft strategy assessed here is in fact the second draft of the strategy. The process has been designed to give feedback to shareholders and allow a response to the predicted environmental impacts of the management proposals. Each draft of the strategy is then modified to ensure that the proposed management framework appropriately addresses the environmental risks identified during the assessment process. Where appropriate, the assessment for the Abalone Fishery has also considered previous assessments for other fisheries in NSW, and abalone fisheries in other states, to take advantage of common approaches to impact assessment to assist in identifying issues.

It is important to recognise that, in assessing the impacts of an existing fishing industry, the activity being assessed (i.e. the Abalone Fishery) already exists. Consequently, changes to fishing practices and levels of harvest will have direct social and economic impacts on already-established fishing and related industries. It is important that when the potential impacts of proposed changes are assessed time is allowed, where appropriate, for Industry and its stakeholders to adjust to such changes.

The assessment of fishery impacts also recognises that there is much that is unknown 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 ecologically sustainable development, 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'.

The EIS for The Abalone Fishery is structured as follows. The first chapter (Chapter A) presents a summary of the EIS. Chapter B reviews the existing operation of the activity, identifying where it occurs, the methods used, species taken, current management arrangements 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 FMS. 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. Chapter D describes the proposed management arrangements for the activity (i.e. the draft fishery management strategy). Chapter E assesses the potential impacts of implementing the draft FMS, that is, the extent to which the draft FMS mitigates the risks identified in Chapter B. Chapter F provides a justification for the preferred strategy, taking into account its implications in terms of ecological, social and economic factors. Together these chapters (Chapters C, D, E and F) comprise Volume 2 of the EIS.

This EIS acknowledges that the NSW commercial Abalone Fishery is currently experiencing considerable pressures due to a prolonged episode of a declining abalone stock and relatively low markets prices, as well as persistent and major external factors that are adversely affecting the fishery (e.g. abalone theft and *Perkinsus*). The assessment also recognises the historical strengths of the fishery. The draft FMS, as presented in the EIS, outlines a number of strategies that are currently in place and ways to build on these to enable the fishery to return to a viable base. The achievements of this outcome will necessitate a stronger and more cooperative partnership within the whole NSW Abalone Fishery, government agencies and the broader community.

The Existing Activity of Commercial Abalone Fishing

Commercial fishing for abalone in NSW began in the late 1950s and the Abalone Fishery is now one of the State's most valuable fisheries. Most of the product is exported to Asia. The Abalone Fishery in NSW is based upon the harvest of only one species, the blacklip abalone, *Haliotis rubra*. Abalone are taken by hand by divers using underwater breathing apparatus mostly from shallow, fringing reefs on the south coast of NSW, although some diving occurs on the mid-north coast and in deeper waters. There is virtually no overlap with other commercial fisheries in NSW as there is no use of bait, no byproduct from the fishery, virtually no bycatch and no other commercial fisheries in NSW are allowed to land abalone.

Blacklip abalone are also harvested in Victoria, Tasmania, South Australia and Western Australia, where catches are generally much larger.

The Abalone Fishery is a category 1 share managed fishery and operates under the Abalone Share Management Plan 2000. Fishing rights in the commercial fishery are gained through the ownership of shares. There are a total of 3,654 shares in the fishery and there are 48 shareholders as of February 2005. As category 1 share managed fisheries are subject to a policy of cost recovery for the management of the fishery attributable to the commercial fishery, shareholders pay the majority of costs associated with administration, research and compliance as well as a 'community contribution' for privileged access to the resource. Shareholders may take abalone themselves if they hold 70 shares in the fishery or may nominate a person to take abalone on their behalf. Shareholders who hold less than 70 shares can transfer their quota to other shareholders with 70 shares or more so that their quota can be fished. As at February 2005, there were 42 people (i.e. divers) endorsed to take abalone in the commercial fishery. Divers travel to reefs to collect abalone using small boats between 5-6 m in length and usually have a deck-hand to assist them. They work during daylight hours when the sea conditions are relatively calm. The fishery operates mostly south of Sydney. Abalone divers harvest a portion of a state-wide Total Allowable Commercial Catch (TACC) as allocated to shareholders in proportion to their shareholding. There are currently no seasonal closures to the fishery and divers generally spread their fishing effort across the whole year, but subject to sea conditions. Some areas of coastline are closed to divers where populations of abalone are known to have been severely depleted due to the *Perkinsus* parasite, or where marine protected areas occur and harvesting restrictions apply.

The Abalone Fishery is one of only three fisheries under the jurisdiction of NSW where a TACC applies (the others being the Lobster Fishery and the Sea Urchin and Turban Shell Fishery). The TACC for the Abalone Fishery is determined each year by the independent TAC Committee. The TACC was set at 206 tonnes for the 2004/5 fishing period and, more recently, at 130 tonnes for the 2005/6 fishing period. An analysis of the recent change has not been included in the EIS. In addition to the catch quota, a minimum legal size (MLS) applies to collection of abalone. The MLS has been set at 115 mm since 1987. At this size, the vast majority of abalone in NSW are mature, and have had the opportunity to spawn at least twice. Thus, within the Abalone Fishery, juvenile abalone cannot be collected and, if they are inadvertently collected, they must be returned to their reef habitat immediately.

Risk, Response and Predicted Outcome

The following section briefly describes the risks of the Abalone Fishery as they pertain to environmental, economic and social components (initial risk), the management responses proposed in the draft FMS to mitigate those risks (response) and a predictive assessment of the degree to which those measures may mitigate the risks (predicted outcome).

In order to address any perceived risks with existing operations, it is first necessary to describe and evaluate the potential risks arising from the manner in which operations are conducted. It is also necessary to attempt to isolate those elements of the operation that contribute most to those risks and to adjust those elements through the draft management strategy.

To address the risks, the draft management strategy offers eight major long-term goals for the management of the fishery, which are supported by approximately 16 objectives and 60 management responses. It is important to note that a single management response can mitigate a variety of risks and therefore it is not necessary to formulate separate responses for each risk.

Biophysical Impacts

Chapter B of the EIS presents a critical evaluation of the available information on the biophysical impacts of harvesting abalone and the underlying mechanisms by which impacts may occur. An understanding of these mechanisms is important for the evaluation of future impacts of abalone fishing, and for evaluating the extent and magnitude of existing impacts.

Broadly, the operation comprises six activities that have the potential for a variety of environmental, economic and social impacts. These activities include:

- Harvesting – the removal of abalone and bycatch from reefs and disturbance of other reef biota;
- Discarding – the returning of under-sized abalone and unwanted bycatch to the sea;
- Boat movements – travel to and from reefs and while diver is harvesting;
- Boat and compressor maintenance and emissions – tasks involving fuel, oil, noise or other boat or compressor engine related activities that could result in spillages or leakages into the air or the sea;

- Loss of fishing gear – loss of catch bags or other diving equipment during harvesting or travel; and
- Marketing – the sale of abalone to processors.

These activities can, potentially, have both direct and indirect impacts on the biophysical environment. For the existing Abalone Fishery, almost all activities are considered to pose only a negligible or low risk to most components of the biophysical environment. Only the activities of harvesting and discarding have the potential to cause a level of risk to components of the environment that require specific management and this was limited to only some sub-components of the target species, and, potentially, to some sub-components of bycatch. This is due to the current state-wide minimum legal size (MLS), along with quota management, which has been the basis for successful management of commercial harvesting of abalone and protection of the majority of individuals on reefs. Although it is not clear how common individuals above 115 mm were in the virgin stock before it was fished down, in most areas individuals above the MLS currently represent only a small proportion of both the total population (~5%) and the mature stock(~33%) (Worthington *et al.* 2001). Importantly, under the current operation of the fishery, the MLS effectively protects at least 95% of the population from commercial harvesting, allows the majority of abalone in populations at least two years of spawning before being harvested and, combined with the TACC, prevents over-fishing of mature stock by the commercial fishery.

The appraisal of the management responses in the draft FMS has been made on the basis that proposed research and monitoring will be undertaken. Research and monitoring should remove uncertainty surrounding the activity and predictions made in the EIS. It should also allow a retrospective analysis of the accuracy of the assessment and facilitate the implementation of new management measures if necessary.

The Target Species

Initial Risk

Broadly, the risk assessed is the likelihood of populations of blacklip abalone, *Haliotis rubra*, being affected adversely by the operation of the fishery. The assessment determined that the current activity of harvesting abalone above the MLS had potential for a high risk to the abundance of mature stock at local geographical scales and a moderate risk at general scales.

There was also a moderate risk to the distribution of abalone at all scales and the size-structure and non-retained (discarded) abalone at local scales.

Issues Arising

The effects of external factors would tend to exacerbate the risk from the commercial fishery. Illegal catch of abalone by unlicensed operators is thought to be great. Illegal operators tend to take abalone much smaller than the MLS and can devastate local populations. The cumulative potential impact of illegal fishing is considered to create a much greater risk than the initial risk from legal commercial harvesting abalone.

There has been large-scale depletion of abalone in recent times between Port Stephens and Jervis Bay due to infection from the parasite *Perkinsus*, although small pockets of abalone within this area remain unaffected. This has effectively restricted the commercial fishery in NSW to areas south of Jervis Bay.

Recently, catch rates in general have declined, a number of new inexperienced divers have entered the industry, and experienced and inexperienced divers may have found it necessary to concentrate their fishing effort in specific areas. Under these circumstances discarding may have increased as a result of dislodging, measuring and returning some abalone more frequently on some reefs. As a proportion of discarded abalone may die, increased rates of discarding are a potential threat to non-retained abalone.

Limited dispersal of abalone larvae away from their parents means that there is slow recovery of depleted populations at local scales. The combined effects of illegal fishing, a geographical shift in fishing effort due to the effects of *Perkinsus* and the potential for increased discarding potentially increase the risk to remaining harvested populations of abalone.

Response

The draft FMS proposes a number of responses that address risks to the target species. The extent to which the overall risks are reduced will depend on the effectiveness of existing and new management controls and successful implementation. The major programs in the draft FMS for addressing risks include the following:

Management:

- Continue to apply the TACC, state-wide MLS, and improve compliance strategy and stock assessment program;

- Development of a more complete harvest strategy, including rebuilding stock - the intent is to develop a set of guidelines based on sustainability that also allow managers of the fishery to achieve specific goals and industry to plan operations more effectively over the medium- and longer-term. Guidelines for the harvest strategy would combine the use of the TACC with other measures proposed to make harvesting more efficient and to rebuild populations where appropriate. Strategies are proposed for re-establishing populations of abalone in areas where abalone were once commercially viable but have now been depleted (e.g. from *Perkinsus*, illegal fishing). Strategies include: closures for protecting some populations as required; and rebuilding through reseedling, translocating abalone (i.e. moving brood-stock over small distances) and restoring populations of abalone through harvesting of sea urchins. There is also intent to investigate the possibility of using different size-limits for different areas and for controlled fish-downs of stunted populations and for developing a harvesting plan for Region 1 (i.e. in and around areas where abalone are infected by *Perkinsus*);
- Catch and effort – alternatives are proposed for how catch and effort are managed to avoid inappropriate concentrations that may result in over-fishing. The final detail of the management response will be determined after options presented in the EIS have been thoroughly considered (Chapter C);
- Minimise the rate of disturbance to abalone under the MLS – development of a method for monitoring the rate of discarding is proposed and there is intent in the code of practice to control the potential for unsustainable harvesting practices (particularly relating to the discarding issue); and
- Minimising external impacts – new strategies are proposed to address illegal fishing. These include: the application of stronger safeguards in the processing sector; investigating the cost and benefits of strategies already used by Compliance; and an industry-based reporting program to assist Compliance in identifying where illegal activity may be occurring. It is important to note that the Compliance strategies in the FMS will be responsive to government decisions to the *Report on Illegal Fishing for Commercial Gain or Profit in NSW* (Palmer 2004). A strategy is proposed for developing a plan for harvesting in

the area affected by *Perkinsus*. Finally, there is intent to seek better communication between the commercial sector and proponents of proposals for development that may adversely affect abalone.

Research:

- Develop ways to mitigate the effects of *Perkinsus*, including a strategy for harvesting in and around areas where abalone are infected;
- Objectively assess the benefits of appropriate alternative size limits for particular areas;
- Objectively assess the benefits of appropriate regional or local catch controls for particular areas;
- Continue to assess the benefits of reseedling, translocating and restoring populations of abalone;
- Finalise a method for estimating the level of discarding in the fishery to be used as a basis for developing a program for minimising potential impacts to non-retained abalone; and
- Continue to investigate methods for estimating the illegal, recreational and Indigenous catches of abalone.

Monitoring:

- Continued monitoring of the general population of abalone and the commercial fishery to assess the status of exploitation; and
- Continued monitoring of populations of abalone in and around areas affected by *Perkinsus*.

Predicted Outcome

These management measures are likely to result in reduced risk to the abundance of mature stock, non-retained abalone and the distribution and size-structure of populations of abalone and therefore enhance the sustainability of the fishery. For many of the management controls, specific mechanisms to be used would be developed during the implementation of the strategy. Therefore, it is most important that the implementation arrangements,

including research and monitoring, will be appropriate to address the goals and objectives stated in the strategy.

Bycatch

Initial Risk

The risk assessed is the likelihood of species of bycatch being affected adversely by the operation of the fishery. The assessment determined that the activities of harvesting abalone above the MLS and discarding bycatch have the potential for a low to moderate risk to species of bycatch. Despite bycatch being confined to small organisms attached to the shell of abalone or living in the foot or mantle cavity, substantial knowledge gaps about the identity and ecology of bycatch leaves some uncertainty surrounding the risks of operations. As most abalone removed from the reef are above the MLS (abalone below the MLS are measured and generally returned immediately to the reef) the risk under current operations was considered low to species of bycatch with general habitat requirements but moderate at local scales for species of bycatch with potentially specific requirements for living in association with abalone.

Issues Arising

Knowledge about the identity and ecology of bycatch species needs to be improved, particularly whether there are any species with specific requirements for living upon abalone and the potential effects the removal of abalone above the MLS would have on these species. As few data exist about species of bycatch it is difficult to quantify the extent to which impacts would be reduced under the draft FMS. It is reasonable, however, to predict that if populations of abalone are maintained, many species associated with abalone would also be maintained.

Response

The measures proposed in the draft FMS to mitigate risk to species of bycatch are focussed on obtaining better information about bycatch and the effects on these species of removing abalone above the MLS. In addition, it is proposed that the information gathered is used for developing 'best practice' diver behaviour in regard to minimising the potential for adverse impacts. The major programs in the draft FMS that address the risk to species of bycatch can be divided into the following:

Management:

- Continued implementation and development of a program to monitor the effects of harvesting abalone above the MLS on the biophysical environment and increase knowledge where appropriate; and
- Promote, through the fishery code of practice, fishing practices that minimise the potential for adverse impacts upon bycatch species.

Research:

- Continued development of a program to increase knowledge of the effects of harvesting abalone above the MLS on the biophysical environment (biota, populations, ecological communities and ecosystem processes).

Monitoring:

- Continued implementation of a program to monitor the effects of harvesting abalone above the MLS on the biophysical environment.

Predicted Outcome

There are still many aspects of bycatch that remain uncertain, particularly whether there are any species of bycatch that have specific requirements for living on abalone. In the absence of scientifically rigorous data, this assessment has taken a highly precautionary approach. Hence, there is no change to the initial risks under the draft FMS.

Given the low to moderate level of risk to bycatch, the measures contained in the draft FMS are appropriate provided that the information obtained from research about bycatch is fed back into other management responses (such as for improvements to the fishery code of practice) and used to reduce the potential for impacts.

Threatened and Protected Species

Initial Risk

The risk assessed is the probability that any aspect of the fishery would impede the conservation and recovery of a threatened species. The assessment determined that threatened and protected species were at low risk, and only from the activities of harvesting and boat movements. There are also specific regulations that apply to interactions with threatened species and these would be re-iterated as part of the code of practice for the

fishery. The low risk considered to threatened and protected species is due to the apparently low rate of interaction between the commercial fishery and these species.

Issues Arising

On-going monitoring of the interaction between the fishery and threatened and protected species is required to ensure that the level of impact on these species does not increase in the future. Such monitoring should involve a mechanism for recording and reporting details of interactions with threatened species where appropriate (e.g. when boat strikes occur, when new aggregations of threatened species are located within abalone grounds, etc.).

The draft FMS includes a mechanism (i.e. the code of practice) to respond to future listings of species under the threatened species legislation. Such a mechanism is necessary to ensure any species that the fishery interacts with is protected in a timely manner. At this stage, compliance with the code of practice will be on a voluntary basis only.

Response

The measures proposed to mitigate risk to threatened and protected species are focussed on obtaining better information on interactions between abalone divers and threatened species in the fishery and providing the means for 'best practice' diver behaviour in regard to minimising the potential for adverse impacts. The major programs in the draft FMS for addressing the risk to threatened and protected species can be divided into the following:

Management:

- Continued implementation and development of a program to increase knowledge of the effects of harvesting abalone above the MLS on the environment;
- Implement actions required in accordance with recovery plans for threatened species or threat abatement plans – adherence to the provisions in such plans will promote the recovery of these species;
- Promote, through the code of practice, fishing practices that minimise negative interactions with protected fish and threatened species; and
- Ensure, through the code of practice, that Industry is aware of increasing knowledge of the distribution, occurrence and requirements of threatened species that may be encountered during the operation of the fishery.

Research:

- Continued development of a program to increase knowledge of the effects of harvesting abalone above the MLS on the environment.

Monitoring:

- Implement a program, through the fishery code of practice, whereby abalone divers record details of interactions with threatened and protected species– to determine when there are any adverse impacts and to improve knowledge about the locations of known and new occurrences of individuals or groups. The extent to which interactions were reported would be verified, wherever feasible, by the scientific research program.

Predicted Outcome

In general, risks to threatened and protected species from abalone harvesting operations under the present management arrangements are low and there is no direct change to these risks predicted under the draft FMS. Given the low level of risk the measures contained in the draft FMS are appropriate provided that the information obtained is fed back into other management responses, such as amendments to the code of practice.

Other Species, Assemblages and Habitats*Initial Risk*

The risk assessed for other species, assemblages and habitat is the likelihood that these components of the aquatic environment will be degraded by the current activities of the fishery. The assessment determined that the activity of harvesting has the potential to affect other species, assemblages and habitats but the risk of adverse impacts was generally low. The risk was considered low due to the apparently low rate of interaction between the fishery and other species, assemblages and habitats. As abalone divers are highly selective in what they take and there is minimal anchor damage and other physical disturbance to other species or habitats, the only risk comes from the ecological consequences of removing abalone above the MLS.

Issues Arising

Despite the generally low risk from abalone harvesting activities it is apparent that knowledge about the ecological interactions between abalone and other species and habitats

could be improved with respect to the effects of the removal of abalone above the MLS. As there is little factual information available it is difficult to quantify the extent to which impacts would be reduced under the draft FMS, hence a precautionary approach was used. Monitoring of the effects of harvesting abalone above the MLS should be continued to ensure there are no adverse impacts and research should be undertaken where gaps in knowledge are identified.

Some measures proposed for rebuilding and reducing risk to the target species (i.e. reseedling, moving brood-stock and rehabilitating habitat through sea urchin harvesting) have some potential to affect other species, assemblages and habitats if not managed appropriately.

Response

The measures proposed in the draft FMS to mitigate risk to other species, assemblages and habitat are focussed on obtaining better information on the effects of removing abalone above the MLS and towards providing the means for 'best practice' diver behaviour in regard to minimising the potential for adverse impacts.

The major programs in the draft FMS to address the risk to other species, assemblages and habitats can be divided into the following:

Management:

- Continued implementation and development of a program to monitor the effects of harvesting abalone above the MLS on the environment and to increase knowledge where appropriate;
- Promote, through the code of practice, fishing practices that minimise the potential for adverse impacts upon the environment; and
- Restrict management responses aimed at enhancing populations of abalone (i.e. reseedling, moving brood-stock and habitat rehabilitation) so that they minimise risk to other species, assemblages and habitats. Programs would be experimental only and restricted to < 1% of reef in water depths of < 20 m and require approval with regard to the *FM Act* and the *Environment Planning & Assessment Act* (this would require an Environmental Impact Statement to be prepared with regard to stocking and an appropriate assessment for translocation and harvesting sea urchins).

Research:

- Continued development of a program to increase knowledge of the effects of harvesting abalone above the MLS on the environment.

Monitoring:

- Continued implementation of a program to monitor the effects of harvesting abalone above the MLS on the environment.

Predicted Outcome

In general, risks to other species, assemblages and habitat from abalone harvesting operations under the present management arrangements are considered low and proposals under the draft FMS would not change these risks. Given the low level of risk from harvesting, the measures contained in the draft FMS are appropriate provided that the information obtained from research and monitoring projects is fed back into other management responses, such as amendments to the code of practice or refinement of the experimental programs and used to reduce the potential for impacts.

Economic Issues*Initial Risk*

The risk being assessed can be broadly defined as the likelihood that the current activities of the Abalone Fishery will have an adverse impact on the economic viability of the Abalone Fishery. It is important to note that there is limited validated data available to accurately assess the economic condition of the Abalone Fishery and the observations drawn in the EIS assessment should be viewed cautiously. Further, the TACC (and revenue), has declined since the observations were made.

The NSW Abalone Fishery is one of the State's most valuable and regionally important fisheries. In 2002, the estimated annual total revenue of the NSW Abalone Fishery was about \$12.5m, being approximately 15% of the total annual fishery production in NSW. Capital investment in abalone fishing equipment amounted to \$4m, with a further \$1.3m invested in the abalone-processing sector. In 2003, about 87 persons were directly employed in the catching sector of the fishery (17 shareholder-divers, 33 nominated divers, 37 deckhands) and about 106 persons in the processing sector.

The market mechanism is central to the share management system, whereby changes in profitability of fishing effort are reflected in changes in share values. The major determinants of short-term profitability are the TACC and beach prices. These are dependent on a range of internal and external factors (stock health, management charges, trade policies, exchange rates and foreign demand). It is estimated that, in 2001-02, the performance of shareholders using nominated divers slightly exceeded that of shareholder-divers, with returns to full equity of 5.1% and 4.4%, respectively. In the same period, the nominated divers had a 7.9% return to full equity. The fishery's economic performance has declined since 2001 due to quota reductions and relatively low beach prices. In 2003-04, the performance of shareholders using nominated divers slightly exceeded that of shareholder-divers, with estimated returns to full equity of shareholders using nominated divers, shareholder-divers and nominated divers of -0.3%, 1.3% and -27.3%, respectively. The long-term viability of the operators in the fishery is therefore at risk.

Issues Arising

The fishery is significantly affected by variations in the abundance of harvestable abalone, as reflected in the TACC, and beach prices for abalone, particularly when low TACCs and prices coincide or prevail for prolonged episodes. The fishery currently is economically under performing and there are risks to economic viability for the fishery and individual businesses (depending on their structure). The recent increase in the number of divers from 37 to 42 and the potential for a further increase to 52 (and associated labour and capital costs) has the potential to erode the economic productivity of the fishery.

There is an apparent lack of Industry preparedness to plan for and adjust to variations in the abundance of harvestable abalone (as reflected in the TACC) or changes in the abalone beach prices, particularly if low TACCs or low beach prices prevail for extended periods. Potential barriers exist both within the industry and the current management arrangements that could limit the industry's ability to adjust their businesses appropriately. With respect to management arrangements, the current rules requiring a minimum trade of 10 shares and limiting the maximum shareholding to 6% are likely to impede flexibility.

Under current arrangements, the economic viability of the fishery is assessed by monitoring the value and transactions of shares. This has proven to inadequately reflect the economic performance of the fishery in some years.

Response

It is the NSW Government's intention to promote a viable commercial abalone fishing industry, consistent with ecological sustainability and to ensure cost-effective and efficient management and compliance. This intent was reflected in the initial establishment of a secure property right under the share management provisions of the *FM Act*, and more recently the decision to revise the methodology for setting the community contribution.

The draft FMS shows a clear intent to continue the key elements of the current management arrangements and to explore new initiatives to improve the viability of the fishery. The major programs in the draft FMS for addressing the risks to the economic viability of the fishery are:

Management:

- The draft FMS proposes a number of measures that aim to reduce the risk of decline to the TACC and for rebuilding stocks including management responses that aim to reduce illegal catch, manage the effects of *Perkinsus*, experimental work to progress the potential for reseedling and translocating abalone, rehabilitating habitat, as well as exploring alternative size limits;
- The draft FMS signals the intent to develop and implement a structured and orderly approach for structural adjustment in the fishery, through capping or potentially reducing the number of divers (and associated labour and capital costs). The effectiveness of this response will be dependent on the detailed arrangements of any such approach, which are yet to be determined;
- The draft FMS includes responses to support the viability of the fishery by providing greater flexibility for shareholders to adjust to the variable TACC and beach prices. These responses include reducing the minimum number of shares that can be traded from 10 to one share, and removing the 6 percent cap on maximum shareholdings;
- The response to examine ways to improve industry's preparedness for significant variations in the TACC or beach price may also lead to the development of more flexible tools, such as changes in the TACC setting process to dampen the impact of the variability of abalone stocks or the concept

of a sinking fund that could be drawn on during periods of low TACC/prices;
and

- The cost-effectiveness of fisheries management services and management service delivery mechanisms is to be critically evaluated under the draft FMS through a review mechanism and service agreements with departmental or private service providers.

Research:

- The continuation of the independent TACC setting process and stock assessment approach; and
- Research into the effects of *Perkinsus*.

Monitoring:

- It is proposed to monitor beach price, commercial catch, catch rate and management fees as key indicators of the economic viability of the fishery.

Predicted Outcome

There are some factors beyond the control of this management strategy, such as market forces affecting the beach price of abalone and the investment and operational decisions made by individual shareholders.

The development of a comprehensive structural adjustment approach to improve long term productivity is required for this fishery, although some of the details are yet to be determined (particularly with regard to the number of divers and associated labour and capital costs). The proposed actions to provide Industry greater flexibility to adjust to environmental and economic fluctuations by adjusting shareholdings should also assist adjustment. The other proposals foreshadowed in the draft FMS regarding the potential refinement of the TACC setting approach and the exploration of financial strategies to mitigate some of the variation in the abundance of harvestable abalone (as reflected in the TACC) and beach prices are considered warranted. Additionally, the proposed actions for experimental work on reseeded and translocating abalone are viewed as positive initiatives to rebuild abalone stocks.

The performance reporting and regime for monitoring the economic viability of the fishery described in the draft FMS are considered to be adequate in terms of the information

requirements and the suitability of performance indicators and trigger points. The new measures are likely to reflect the economic viability of the fishery more directly than the existing indicators related to shares. Hence there is a greater probability of identifying economic problems more rapidly, so that remedial action can be taken.

The commitment to develop and implement service agreements is viewed as a positive step towards better definition of the relationship between Industry and the service providers, as well as more transparent costing and reporting. Equally, the provision for reviews of the costs of services is appropriate.

Social Impacts

Initial Risk and Issues Arising

In the context of the social environment, the risks being assessed can be broadly defined as the likelihood that the current activities of the Abalone Fishery will have negative impact on social values in the community.

A social profile of shareholders, divers and deckhands in the Abalone Fishery revealed that most are male, live around key south coast towns and have substantial experience in the industry. Approximately 42% of respondents considered fishing as a lifestyle, rather than merely a business and, as such, about 25% of respondents would not consider re-training.

There were 117 persons directly employed in the catching side of the industry and 106 directly employed in the processing sector. There are approximately 111 jobs indirectly depending on the Abalone Fishery. The total number of jobs attributable to the fishery would be 376.

The main source of income for shareholders and divers is from the Abalone Fishery (79% of total household income) with the average net taxable annual income in 2001-2 being \$80,750. Half of abalone shareholders and divers have financial dependents.

Social issues arising from the current operations of the fishery are:

- Prohibitive costs to nominated divers becoming shareholders. The lack of opportunity for nominated divers to obtain shares in the fishery has potential to lead to some nominated divers to use unsustainable fishing practices;

- Continued illegal activities, which potentially decrease the value of the community's resource, economic viability and employment opportunity and cause conflict within the community; and
- The potential for reduced employment and limited alternative employment. This comes from the potential for rationalisation of the number of fishing businesses during times when economic conditions in the fishery are hard, such as the present, and from potential loss of fishing grounds through the creation of more marine protected areas or from closures.

Response

In addition to those measures already described for protecting revenue in the fishery by maintaining or increasing the biomass of the target species the draft FMS proposes a number of measures for directly addressing the above issues. The major programs in the draft FMS for addressing the risks to social values in the community can be divided into the following:

- Continued assessment, monitoring, and regulation and policing of the commercial Abalone Fishery, and illegal fishers, are key strategies for addressing the threat of illegal harvesting to the commercial fishery and the community's resource; and
- Changed arrangements for structural adjustment to the capacity of the fishery, including limiting the number of divers and removing the maximum limit of share aggregation and allowing smaller packages of shares to be traded (although the means to do this is yet to be determined).

Predicted Outcome

There may be some reduction in illegal activity as compliance issues are comparatively well addressed in the draft strategy, with new programs to be designed for making compliance operations more efficient and new regulations for processors. Reduced illegal activity would protect or increase the economic viability of the commercial fishery thereby protecting social values in the community.

Changes to arrangements for structural adjustment to the capacity of the fishery may displace some shareholders, divers and deckhands on occasion, as the fishery adjusts to economic conditions such as seen in the past couple of years. Greater flexibility for self

adjustment provides the basis for a viable commercial fishery, with more opportunities for investment, jobs and value adding and minimises the disruption from structural adjustment.

Indigenous Issues

Initial Risk and Issues Arising

There is very limited potential for commercial abalone diving activities to impact on Aboriginal archaeological sites along the coast. Similarly, commercial abalone diving on the NSW south coast has little or no impact on gazetted Aboriginal places.

Commercial abalone divers access the same abalone resources, which are mostly on nearshore reefs, as Indigenous people. Abalone has different meanings for different areas, and even between different family groups and may have been a trade item among Indigenous communities even before European settlement. For many groups, however, especially on the south coast, abalone is important.

Fundamentally, the Indigenous community concerns associated with the operation of the Abalone Fishery are about progressive loss of access to resources, with Indigenous communities considering that their right to maintain traditional fishing practices (i.e. fishing for traditional cultural and community purposes and responsibilities), conflicts with the current licensing system and allocation of non-commercial access to abalone resources. Two commercial abalone licences were held by Indigenous people some 20 years ago, but were sold by the holders. Currently, no Indigenous people hold shares or entitlements in the commercial Abalone Fishery. The concerns about progressive loss of access to resources have a history extending to the first issue of separate commercial abalone licences and reflect a combination of lost skills, lost income, poor communication, local community politics, and lost opportunity to participate in the fishery. In addition, there is no Aboriginal person currently attending ABMAC.

Response

Fundamentally, issues about Indigenous access rights to abalone and regulations as to how Aborigines collect abalone for community purposes require canvassing of potential changes to policy at a broader level than the commercial Abalone Fishery. The draft FMS can, however, address concerns about poor communication between Aboriginal people and the abalone industry and the potential for Aboriginal people to be employed in the industry.

The draft FMS proposes to address Indigenous issues as they relate to the Abalone Fishery as follows:

- Managing the fishery in a manner that is consistent with the Indigenous Fishing Strategy and Implementation Plan;
- Creating a code of practice for ensuring that abalone divers are aware of areas or items of cultural significance that may be affected by their activities and respond to new information as it becomes available;
- Explore ways to improve the communication between ABMAC and Indigenous people, in a culturally appropriate manner;
- In addition to the Indigenous position on ABMAC, possible ways of improving communication between the commercial sector and Indigenous communities include inviting other Indigenous people to discuss issues with the MAC and/or holding workshops on the south coast to resolve issues on an annual or as-needs basis; and
- Encouraging Indigenous fishers and communities to be involved in the commercial sector, for example, through employment opportunities.

Predicted Outcome

Many of the Indigenous issues to do with commercial fishing in general (i.e. access rights and regulations as to how Aboriginals collect seafood for community purposes) involve policy issues at a broader level than at the individual fishery management strategies or cannot be resolved with reference to the commercial sector in isolation. Hence, these issues will not be resolved by the draft FMS. In addition, the potential for changes to regulations about how Aboriginals collect abalone for community purposes also will need to be discussed at a broader level.

The initial risk of current operations of the fishery to Aboriginal sites and places was small and so there was limited need for changes under the draft strategy. Under the draft strategy, the use of the fishery code of practice will diminish this risk further.

The commitment in the draft strategy to improving communication between the abalone industry and Indigenous communities on the south coast of NSW and encouraging Indigenous participation in the commercial sector will go a long way to resolving many

issues. Fundamental to this, is involvement of Aboriginal people in ABMAC as it a direct line of communication between the commercial industry, Aboriginal people and DPI. ABMAC provides the forum where strategies can be developed to encourage the involvement and employment of Aboriginal people in the commercial abalone industry.

European Heritage Sites

There was very little 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. Notwithstanding this, the proposed fishery code of practice would instruct divers on how to operate when working near shipwrecks.

Justification for the Draft Fishery Management Strategy

The EIS highlights the importance of the commercial fishery for abalone in terms of employment and economic benefits to communities on the coast of NSW and for protection of the resource. The fishery directly employs 225 people, and has recently produced over 200 tonnes of abalone annually, valued at about \$7-8 million at first point of sale. The economic and employment flow-on effects to local and regional communities are significant, and across the fishery the multiplier values are approximately 1.5-2.0 (i.e. every person directly employed in the fishery is worth 1.5 to 2 jobs in the community).

The nature of abalone diving, the TACC, the conservative size limit and negligible bycatch indicate the commercial fishery has minimal potential for causing adverse effects to the target species and ecology of reef environments. Of some concern was the risk the commercial fishery could potentially cause to some local populations of abalone. This risk would be minimised if proposals are implemented for improving the way harvesting is managed at local scales. The draft FMS provides for a significant improvement to the economic viability of the fishery by providing flexible means for altering the number of divers and shareholdings where appropriate and for providing the means for more efficient and cost-effective services required to manage the fishery. Another issue for the commercial fishery is that of Indigenous consultation. Options for increasing consultation with regard to Indigenous issues are to be developed and implemented. Ongoing assessment of the impacts of significant management reforms is also proposed under the draft FMS.

The Abalone Fishery was assessed in terms of the Principles of Ecologically Sustainable Development (ESD). The fishery was found to be consistent with the major principles, particularly in terms of the Precautionary Principle. For example, the setting of a minimum legal size well above the reproductive age of abalone, the reliance of the TAC Committee on the Precautionary Principle in setting commercial quotas and the framework of rigorous scientific research and monitoring are highly consistent with ESD.

The draft FMS 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. A significant level of work will be required to undertake the tasks which the EIS recommends for the long term sustainable management of the Abalone Fishery. In order to ensure that the fishery operates in an ecologically 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 draft FMS are implemented to fulfil the stated goals and objectives.

Consulting the Community

You are invited to comment on the Environmental Impact Statement on the Abalone Share Management Fishery in NSW, which is on public exhibition until 14 October 2005. The full EIS can be viewed at offices of the NSW Department of Primary Industries, the head office and regional offices of the Department of Infrastructure, Planning and Natural Resources, NSW Government Information Service, local councils and the Sydney office of Environment Centre (NSW) during normal business hours. A CD copy can be purchased for \$5 by contacting The Ecology Lab on (02) 9907 4440. It is also available on the NSW Department of Primary Industries website at www.fisheries.nsw.gov.au

Would you like to comment?

Write to : Abalone Fishery Environmental Impact Statement
 Submission
 4 Green St
 Brookvale NSW 2100

Fax: (02) 9907 4446

Email: projects@theecologylab.com.au

Comments must be received by 24 October 2005

CHAPTER B REVIEW OF THE EXISTING ABALONE FISHERY

The existing Abalone Fishery is one of the most valuable fisheries in NSW, although it is small by comparison to most abalone fisheries in other southern states of Australia. The NSW Industry continues to actively participate in managing the Abalone Fishery, and supports management, research and compliance initiatives. The fishery has been governed by a comprehensive share management plan since 2000, which will respond to the Abalone Fishery Management Strategy currently being developed.

This chapter describes the way in which the Abalone Fishery currently operates, covering the geographical extent of the fishery, participants, rules and management objectives, research initiatives and compliance (Section B1). It then describes the biophysical context of the fishery, including any effects of the fishery on the environment (Section B2). Further sections describe socio-economic factors currently applicable to the fishery (Sections B3 and B4) and concludes with a summary of key risks to the fishery as it now operates (Section B5).

The review of the existing fishery is based on information collected from a number of sources, current as at February 2005, and generally excludes any subsequent changes to operations after this time. The recent reduction in TACC to 130 tonnes for the 2005/6 fishing period is acknowledged but a detailed analysis of its effects has not been included in the EIS. The primary sources of information about the history of the fishery, current operations and management arrangements and the effects of harvesting on the stock of abalone were The Abalone Share Management Plan (2000) and annual reports for the Abalone Share Management Fishery written by NSW Fisheries (2002, 2003, 2004) and The Total Allowable Catch Setting and Review Committee Reports (2002, 2004a, 2004b). The assessments of the effects of current operations on other aspects of the biophysical environment were obtained from available published scientific studies (e.g. Jenkins 2004) and similar assessments done for abalone fisheries in other states (e.g. DPIWE 2001, DNRE 2001). New information was collected to assess the socio-economic effects of current operations.

B1.0 OPERATION AND MANAGEMENT OF THE FISHERY

B1.1 Extent of the Fishery

Official records of commercial catches of abalone in NSW begin in 1958, but there is anecdotal evidence that abalone were harvested prior to that time. It is a fishery where the target species is taken by diving. Divers target the blacklip abalone, *Haliotis rubra*. The Abalone Fishery is one of two fully established category 1 share managed fisheries under the NSW Fisheries Management Act 1994 (the other being the Lobster Fishery). A share management plan (SMP 2000) commenced for the Abalone Fishery in 2000.

B1.1.1 Number of Shareholders and Divers

The basis of share managed fisheries is that all shareholders have a basic access right to the fishery (Section B1.3.2). As at February 2005, there were 48 shareholders. Some shareholders were, however, closely linked either through family connections or through companies with common directors. Shareholders may nominate another person (i.e. a diver) to take abalone on their behalf and can take abalone themselves only if they own 70 shares (termed the minimum shareholding). There are a total of 3654 shares in the fishery. As at February 2005, six of the 48 shareholders held less than 70 shares; i.e. 42 divers were endorsed to take abalone. Of these, 34 were nominated divers (Section B1.3.2.7) compared with 27 in 2000. Some abalone shareholders and divers held endorsements to other fisheries (mainly the Sea Urchin and Turban Shell Fishery) but most specialised in collecting abalone.

B1.1.2 Methods of Harvest

B1.1.2.1 Operations and Activities of Divers

An endorsement to take abalone is needed to harvest the species commercially. Endorsement holders dive mostly with compressed air supplied from a hookah unit, although in some cases divers may use SCUBA or free-dive. A typical commercial operation consists of one diver and one deckhand, but two divers may work together from the same boat. Boats are typically of a mono-hull design, 5-6 m in length and powered by 1 or 2 large outboard engines (90-200 hp). Some divers use a twin-hull design or slightly smaller or larger vessels.

Divers typically work parts of a reef, known as 'drops', where abalone are known to occur. On any day, a diver may work a number of drops over a large area of coast. At each drop, abalone are removed from the reef using a hand-held, chisel-shaped abalone iron. All divers are required to carry a calibrated device for measuring abalone; hence they generally remove only abalone above the minimum legal size (MLS). Abalone are placed into mesh bags which are buoyed to the surface using an inverted canvas or plastic bag ('parachute') when the bags are full. When a diver is submerged, boats are usually not anchored as the deckhand may be required to manoeuvre the boat to retrieve bags of abalone or to follow the diver as he searches the bottom (hence, there is little chance of anchor damage to the seabed). Abalone are re-measured by the deckhand on board the vessel, to confirm they are of legal size, and scraped of any attached growth. Those above the MLS (abalone equal to or greater than 115 mm in length) are stored live in plastic boxes. On some vessels these boxes are kept in seawater tanks to minimize any emersion damage or disturbance to the abalone. If the deckhand finds any abalone under the MLS they are given to the diver for return by hand to the reef at his next available opportunity. A maximum of 10 abalone under the MLS may be held on board commercial abalone boats at any one time while a diver is operating. This process is designed to minimize disturbance (and potentially associated damage and mortality) to non-retained abalone.

B1.1.2.2 Operations and Activities of Processors

Abalone divers are required to sell their product through a registered receiver (processor). The processing sector is an important part of the abalone industry. Five processors received abalone during 2003, with the three largest processors receiving 84% of the total catch of abalone (NSW Fisheries 2004). As the majority of the commercial abalone catch is exported, these receivers or processing companies must be registered by the Australian Quarantine Inspection Service (AQIS). In most cases, catches are transferred to processors immediately upon return to the boat ramp. In some cases, such as when divers are working on the north coast, catches are penned in sheltered waters until a processor is available to take the diver's catch. As processors, on occasion, may have to transport catches of abalone for large distances, trucks are usually fitted with the necessary equipment for keeping abalone alive for long periods of time. When catches of abalone reach a processor's factory they are transferred to tanks and stored live until processed or exported.

Since the early 1990s, the majority of the total commercial catch has been exported live to Asian markets with a proportion of the catch canned, frozen on shell, par-boiled on shell, chilled or sold as frozen meat, depending on demand at the time for a particular product.

B1.1.3 Area of Operation

B1.1.3.1 General

The commercial fishery for abalone has historically extended from the mid-north coast of NSW to the Victorian border, but harvesting may on occasion occur further north (e.g. Coffs Harbour). Unlike populations of abalone in southern states, most abalone in NSW live on fringing reefs close to shore. As a consequence, abalone divers in NSW tend to operate in these areas. There are, however, a few very productive offshore reefs in NSW (e.g. those close to the Victorian border) where divers may harvest abalone to depths between 20 – 40 m. Abalone are also collected from reefs around some coastal islands such as Montague and Broughton Is. Since the closure between Port Stephens and Wreck Bay was implemented in 2002 (Section B1.1.3.3), the commercial fishery in NSW occurs effectively between Wreck Bay and the Victorian border, with only a small amount of catch now coming from north of Port Stephens (see Section B1.5.1).

As long as they avoid closures to commercial harvesting of abalone (Section B1.1.3.3), divers can work along the entire coast of NSW and can relocate their operations within the area of the fishery without restriction. Nevertheless, the port of Eden is the major landing port for abalone by far, having the largest number of divers and processing facilities (Appendix CR1).

B1.1.3.2 Definition of Regions and Reporting Zones

The coastline of NSW has been divided into the following six regions for the purposes of stock assessment (Figure B1.1): The definitions of regions are as follows:

Region 1	Tweed Heads – Wreck Bay;
Region 2	Wreck Bay – Tuross Lake;
Region 3	Tuross Lake – Mimosa Rocks;
Region 4	Mimosa Rocks – Eden;
Region 5	Eden – Green Cape; and
Region 6	Green Cape – Cape Howe.

Although regions differ in size, they were originally chosen in 1994 to be equivalent in the amount of commercial catch of abalone over the previous 10 years (TAC Committee 2002), although this has since changed (Section B1.5.1). In addition, the coastline of NSW has been divided into 72 sub-zones (Appendix B2). This has been done to provide information on the harvest of abalone at small spatial scales, and for the purposes of compliance reporting.

B1.1.3.3 Area Closures

B1.1.3.3.1 Region 1

Geographically, Region 1 is the largest of the stock assessment regions, extending from the Queensland border to the middle of Wreck Bay, near Sussex Inlet (Figure B1.1). Historically, the southern sections of Region 1 have been regularly fished, whereas areas to the north of Port Stephens were visited less regularly. The sporadic effort north of Port Stephens meant that large catches could be made by divers when they visited. Because it required more travelling, the area north of Port Stephens was generally fished more frequently when catch rates were reduced in the south or due to seasonal preferences of some divers. Until recently, Region 1 provided a large (about 15%) proportion of the total catch of abalone (Section B1.5.1). Since the early 1990's, however, there have been dramatic and localised declines in abalone stocks between Port Stephens and Jervis Bay (beginning in Sydney and the Central Coast), which have been attributed to infections of the *Perkinsus* parasite (Sections B2.3.3.2 & B2.3.4). This has corresponded to a gradual decline in catch for the whole of Region 1. As *Perkinsus* spread further south to the more productive and regularly fished parts of Region 1 (such as Kiama) the catch in Region 1 no longer provided the same proportion of the total catch for the fishery as it had historically (Section B1.5.1). With less predictable catches and fewer abalone, divers were less inclined to fish in Region 1 and this contributed to a shift in effort in the fishery towards the more southern regions where catch rates were higher and more predictable. Most of this shift occurred before 2000. Potential risks associated with this shift in effort are discussed in Section B2.3.4

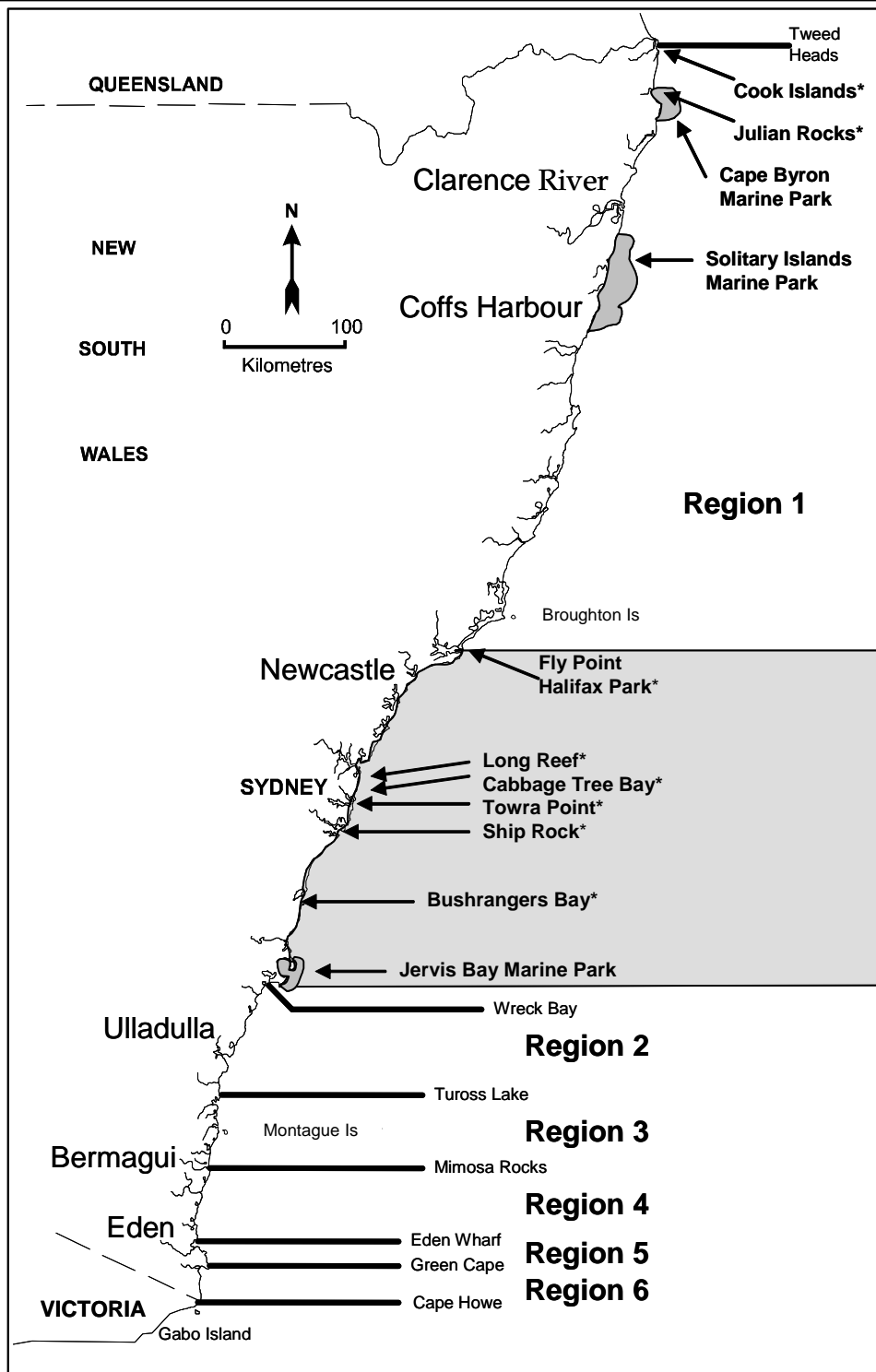


Figure B1.1. NSW coast, showing: abalone assessment regions 1-6; marine parks (dark grey) and aquatic reserves (*) where abalone harvesting is limited; and the current general closure to the taking of abalone (light grey) (see Sections B1.1.3.4 for complete list of closures).

Initially, some subzones in Region 1 on the NSW Central Coast, Sydney and Kiama were closed in response to the effects of *Perkinsus* to conserve the remaining healthy populations. In November 2002, following a dramatic decline in populations at Port Stephens these closures were superseded by a new closure (effective until November 2007) to both commercial and recreational harvesting of abalone, which includes all waters between Port Stephens and the middle of Wreck Bay near Sussex Inlet (i.e. sub-zones F to L inclusive) (Figure B1.1, Appendices B1 & B2). This closure was implemented in response to a recommendation made by the TAC Committee (2002) and the results of surveys of *Perkinsus* infection in abalone which indicated further declines in the populations of abalone around Port Stephens.

Removal of access to a large part of Region 1 raises a number of concerns and Industry contends that the closed area of Region 1 south of Port Stephens should be open to commercial harvesting (TAC Committee 2004b). The key points made by Industry in support of this opinion are that:

- illegal fishing may be occurring in the closure in the absence of commercial operators, which may be eroding any benefits of the closure to recovery of stocks from *Perkinsus*;
- exploratory harvesting in the previous fishing period indicated that some localised areas were apparently not affected by declines, and that other localised areas in the Region 1 closure may have recovered from *Perkinsus*.

The argument against revoking the closure is that the few remaining healthy populations of abalone are considered to provide the best chance of achieving successful reproduction, recruitment and recovery of the stock in the closure (TAC Committee 2004a, 2004b). There is evidence that dispersal of abalone larvae is localised (Section B2.3.1) and hence healthy localised populations may only increase recruitment over larger areas over a long period of time. Although the TAC Committee does not recommend an opening of the closure for commercial operations, it did support the taking of an additional 5 t of abalone in Region 1 north of Port Stephens if (experimental) harvesting was done according to a design agreed to by DPI and Industry (TAC Committee 2004a, 2004b). The 5 t was in addition to the state-wide quota (i.e. for all other regions) set by the TAC Committee. The TAC Committee recommended details of the experimental fishing would give consideration to:

- i. identifying and checking the status of abalone populations on reefs and sites that had historically large abundances and productivity;
- ii. establishing estimates of the current stock abundance and size composition; and
- iii. reconstructing a time series of abundance data based on the experience of divers and scientists and data from the proposed experimental fishing, thus allowing an initial stock assessment of the northern part of Region 1.

The TAC Committee also recommended that these suggested approaches to management of Region 1 should be linked to a study of *Perkinsus* being done by DPI and funded through the Fisheries Research and Development Corporation. Such an arrangement was intended to occur in the previous fishing period, where commercial divers harvested small amounts of abalone in Region 1 under a Section 37 Research Permit (Sections 1.3.2.13). The Committee, however, was concerned that the exploratory fishing occurred mostly in the southern parts of Region 1 and offered no information about the status of the stock north of Port Stephens (TAC Committee 2004a), which was not subject to a *Perkinsus*-related closure.

It is noteworthy that in South Australia, where *Perkinsus* also affects some populations of abalone, infected areas are not closed. In South Australia, abalone are harvested from infected areas under no limitations of quota. It is understood that the policy is designed to remove the potential source of infection from the water.

B1.1.3.3.2 Marine Protected Areas

Marine parks are the largest type of marine protected areas in NSW (Figure B1.1). Marine parks are declared under the *Marine Parks Act 1997* and managed to help conserve biological diversity and associated natural and cultural resources, while still allowing for the sustainable use and enjoyment of these areas by the community. Depending on the level of zoning, Marine Parks also aim to protect species otherwise harvested, including abalone. The community has input into the management of marine parks. The four marine parks already declared are:

Lord Howe Island;
Cape Byron;
Solitary Islands; and
Jervis Bay.

Aquatic reserves declared under the *Fisheries Management Act 1994* also play an important role in conserving biodiversity and protecting significant marine areas. The type of protection varies between reserves. Reserves where abalone harvesting is not permitted are:

Cook Island Aquatic Reserve;
Cabbage Tree Bay Aquatic Reserve;
North (Sydney) Harbour Aquatic Reserve;
Julian Rocks Aquatic Reserve;
Fly Point-Halifax Aquatic Reserve;
Long Reef Aquatic Reserve;
Towra Point Aquatic Reserve;
Shiprock Aquatic Reserve; and
Bushrangers Bay Aquatic Reserve.

The final type of marine protected area is the Bouddhi National Park Marine Extension. This is located just north of the Sydney Metropolitan Area. The marine extension covers about 300 ha of the marine environment adjacent to the terrestrial part of the park. A general fishing closure exists for this area.

Not all marine protected areas contain abalone habitat, and some are within the existing area closure for abalone in Region 1 (Figure B1.1). A range of marine protected areas has been established in NSW to ensure that all types of ecosystems and habitats are protected and more are planned. The potential of planned marine protected areas to affect the Abalone Fishery will depend on whether they contain abalone habitat. The issue was dealt with during the creation of the Jervis Bay Marine Park following consultation with the abalone fishing industry. Part of the proposed Sanctuary Zone in the Park was proposed to be located on productive abalone diving grounds. Forty-six shares in the Abalone Fishery were bought by the State Government to ensure that there was no lateral shift of catch and effort (equivalent to what occurred historically in the affected area) to other zones within the park or to areas outside the park. The shares purchased were then cancelled.

B1.1.3.4 Seasonal Closures

The Abalone Fishery has a history of implementing short-term voluntary closures to commercial abalone fishing. These have occurred for various reasons and have included:

- closures of some subzones identified as requiring additional management following declines in abalone or to minimize disturbance to spawning abalone (November to March); and
- closure to reduce the costs of processing and holding of abalone when the traditional Japanese market was reduced and providing a shut down period for processing plants for their maintenance (i.e. the Christmas holiday period and, more recently, in February).

There is no evidence that short-term closures have allowed stocks to recover although catch rates immediately after the closures were opened were relatively greater than immediately before. There are differing views within Industry regarding the use of these types of closures in the future. Following consultation with ABMAC and shareholders, however, the 6 week closure was not implemented for the summer of 2003/4 (NSW Fisheries 2004), and 2004/5.

B1.2 Interaction with Other Fisheries

Linkages between fisheries come into play during development, and reviews, of the fisheries management strategies for each fishery. Reviews may require the involvement of stakeholders in fisheries or sectors other than the Abalone Fishery. The *Fisheries Management Act 1994* establishes a system of advisory councils who advise the Minister for Primary Industries on issues that cross fishery management arrangements in NSW. Similar structures do not always exist where management issues cross jurisdictions (i.e. across state borders).

B1.2.1 Other NSW Commercial Fisheries

There is no direct overlap between the Abalone Fishery and other commercial fisheries in NSW as none of the other fisheries are permitted to land abalone, and divers with endorsements to take abalone are not permitted to land any other species. Therefore, the only way that abalone are taken commercially in NSW is via the Abalone Fishery, being assessed in this EIS. In addition, very few abalone divers are endorsed in other fisheries. Many of the abalone divers with other endorsements have an endorsement in the Sea Urchin and Turban Shell Fishery (SUTS). Sea urchins and turban snails were once taken as part of the Abalone Fishery, but the SUTS fishery is now a fishery in its own right (see Section B1.3.1). The harvesting operation in the SUTS fishery is very similar to that for abalone.

Target species in each fishery live in similar habitat and are collected by divers. SUTS

operators typically use smaller boats and often work alone. The total number of endorsements in the Abalone and SUTS fishery are similar, but there are only a few active divers in the SUTS fishery at any one time. The similarity between the methods of operation in the SUTS and abalone fisheries presents a potential avenue for illegal fishing.

The Abalone Fishery interacts with some other commercial fisheries on a small spatial scale as other fisheries can operate in abalone grounds or set untended fishing gear there. Lobster and fish traps, and setlines may be set in areas where abalone divers work, but these are easily avoided and not disturbed by the divers.

B1.2.2 Abalone Fisheries in Other States

There are large fisheries for blacklip abalone in other states. Slightly less than 5,000 tonnes of blacklip abalone are caught each year in Australia, of which about half is caught in Tasmania. The fishery for blacklip abalone in NSW is generally much less than those of other southern states, although only a small harvest of blacklip occurs in Western Australia. Elsewhere, abalone are managed as separate stocks, even though some populations are likely to be interconnected. For example, divers in the NSW Abalone Fishery harvest alongside divers in the Victorian Abalone Fishery but on different sides of the state border.

For the NSW Abalone Fishery, the biggest interaction with abalone fisheries in other states is through the market. All the abalone fisheries are competing essentially for much the same overseas market. The size limit for abalone in NSW (115 mm) is smaller than the size at which abalone are typically harvested at in other states; although small abalone are harvested in most states in some areas or through fish-down programs for stunted populations. The live trade prefers smaller abalone at some times.

Differences between the states in the size limits for blacklip abalone are a consequence of variation between the states in the rate at which abalone grow and the maximum size obtained and particularly the size at maturity (McShane 1999). In setting size limits based on growth there is a trade-off between weight gain from allowing the abalone to grow to a large size and the loss from natural causes. Minimum size limits are generally applied to balance harvesting with the capacity of the population to replenish itself. If a size limit is set too high then only a small proportion of a stock will be available for harvesting. If set too low, then immature abalone could be exposed to harvesting thereby increasing the risk of recruitment overfishing. Hence, there are many different size limits for abalone in different

fisheries in Australia, ranging from 100 mm in parts of Victoria (and provision to harvest at 90 mm in fish-downs) to 140 mm in parts of Tasmania. The size limit for abalone in NSW (115 mm) is on the smaller side because abalone attain maturity at smaller sizes than in other states (McShane 1999). They mature in NSW when about 90 - 100 mm and hence are thought to reproduce at least once before reaching the MLS (Section B2.3.1).

As NSW divers take abalone on a reef adjacent to the Victorian border, a potential cross-jurisdictional compliance problem exists. It is likely that there are many abalone of a size above the NSW MLS immediately across the Victorian border as this area is a marine park (i.e. Cape Howe Marine National Park). Cape Howe Marine National Park was only recently proclaimed and the reef was previously part of the abalone grounds of the Victorian Abalone Fishery. Anecdotal evidence suggests that NSW divers have taken abalone from across the Victorian border on occasion in the past. If this does occur, the inflated catch rates that would be associated with such activity would affect estimates of biomass in the stock assessments of abalone in NSW. In turn, this could lead to overestimates of sustainable TACCs. From the Victorian perspective, such activity would not affect their harvestable stock as there is a general ban on fishing in the Park. The risk of Victorian divers taking abalone from NSW reefs would be increased if the MLS for abalone in Region 6 were increased so that it was greater than or equal to 120 mm (i.e. this is the MLS at which abalone are harvested at in most areas in most parts of the Eastern Zone of the Victorian Abalone Fishery).

B1.2.3 Recreational Fishery

The main interaction with other fisheries, in terms of competition for the abalone resource in NSW, is with the recreational fishery. Recreational divers who take abalone must hold a recreational fishing licence and can take abalone only at or above a size of 115 mm (i.e. the same MLS as for commercial divers). Recreational divers who take abalone are restricted to a daily bag limit and possession limit. This was set originally at 25 in 1972 and reduced to 10 in 1987. These restrictions coincided with graduated increases in minimum size limits (from 100 mm to the current 115 mm). It needs to be recognised, however, that these changes have been in response to increasing concerns about the fragility and size of NSW abalone stocks and have been mirrored by significant reduction in abalone commercial catch quotas. In addition, following a recommendation from the MAC, regulations were amended in March 1999 to disallow recreational divers the use of compressed air to assist in taking

abalone. In effect, this restricts recreational abalone divers from taking abalone in deeper waters where they are difficult to access while free-diving.

Despite these restrictions, the recreational fishery for abalone is one of the largest external impacts to the commercial fishery as there is direct competition for the resource (Section B2.3.3.1). This is particularly so near urbanized areas or popular, coastal holiday destinations. In addition, there is no control of the total recreational catch of abalone at any scale. The first estimate of the recreation catch of abalone was made by Prince (1989) who estimated the catch to be about 18 – 25 tonnes, or about 5.5 – 8% of the commercial catch at the time. In 1997, a survey of underwater harvesting estimated the total recreational catch of abalone in NSW to be 52 ± 26 tonnes (Andrew *et al.* 1998). This was approximately $16 \pm 8\%$ of the commercial catch at the time. A more recent survey of recreational fishing in NSW in 2002 as part of the National Recreational and Indigenous Fishing Survey estimated the recreational catch of abalone to be 35,233 \pm 15,851 individuals, or about 12 ± 7 tonnes (Henry and Lyle 2003). This was about $4 \pm 2\%$ of the commercial catch at the time. It is possible that the discrepancy between the two estimates may have been due to changes to regulations about the use of compressed air by recreational abalone divers and the introduction of closures to recreational harvesting that occurred during the period between the surveys. It is more likely, however, that the discrepancy is due to problems with the recent estimate as the survey did not specifically target underwater harvesting and lacked an effective sample size. An estimated recreational catch of 50 t is used when annual assessments of the status of the stock of abalone are made (see Section B1.6.1) because of the more rigorous methodology of the 1997 survey.

B1.2.4 Indigenous Fishery

In most circumstances, Indigenous people must harvest abalone under the general regulations for recreational fishing (i.e. they must hold a recreational fishing licence, abide by the MLS of 115 mm and the bag and possession limits of 10 abalone per individual). Licence exemptions exist when individuals harvest within the borders of their own Land Council. In addition, special permits are issued to Indigenous people/communities, on occasion, to take more than the recreational bag limit of abalone for traditional cultural purposes. The Department's policy in this regard has been to encourage written requests outlining the applicant's requirements. Under this strategy, Indigenous people can apply to the Department for a Section 37 'special permit' allowing exemption from particular

regulations for special events. During 2003, two special permits were issued for access to abalone by Indigenous communities on the south coast for community cultural events.

In December 2002, the Indigenous Fisheries Strategy (IFS) (see Appendix CR2) and Implementation Plan were released, with the Government providing \$1.6 million over two years to implement the Strategy. It aimed to recognise the importance of traditional cultural fishing activities of Aboriginal communities and to encourage their involvement in the stewardship of fishery resources. The Strategy was based on achieving key results, including the sustainability of the resource, respect for Aboriginal fishing heritage, involvement of Aboriginal people in fisheries management, access to social and economic development and employment opportunities in the fishing industry. The implementation of the Indigenous Fisheries Strategy will promote Indigenous involvement in shellfish aquaculture, including training, extension service, business development and hatchery development.

B1.2.5 Illegal Fishing

B1.2.5.1 General

Illegal fishing of abalone stocks in NSW can take on a number of forms. These are: commercial divers exceeding their quota; recreational divers exceeding their bag limits; breaches of the MLS; catches in closed areas; and catches taken for sale by persons who do not hold quota allocations (TAC Committee 2004a). All of these are likely to contribute to the total illegal catch, although the relative contribution of each component is largely unknown.

The biggest problem is thought to be caused by persons without quota operating on a commercial scale (i.e. abalone thieves) (TAC Committee 2004a). Over-quota catching by divers with commercial endorsements is thought to have been much reduced (TAC Committee 2004a). Illegal fishing is expected to continue whilst the value of abalone remains high. The recently announced initiative to substantially increase the fines for illegal fishing in NSW will contribute to efforts to control the illegal catch.

Despite a much improved surveillance program (Section B1.7), illegal catches of abalone continue to pose special problems for the Abalone Fishery. Illegal catch poses an economic threat to the commercial sector and to the sustainability of the fishery. A significant proportion of illegal catch (by thieves) is thought to contain abalone less than the MLS (NSW

Fisheries 2004), and, as such, illegal fishing threatens the resource (see also Section B2.3.3.1). That is, the impact of illegal catch of undersize abalone is likely to be greater than the comparable weight of illegally caught abalone > MLS. This is because undersize animals are less likely to have had a spawning opportunity and their removal is often characterised by the clearing of all individuals from small areas, hence causing severe impacts on future reproductive potential. The threat is aggravated by the proximity of abalone stocks to the large coastal population of people in NSW. Valuable enforcement resources are also consumed in reducing these activities.

In 2003, there were approximately 46 abalone related prosecution briefs produced, but none of these were levelled at divers in the commercial fishery (NSW Fisheries 2004). This is important as it suggests that illegal activity by commercial operators (including over-quota activity) is extremely well concealed or relatively low. Over 95% of briefs prepared resulted in successful prosecutions. Fines ranged from \$200 to the maximum of \$10,000. Jail sentences, the issuing of bench warrants, strict bond conditions and community service orders have also been imposed. Penalties imposed have been substantial particularly when a commercial/marketing link can be demonstrated, large quantities of abalone have been seized or the person is a habitual offender. A total of \$18,700 in fines was imposed on abalone offenders in 2003. These included the issuing of 39 penalty infringement notices for minor abalone offences involving \$10,100 in fines.

In 2003, several large seizures of illegally harvested abalone were made at a number of locations on the south coast including Greencape, Bendalong and Batemans Bay. The total quantity of abalone seized for 2003 was approximately 4,187 individuals (NSW Fisheries 2004). This included live abalone, shucked meat and frozen abalone of varying sizes.

Estimating the total harvest of illegally caught abalone is difficult as illegal fishing activities are generally covert and the frequency of operations is largely unknown. The estimate is also contentious as there are a number of conflicting opinions and opinions have changed through time. An earlier estimate was that the illegal catch was as high as 340 tonnes (Prince 1989), which was similar to the commercial catch at the time. In more recent years, DPI Compliance has estimated the total, annual illegal catch to be in the order of 60 - 120 tonnes (NSW Fisheries 2004). DPI's most recent estimate, is that the illegal take of abalone in NSW is likely to be in the 40 to 60 tonne range, or between about 20 and 30 % of the 2004/05 TACC (DPI pers. comm.). This is based on the total amount seized and the size of

individual seizures. Seizures of illegal abalone have ranged from one to three tonnes in the last four years. Individual seizures above 20 or 30 kg are rare, even when the offender is known to be part of an organised group. Fisheries compliance staff believe that if the illegal harvest was greater than 100 tonnes then there would be more frequent seizures with larger quantities of abalone (DPI pers. comm.). It is important to note that the various estimates have been based on extrapolation and their accuracy is not known. It has been suggested that there is no evidence of any significant change (better or worse) of illegal fishing activity for any species in NSW (Palmer 2004).

In recent times, the size of the illegal catch used in the stock assessment modelling for abalone has been estimated at 40% of the TACC in 1997, or 145 tonnes (TAC Committee 2002, 2004). It should be noted that this represents the high end of recent estimates by DPI, which is better suited to the 'precautionary approach' used in stock assessment for the determination of TACC (Section B1.8.3). Further research may improve the estimated size of the illegal catch but proposals for FRDC funding to undertake research surveys of illegal catch rates using hidden cameras and time-lapse photography have been unsuccessful to date.

B1.2.5.2 Recommendations from the Black Market Review

In mid 2003, ex-Federal Police Commissioner, Mick Palmer was engaged to lead a review of the illegal harvesting of fish for commercial gain in NSW (Palmer 2004). The review examined the extent of the black market fishing issue with particular focus on high value species such as abalone and rock lobster. The review involved community and stakeholder meetings held throughout NSW during late 2003 and submissions were invited from interested persons and organisations. Palmer's general conclusions were that the illegal harvesting and black marketing of fish is a serious, widespread and entrenched problem in NSW, and the activities and practices threaten resource sustainability. He also concluded that neither the risk of being apprehended, nor the fear of significant penalty or sanction, are sufficient to deter illegal activity and whilst a multi-faceted approach to this situation is essential it is obvious that current Fisheries Officer numbers and overall compliance resource capacity is inadequate to deliver effective compliance.

In relation to illegal harvesting of abalone, Palmer concluded that:

- The accessibility of the NSW abalone bearing reefs to the general public as well as commercial divers, and the high prices that abalone can fetch in the export and domestic markets, pose particular enforcement problems whilst creating significant opportunities and incentives for illegal harvest and sale;
- The size of the illegal catch is large and there is little to suggest that illegal activity is being reduced;
- The majority of fish theft and black marketing is committed by a relatively small number of people;
- Offenders are frequently becoming more highly organised, sophisticated, counter surveillance conscious, well funded and equipped, and with a willingness to be aggressive, litigious, and potentially violent; and
- Parts of the post harvesting sector are likely to be heavily involved in illegal activity.

Palmer suggested that there are genuine opportunities, through sensible, properly targeted legislative reform, educational programs, culturally based equitable allocations and fisheries enforcement, to markedly reduce illegal activity and improve compliance levels. For example, he recommended a comprehensive, multi-faceted and sustainable, education and awareness strategy be developed and implemented jointly by government and Industry, targeting all stakeholders and with a particular focus on youth, Indigenous issues, community-wide awareness of the actual impact of illegal harvesting and black-marketing, and cultural change. Another general recommendation was that the establishment of Fisheries Officers be immediately reviewed and properly integrated steps taken to increase both fisheries officer numbers and compliance capacity to the level necessary to deliver acceptable compliance outcomes.

The major specific recommendations for the Abalone Fishery were to:

- Improve the current legislation and compliance practices to a level that is sufficient to deter illegal activity in the post harvest sector;

- Investigate the potential closure to recreational harvesting on remote reefs where recreational diving would not normally occur, apart for defined periods of the year when compliance activity could be appropriately focussed;
- The introduction of an abalone docketing system that requires a document to accompany the fish from initial receipt, through handling, to final point of sale or export, and which records the numbers of abalone as well as the weight that are transferred, sold or received, is an important requirement. The present NSW system, only requires total weights - rather than total weight and total abalone fish numbers - to be recorded on documentation, other than divers catch records, and this creates the potential for fish substitution (e.g. of whole abalone weight by dried or canned abalone, with ratios of 1:12 and 1:4 respectively) and massive quota avoidance;
- The recreational bag and possession limit for abalone is currently 10. A previous bag limit review recommended that this be reduced to 5. This change is supported as a priority both for resource conservation purposes and to reduce the ability for bag limit compliant illegal harvesting, where the same person enters the water on multiple occasions each day, taking the bag limit on each occasion. As well, consideration should be given to the introduction of a vehicle and boat possession limit of twice the bag limit;
- Reducing abalone bag limits potentially raises an issue with Aboriginal traditional cultural harvesting that needs to be addressed by the NSW Government and DPI on advice from the Indigenous Fisheries Strategy Working Group and considered as part of wider Indigenous reforms mentioned in this report. Indeed there is recognition of the need to consider increasing recreational abalone bag limits for Indigenous folk to properly allow for cultural occasions and cultural fishing rights. These issues should be fully considered in the development of any new policy or legislative arrangements (see also Appendix CR2); and
- Increase the scope of potential offences and penalties for recreational abalone diving.

The NSW Government is currently developing its response to the enquiry recommendations.

B1.3 Existing Management Arrangements

B1.3.1 History of the Abalone Fishery and its Management

Controls on commercial fishing in NSW date back as far as 1865 to 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 management tools such as licensing rules, gear controls and fishing closures, and was in force for some 60 years. 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 the state's fisheries.

Official records of commercial catches of abalone in NSW begin in 1958, but there is anecdotal evidence that abalone were harvested prior to that time. The commercial catch increased slowly until the mid-1960s where it reached levels of between 200 - 400 tonnes (Figure B1.2). After rapid expansion in the early 1970s, when reported annual catches briefly exceeded 1000 tonnes, further management measures were introduced as catches began to decline (TAC Committee 2004a, Figure B1.2). Somewhat later than other States, and following amendments to the *Fisheries & Oyster Farms Act 1935*, the Abalone Fishery became a restricted entry fishery in 1980; the first in NSW. While over 100 divers had participated in the fishery during 1979, only 59 were granted access to the restricted fishery in 1980.

An economic study conducted in 1979 recommended that a 'reasonable' annual income for a diver was about \$26,000 (SMP 2000). Although the number of divers was still considered too high after restriction in 1980 (SMP 2000), economic conditions within the fishery improved and catches remained steady at about 600 tonnes per annum (Figure B1.2). In the first four years of restricted access only two divers retired from the fishery.

In 1983, a joint Industry and Government Working Party examined transferability, quotas and other measures to further improve the economic efficiency of the fishery (SMP 2000). A strategy of transferring access rights under a 'two out - one in' basis to reduce the number of divers was introduced in January 1985. Two divers left the fishery in April of that year. Although diver numbers decreased, overall diving hours increased as new divers sought to service the capital investment required to buy a 'consolidated' permit under the '2 for 1' scheme (SMP 2000). The '2 for 1' buy-back scheme eventually reduced the number of divers to 37.

In addition to controlling effort, there have been a number of changes to the minimum legal size of abalone (Figure B1.2). There was no minimum legal size early in the history of the fishery. In 1973 the minimum size was set at 100 mm, as a precautionary approach to avoid the potential for overfishing. It was increased from 100 mm to 108 mm in 1980, and then further increased to 111 mm in 1986 and to 115 mm a year later. These increases to the MLS, phased in to ease the impact on catches, were proposed by Industry and were in response to the larger minimum legal size in Victoria (J. Smythe pers. com). Abalone fisheries in other southern States set minimum legal sizes earlier in the history of their fisheries than did New South Wales. In addition, minimum legal sizes vary between and within the states due to difference in the rate of growth and maximum size of abalone (Section B1.2.2).

The reduction in diver numbers from 59 in 1980 to 37 in 1992, combined with restricted entry, the imposition of quota, and an increase in minimum legal size from 100 mm to 115 mm saw catch rates increase slowly in most areas of the fishery. Initially, consultation between government and Industry about changes to the fishery was achieved through the United Abalone Divers Association, which remained a cohesive group until 1990. In late 1989, the first Abalone Management Advisory Committee (ABMAC) was established. Industry support and cooperation has been vital for the success of management, compliance and research within the fishery.

From 1985 to 1990, as a result of increasing overseas demand and a devaluation of the Australian dollar, the beach price of abalone increased dramatically, and, as such, substantial illegal fishing problems developed (SMP 2000). Considerable compliance effort has been focused on the illegal fishery in an attempt to minimise the illegal catch of abalone and to ensure strict compliance with the quota system.

A quota management system was introduced to the Abalone Fishery on 1 August 1989 to further stabilise catches (Figure B1.2). The initial allocation was 10 tonnes per diver per year, retrospective to 1 August 1988. Quota was reduced to 9 tonnes in 1992 to stabilise catch (SMP 2000). The TACC remained at 333 tonnes from 1992 to 1999, but was reduced to 305 tonnes in 2000. A statewide TACC of 450 t was enforced during the 18 month fishing period from January 2002 until June 2003. The statewide TACC for 2003-4 was set at 281 tonnes and then reduced by 27% to 206 tonnes in 2004-5 and recently by 37% to 130 tonnes for 2005-6. The TACC is reviewed and determined annually by 'The Total Allowable Catch Setting and

Review Committee' (TAC Committee) according to an assessment of the status of the stock (Sections B1.6.1 and B1.8.3).

The concept of share management fisheries was introduced with the *Fisheries Management Act 1994*. Under this type of management arrangement fishers are allocated a right in the fishery by way of shares. For this privileged access to a community resource, shareholders must pay a levy that is credited directly to consolidated revenue known as a 'community contribution' (Section 1.3.2.17). This is in addition to any management charges applicable to the fishery. Shareholders may be eligible for compensation if the fishery is closed. The Abalone Fishery was included in Schedule 1 of the Act on 15 February 1995, and an invitation for applicants to apply for shares was issued on 10 March 1995. In August 1995, a Ministerial review into the implementation of share management fisheries recommended that the Abalone and Rock Lobster fisheries should proceed directly to share management and the Sea Urchin and Turban Shell fishery should remain as a restricted fishery. On 9 February 1996, the Abalone Fishery entered the limited access phase of share management. Each endorsement holder in the restricted fishery was issued with 100 equal shares on a provisional basis. On 18 February 2000, the Abalone Fishery entered the fourth and final stage of share management with the gazettal of the Abalone Share Management Plan (see also Section 1.3.2.1).

As at February 2005 there were 48 shareholders, a number of whom are linked through common directors. The use of nominated divers since 1996 is increasing and there are <10 shareholders that dive commercially for abalone. As at February 2005 there were 42 divers operating in the fishery (with 70 shares or more), 34 of whom being nominated divers. This trend is expected to continue and will have a growing impact on how the fishery is managed. Nominated divers receive about a third of the value of their catch - about \$10-15/kg (Appendix CR1). In comparison, employee divers in the Tasmanian fishery receive \$4/kg and the Industry view is that this difference is related to the density of abalone available in the two fisheries (i.e. this affects the amount that can be caught by a nominated diver in a day).

In order to maximise economic returns and provide operational and administrative efficiencies for both DPI and Industry, in 2003 the 'fishing year' for abalone was changed from the calendar year to the financial year (i.e. 1 July to 30 June).

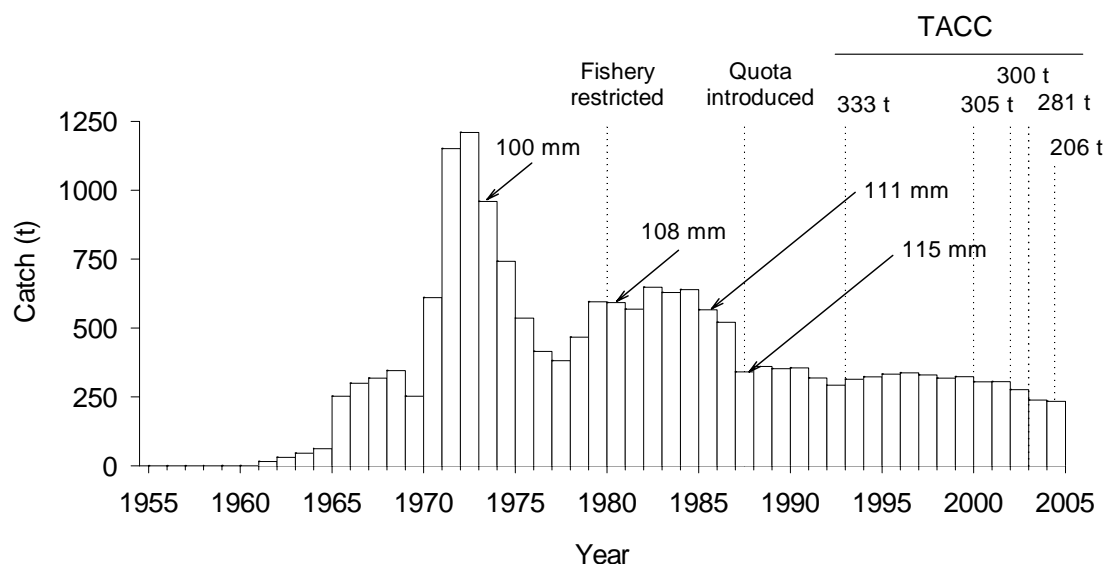


Figure B1.2. Total reported commercial catch and major management changes in the NSW Abalone Fishery. Changes to MLS are shown by arrows. (Source: NSW DPI).

B1.3.2 Management Controls and Administration

There are two broad types of management controls for commercial fisheries: input 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 often need to be modified in response to changes in fishing technology. Input controls can include restrictions on the number of licences, the size and engine capacity of boats, the size of fishing gear, and the areas and times that can be worked. Output controls, directly limit the amount of fish that can be taken from the water and are well suited for single species, high value fisheries using single gear types (Goulstone 1996).

The Abalone Fishery is currently managed by a combination of input and output controls including restricted entry, size limits and a Total Allowable Commercial Catch (TACC).

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 right along with different levels of cost and responsibility for Industry. Table B1.1 compares the three management frameworks.

Table B1.1. Comparison of the restricted fishery and share management fishery frameworks. The Abalone Fishery is a category 1 share management fishery. (Source: DPI 2004).

Management Component	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
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 within 15 year term
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	Yes, but much smaller than for category 1 fisheries

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

B1.3.2.1 Abalone Share Management Plan

A statutory management plan commenced for the Abalone Fishery on 18 February 2000. The plan was developed in accordance with sections 56 - 58 of the *FM Act* including an extensive consultation process with Industry and other stakeholders. At present, only the Abalone and Lobster Fisheries are fully established category 1 share managed fisheries. The management plan provides shareholders with a statutory basis for their fishery and provides objectives, performance indicators and trigger points which aim to ensure that the fishery remains sustainable. The share management plan is made available to all shareholders and nominated divers. It includes four parts as described in Table B1.2.

Table B1.2. Components of the current Abalone Share Management Plan.

Part	Title	Purpose
Part 1	Management Advisory Committees	Describes the role and composition of the MAC
Part 2	The NSW Abalone Fishery Profile	A brief description of the fishery and its key management components
Part 3	Strategic Plan for the Abalone Fishery	Outlines strategies in management, research and compliance to meet objectives of the fishery
Part 4	Fisheries Management (Abalone Share Management Plan) Regulation 2000	The legislated component of the share management plan

Within Part 3 of the share management plan for the Abalone Fishery are the Strategic Plans for management, research and compliance. These plans include the objectives for the fishery and the strategies (or actions) to achieve these objectives. Table B1.3 includes the existing objectives and strategies for management as identified in the share management plan. The strategic plan for research and compliance are included in Sections B1.6 and B1.7 respectively.

Table B1.3. Existing objectives and strategies for management (Source: SMP 2000).

Objective: Promote commercial fishing practices for abalone that do not impact on the broader ecosystem	
Strategies	Identify practices that may have an impact
	Direct and oversee ongoing education of divers through meetings and training programmes
	Assess, monitor and review ecological impacts through a team approach to management with research and the Office of Conservation
	Biodiversity strategies developed
Objective: Maintain or increase the biomass of mature and legal sized abalone	
Strategies	Support sound initiatives and recommendations from research
	Ensure up to date catch and effort information is entered on to the database
	Implement closures as required, in a timely manner
	Review current strategies

Objective: Ensure management arrangements for the fishery do not have a significant impact on the costs of taking abalone for sale, and promote cost efficient management, and ensure the fishery remains economically viable	
Strategies	Pursue best practice by providing high levels of Client service by being responsive, consulting, communicating and showing integrity
	Respond promptly to requests for information from shareholders
	Transparent budget setting process
	Effective Industry consultation
	Monitor share and quota trading
	Promote best practice by continually reviewing and refining performance where necessary
Objective: Ensure appropriate research and monitoring in relation to the fishery	
Strategies	Provide timely catch information to research and compliance
	Administer Quota System
	Consultation with Industry, the community, within the Department and other agencies
	Keep informed of how other agencies are managing their fishery
Objective: Ensure the number of endorsements in the fishery does not increase significantly	
Strategies	Monitor share trading
	Consult with Industry
	Monitor effort patterns within the fishery
Objective: Minimise the number of offences committed by commercial fishers and fish processors	
Strategies	Review and amend legislation where appropriate
	Promote legislation by keeping Industry informed of current rules and any changes
	Continue to educate through port meetings
	Act in timely fashion in relation to illegal activity
	Review current performance

B1.3.2.2 Share Allocation

The Abalone Fishery was added to Schedule 1 of the *FM Act* on 15 February 1995, and an invitation for applicants to apply for shares was issued on 10 March 1995. Following the recommendations of the Interim Management Advisory Committee (IMAC), and in accordance with section 50(4) of the *Fisheries Management Act 1994*, only persons who were endorsed in the restricted fishery were invited to apply for shares (SMP 2000). As a

consequence of amendments to Schedule 1, the application period for shares was extended to 31 January 1996. Each endorsement holder in the restricted fishery was issued with 100 equal shares on a provisional basis. New entrants (i.e. those who had entered the fishery since 18 February 2000, when the share management plan commenced) must have held a minimum of 70 shares before an endorsement was issued with respect to that shareholding. The current maximum shareholding permitted in the fishery is 210 shares. The total number of shares in the fishery at the commencement of the 2003/04 harvesting period was 3,654.

B1.3.2.3 Management Charges (IPART Principles)

The NSW Government policy on cost recovery for share management fisheries applies to the Abalone Fishery. To assist in determining how cost recovery is implemented the Independent Pricing and Regulatory Tribunal (IPART) was requested to investigate how management charges should be shared between the commercial sector and the community (IPART 1998). IPART recommended that DPI use the following pricing principles for implementing cost recovery for the management of commercial fisheries:

1. Users should only pay the efficient costs of management;
2. Costs allocated to commercial fisheries should be clearly identified in a transparent process;
3. Costs allocated to commercial fisheries should be paid for by those who create the need for, or who benefit from, management of commercial fisheries;
4. Subject to its responsibility to administer the *Fisheries Management Act 1994* and implement government policy, DPI should be accountable to those paying for management; and
5. To encourage services to be delivered more efficiently, the right to provide management services over a specified period should be subject to competition wherever practicable.

Principles 1, 4 and 5 refer to the efficiency and effectiveness of management. Efficiency savings are currently being made for the Abalone Fishery and there are ongoing negotiations regarding provision for services to be outsourced. At this time there are no accepted arrangements in the Abalone Fishery regarding the accountability of service providers to those paying for management (i.e. the services), although there is a service

delivery agreement under development for Compliance matters (i.e. within the fishery, recreational and Indigenous fisheries and theft of abalone).

Principle 3 refers to the appropriate apportioning of the costs of managing the fishery that should be met by each sector. This varies between fisheries, and depends upon, among other things, on who stands to benefit from management arrangements. Under the policy, a proportion of the cost of management, research, administration and enforcement will be paid by the participants in the fishery, or be subsidised by the community through the Government. Some of DPI's administrative, research and compliance activities are focused on the Abalone Fishery and these are regarded as direct costs attributable to managing the fishery. Other costs associated with managing the Abalone Fishery, as determined by IPART, are a proportion of the shared costs and overheads required for managing commercial fisheries in general. IPART recommended that 4% of management charges for the fishery were to be paid by government due to an assumed recreational catch of abalone of 20 tonnes, which compared to a commercial catch of 335 tonnes at the time. In May 2005, DPI increased the proportion of charges paid by government to 14% in line with the more recent survey (1997) which estimated the recreational catch of abalone to be 52 tonnes (Section B1.2.3), compared to a commercial catch of 330 tonnes at the time.

Principle 4 refers to IPART's belief that the best way to share DPI's costs of management is to follow a transparent process to negotiate cost sharing with those (shareholders) being asked to pay. This process should:

- Explain each fisheries management activity and why it is required;
- Identify the cost sharing rule being used for each activity; and
- Demonstrate that the benefits of the activity are greater than its management costs.

IPART recommended that ideally this cost sharing process would be undertaken in the preparation of management plans for each fishery and the result would be included as part of the management plan. The Department of Primary Industries (DPI) and Industry are currently negotiating potential changes to cost sharing arrangements for the fishery that could be incorporated into the draft FMS.

The management charge for the Abalone Fishery is payable in proportion to a shareholding and is set to meet the costs of management. The IPART recommendations and broad pricing principles adopted by the Department apply to the budgetary requirements for the Abalone

Fishery and a fee per share is calculated annually (Table B1.4). In 2003, management charges equated to ~11 percent of the total value of the landed catch (Section B3). The management charge is not to exceed \$325 per share under the existing share management plan.

Table B1.4. Management fees per share in the Abalone Fishery from 2000 - 2003. (Source: NSW Fisheries 2004).

Year	Management fee per share
2000	\$242
2001	\$250
2002	\$231
2003	\$242

B1.3.2.4 Fees for Licence Administration

In addition to the Abalone Fishery management charge, a number of commercial fishing fees are payable by abalone divers relating to licence administration. A range of regulatory and administrative fees are payable by business owners in the Abalone Fishery. The management strategy does not, in itself, set the charges, or limit or otherwise govern the way fees are charged.

B1.3.2.5 Quota Management

A quota management system was introduced into the Abalone Fishery on 1 August 1989. Quota was originally equally allocated to divers. Since becoming a share managed fishery, individual quotas are allocated (by weight) in proportion to shareholding on an annual basis. The total allowable commercial catch (TACC) is set by the statutory and independent Total Allowable Catch Setting and Review Committee (Section B1.8.3). The TACC setting process takes into account an assumed level of recreational catch and unreported (illegal) commercial catch and all relevant scientific, Industry, community, social and economic factors.

The TACC is to be allocated among all shareholders, including those who do not hold the minimum shareholding required to fish in the fishery¹. Each shareholder and any nominated fisher of the shareholder are notified of the shareholder's quota allocation and any period(s) in which that quota may be taken.

B1.3.2.6 Commercial Fishing Licence

A personal 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 any waters. Whilst the right to take abalone for sale is through share ownership, an abalone fisher must hold a commercial fishing licence endorsed in the Abalone Fishery. A person applying for such a licence must have a 5-year conviction-free record for any abalone or serious fishery related offence. They must also apply in relation to a shareholding in the fishery of not less than 70 shares. New entrants to the fishery must hold, or be nominated to hold, at least 70 shares to obtain an endorsement in the Abalone Fishery.

B1.3.2.7 Nominated Divers

Since 1996, shareholders who hold a minimum of 70 shares have been allowed to nominate another person to take abalone on their behalf. Only one fisher can be nominated with respect to a shareholding at any one time. Similarly, nominated divers may only work for one shareholder at any one time. The minimum nomination period is 4 weeks, unless otherwise approved.

Nominated divers are endorsement holders in the fishery and are therefore subject to a conviction record check upon application. They are required to comply with the rules for the fishery, including the completion of log sheets. A nominated fisher is required to notify the relevant shareholder if he/she is charged with an offence under the *FM Act* or the share management plan.

The trend in the fishery is for the proportion of nominated divers to increase as more original shareholder divers retire. Over the last five years the number of nominated divers has increase from 27 in 2000, to 34 as at February 2005. There are potential problems with this. Although some nominated divers are the relatives of shareholders and, as such, would

¹ Shareholders who cannot actively take their share of the quota due to the minimum share holding requirement may still transfer their quota to other abalone shareholders.

have an interest in the sustainability of the fishery, most nominated divers have less incentive than shareholder divers to dive according to sustainable practices as they have no stake in the future of the industry. This could potentially increase the risk of illegal activity in the commercial sector at times when profitability to divers is reduced, such as when catch rates and the TACC are reduced, as is the current trend in the fishery (Section B1.5.1). There is also potential for an increased proportion of nominated divers to have other adverse effects on the stock. These are discussed in Section B2.3.4.

It is noteworthy that in Tasmania, shareholding and the right to dive for abalone have been decoupled, establishing two distinct access rights in the fishery. The system was developed in response to increasing numbers of divers leasing their licences from former divers, processors or other financiers (DPIWE 2004). Under the Tasmanian system both the shareholders and divers have direct investment in the fishery.

B1.3.2.8 Crew

To assist an endorsement holder in the Abalone Fishery one must either hold a commercial fishers licence or hold a current crew registration. All crew must be recorded on the daily log sheet. An application for crew registration must be recommended by a diver endorsed in the Abalone Fishery, hold first aid qualifications and can be refused if the applicant has been convicted of a State or Commonwealth fisheries offence in the 5 years prior to submitting the application. An endorsement holder may have unauthorised crew members present while working in the Abalone Fishery on up to two times in any calendar month.

B1.3.2.9 Commercial Boat Licence

Only commercially licensed fishing boats may be used to take abalone for sale. Divers are not restricted as to the size or the number of vessels that they may operate, but must in addition to their LFB number display the letter "A" followed by the letter of their home port on their vessel. Some divers own more than one vessel. A variety of vessels, generally powered by outboard motors are used (Section B1.1.2). Commercial abalone divers are permitted to use their licensed fishing boat for recreational purposes provided they notify the local Fisheries Office and remove commercial fishing gear from the vessel.

B1.3.2.10 Renewal of Licences

Commercial fishing licences and fishing boat licences must be renewed annually. Divers 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, the renewal application is taken to be an application for a new licence. Additional fees apply to late renewal applications (see below).

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.

B1.3.2.11 Appeal Mechanisms

Divers 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 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 has been 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/>

B1.3.2.12 Time and Area Closures

See Sections B1.1.3.3 and B1.1.3.4.

B1.3.2.13 Permits

Section 37 of the *Fisheries Management Act 1994* allows for permits to be issued for research and other authorised purposes. These permits provide a legal framework for activities that fall outside normal operating rules set out in the *FM Act* or the share management plan. 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 are currently issued are outlined in Table B1.5. To assist in investigating the present status of abalone stocks in Region 1, six abalone divers were issued a Section 37 permit to take abalone in closed areas of that Region in 2003-4.

Permits issued under Section 37 are valid only in so far 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. Permits are not transferable.

Table B1.5. Permits that may be issued in the Abalone Fishery. (Source: DPI 2004).

Permit Type	Description
Research	Permits are issued to research scientists (including 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 in excess of the possession or bag limits or use of gear not prescribed in the Regulation.
Development of new fishing gear	This permit provides 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 in the regulations. Permits may be issued to facilitate Industry in developing alternate fishing practices in line with goals of the Act and existing policy.

B1.3.2.14 Reporting Requirements

Endorsed divers must comply with a daily catch reporting procedure. A daily docket recording catch and effort information such as the zones fished, dive time, catches taken from each zone, as well as information on the crew, boat used and the consignee must be recorded. Divers are required to validate their catch before moving more than 50 metres

from the boat ramp or associated car park. The daily docket, or a copy, must be forwarded to DPI within 24 hours of the catch being validated. Divers are also required to furnish a monthly reconciliation sheet no more than seven days into the new month. The reconciliation sheet provides a cross reference for the daily docket and allows divers to maintain accurate records of their catch.

B1.3.2.15 Share Transactions

Share transactions in the Abalone Fishery include share transfer, assignment, transmission and mortgage. A share transfer is the standard way for a shareholder to pass a quantity of their shares on to another party. A share assignment is a transfer of shares which may be of a temporary nature. A share transmission is a transfer of shares in accordance with a will. A share mortgage occurs if shares become security for a loan.

Abalone shares may be transferred in share packages, each comprising 10 shares, unless otherwise approved. A shareholder may transfer all of the shares he or she holds in the fishery. Any applicable unused allocated quota is also transferred with the shares. The minimum number of shares required by a new entrant to gain an endorsement in the fishery is currently 70 shares.

A shareholder may assign, transmit or mortgage their abalone shares, however, all shares held must be assigned, transmitted or mortgaged to only one person (or one partnership or company). Share transactions may be refused for a number of reasons, such as:

- the transaction is to avoid share forfeiture;
- any fee or contribution under the *FM Act* is outstanding in respect of the shares;
- any assignment or mortgage of the shares has not been discharged or cancelled; or
- the person to whom the shares will be transferred would be refused an endorsement in the fishery because of having been convicted of an abalone offence or a serious offence² in the previous 5 years.

² Serious offence means: an offence against the *FM Act* or regulations that is punishable by imprisonment, an offence against clause 108 of the *Fisheries Management (General) Regulation 2002*, or an offence punishable under the *Crimes Act 1900*.

All abalone share transactions must be registered in the Share Register to take effect. For the 2003-4 fishing period, the fee for registration of share transfer, assignment and transmission transactions was \$221. The fee for share mortgage transactions is \$388.

Since 1996, the volume of share trading has been fairly volatile (Table B1.6). Prices, after an initial surge in 1997, plateaued over the next four years and surged again in 2001 and 2002. The 2002 surge, along with the fall in the number of shares traded, was suggestive of optimism about the future of the industry. If so, the fall in price and the rise in the number of shares traded in 2003 would imply a subsequent decline in confidence. It could, however, also reflect the introduction of the community contribution (Section B1.3.2.17), which would have had a depressing effect on the share price. Even so, share prices in 2003 were still the second highest on record and by no means could be taken as being indicative of an industry with a poor outlook. Further discussions of the implications of changes to the price of shares are made in the sections evaluating the economic viability of the fishery (i.e. Sections B3.5.2 and Appendix CR1).

Table B1.6. Share transfers and average price per share. (Source: NSW Fisheries 2004).

Year	Number of shares transferred	Estimated average price per share	Minimum shareholding required for endorsement
1996	700	\$ 9,400	100
1997	100	\$14,100	100
1998	200	\$14,650	100
1999	500	\$14,440	100
2000*	270	\$15,103	70
2001	370	\$18,737	70
2002	190	\$26,972	70
2003	426 [#]	\$22,400	70

* Share management plan commenced. [#] Includes purchase and surrender of 46 shares for Jervis Bay Marine Park buy-out

B1.3.2.16 Quota Transferral and Leasing

Quota is transferable, but subject to the approval of DPI. Quota maybe transferred in lots of 100 kg, or as otherwise approved, but only for the harvesting period for which the fishery relates. A shareholder may not acquire by any such transfer more than twice the amount of the shareholder's initial quota for the fishing period. Nor is there any carry over or

borrowing of quota from another fishing period. For the 2003-4 fishing period, the fee for quota transferrals was \$166.

The recent pattern of quota leasing is shown in Table B1.7. Leasing declined from a peak in 2000, despite the incentive towards greater leasing induced by regional catch limits for Region 1 and Region 2-6, but increased again in 2003. The increase in 2003 may be reflecting present lower catch rates (Section B1.5.1) and that some divers are finding it difficult to achieve their quota. However, quota is transferred for a variety of reasons independent of abundance (e.g. the SARS outbreak of 2003 may have influenced the supply of leased quota due to reduced demand for abalone).

Table B1.7. The number of shareholders leasing out quota, 1998-2003. (Source: NSW Fisheries 2004).

Year	No. Shareholders
1998	7
1999	13
2000	23
2001	19
2002	15
2003	21

DPI does not record the arrangements between quota holders and lessees and so information on lease arrangements, including financial arrangements, is not available.

B1.3.2.17 Community Contribution

Shareholders in a category 1 share managed fishery are required to make a periodic contribution to the community for their right to access the resource which takes the form of a community contribution payment, via consolidated revenue. The *Fisheries Management Act* does not specify the form of the 'community contribution', but makes an in-principle requirement to make a return to the community in respect of privileged access.

In fisheries where the access is limited through controls on the number of licences, the participants are receiving a privileged access that is denied to the rest of the community. In such cases, the community should receive compensation for the denial of their right to extract abalone for commercial sale. The community contribution is a payment to the

community in respect of access, as opposed to other licensing fee payment which cover administrative expenses.

A fishery is considered to be economically profitable if the money generated by the participants (in this case, shareholders) is greater than all economic cost, including the operating costs. Determining the operating costs of a fishery involves an economic survey of a range of operators on an industry wide basis, not just for an individual. If there is an economic surplus being generated then the Government may choose to collect a proportion of this surplus (often called resource rent) for the community.

In the Abalone Fishery, access to both the quota (through abalone shares) and harvesting (diving licences) sectors is limited and overall the fishery can generate an economic surplus to shareholders if catch and prices are sound. The profitability to shareholders varies between individuals. The profitability of the industry, as a whole, can vary significantly depending upon the abalone beach price and TACC. In recent years, this beach price has fluctuated dramatically over relatively short periods (see Section B1.5.2) and the TACC has been reduced (see Section B1.3.1). Until recently, the contribution was set at 6% of the gross value of the fishery for the fishing period, with a four-year phase-in period beginning in 2001 after which payments were gradually increased from 2%. Given the average beach price of \$46.1/kg the community contribution for the 2001 fishing period was \$76 per share. In April 2004, shareholders in the Abalone Fishery sought relief from this charge, on the grounds that poor economic conditions resulting from low beach prices, a reduced TAC and increased (e.g. fuel) costs had reduced their ability to pay. In July 2004, the Government agreed to a moratorium on the charge, initially for three months, and then extended for a further five months until mid-February 2005, providing the average beach price remained below \$42. In August 2004, the Government established a Working Group to consider future arrangements for the community contribution based on a cost-benefit approach to potential options.

Based on the recommendations of the Working Group, the community contribution (to come on line with the 2005/6 fishing period) will be calculated as percentage of gross revenue per share that varies on a sliding scale in accordance with a CPI adjusted average annual beach price (AABP). For example:

- if the AABP is below \$43/kg the percentage rate will be 0% (i.e. no charge will be payable);

- for an AABP between \$43 and \$52/kg the rate will increase by 0.5% per dollar to 5% of the revenue at \$52;
- for beach prices from \$52 to \$62 the rate will increase by 1% per dollar to 15% of revenue at \$62; and
- above \$62/kg the rate will remain at 15%.

To take into account the impact of any significant changes in the Total Allowable Catch (TAC) on industry profitability, threshold points relating to the sliding scale will be adjusted as follows:

- if the TAC decreases by less than 10%, the thresholds remain unchanged;
- If the TAC decreases by 10% or more, all thresholds for calculating the charge in the year affected increase by \$1 for each 10% decrease in TAC. Note that a TAC decrease will be rounded to the nearest 10% to calculate the increase in the threshold;
- If TAC reductions in any one year increase the thresholds by \$2 or more, the thresholds for each subsequent year will increase by half the amount of the immediately preceding year's adjustment for that TAC change, rounded to the nearest whole dollar;
- If the TAC increases, the threshold levels will be reduced by the same amount as thresholds are increased when the TAC decreases, with some exceptions as follows;
- If a TAC adjustment wholly or partly reverses an adjustment which applied in the previous year, the thresholds for the latest year will be set at the level that would have applied if the net TAC change had all occurred in that year; and
- If more than one adjustment in the same direction applies in any one year, the final adjustment for that year will be the total of all the adjustments that apply.

The proposed new arrangements have the advantages of a lower but more sustainable revenue flow to the Government, and offer significant benefits to industry, including:

- moratorium extended to 30 June 2005;
- no charge payable when beach price below long-term average of \$43;
- long-term average dollar amount of charge reduced by approximately 60%;

- charge will respond to variations in profit resulting from beach price changes;
- charge will respond to variations in profit resulting from TAC changes; and
- thresholds will be CPI adjusted annually and charge reviewed every 5 years.

B1.3.2.18 Seafood Safety Programs

The NSW Food Authority assists in implementing food safety programs for all commercial fisheries as required under the *Food Production (Safety) Act 1998*. Abalone diving businesses must hold a licence with The NSW Food Authority but as long as abalone divers pass only live abalone to the receiver (processor), however, they do not have to register a Food Safety Program. Abalone processors, on the other hand, must register a Food Safety Program (see also Section B4.5).

B1.4 Existing Performance Indicators and Trigger Points for Monitoring the Fishery

The share management plan includes a performance monitoring regime for the Abalone Fishery. Table B1.8 includes the objectives, performance indicators and trigger points as presented in the plan.

B1.4.1 Performance Indicators and Trigger Points

The performance indicators for the share management plan were developed to determine if the management objectives are being attained. The trigger points specify a point when a performance indicator has reached a level that suggests there may be a problem with the fishery and a review is required. Some performance indicators vary naturally from time to time. Table B1.8 identifies the performance indicators and trigger points that are used to measure whether each of the management objectives described in the share management plan are being attained.

A number of monitoring programs are being used to gather information to measure performance indicators for the fishery. For example, the stock assessment program (Section B1.6.1) is the basis for providing information about biomass. Performance indicators and trigger points for biomass and commercial catch rate are related to values for 1994, as this was the first year of the current stock assessment program for the fishery. Other monitoring programs include measuring rates of compliance, as indicated by the number of inspections

that show illegal activity. Monitoring rates of compliance are used as an indication of whether the number of offences is being minimised.

The effectiveness of performance indicators in the share management plan in monitoring the performance of the fishery depends on how well they monitor the achievement of objectives. For example, the failure of the economic indicators to trigger in recent years when information has pointed to a reduced economic viability in the fishery (Section B3) suggests a review of economic indicators may be required. Current indicators of economic viability are based mostly on the value and market of shares in the fishery and the independence of these to the economic situation in the fishery is discussed in Section B3.

In addition, indicators for biomass are ambiguous as it is unclear as to whether the objective is to maintain stocks at current levels or increase them. There is also no indication of the preferred time period for recovery of the target stock should recovery be required.

B1.4.2 Review

Under this existing regime a review of the share management plan is required if the Minister for Primary Industries is satisfied that a trigger for review is breached.

An annual report is completed at the end of each fishing period, which examines the performance of the fishery against the objectives of the plan. Specifically, it addresses each of the performance indicators and triggers identified in Table B1.8.

Table B1.8. Current performance monitoring for the Abalone Fishery (Source: SMP 2000).

Objective	Performance Indicator	Monitoring and Trigger for Review
Promote commercial fishing practices for abalone that do not impact on the broader ecosystem	Commercial fishing practices for abalone do not have an adverse environmental impact on the broader ecosystem	Research conducted by or on behalf of DPI indicates that commercial fishing for abalone is having an adverse environmental impact on the broader ecosystem
Maintain or increase the biomass of mature and legal sized abalone	Biomass of mature and legal sized abalone increase or do not change in any area to which a total allowable catch applies (using a model based assessment, with survey of abalone stock conducted by DPI in 1994 to be used as a benchmark)	(a) The biomass of mature or legal sized abalone in an area in which a total allowable catch applies falls below the 1994 benchmark by more than 15% (b) There is > 50% chance of (a) occurring in the next 5 years if the total allowable catch is unchanged
Ensure management arrangements for the fishery do not have a significant impact on the costs of taking abalone for sale	Management charge for the fishery (under Section 76 of the Act) does not increase significantly, disregarding any increase that is attributable to the provision of additional resources by DPI (e.g. the provision of additional compliance officers)	Management charge for the fishery increases in any year at a rate exceeding the rate of inflation (as measured by the consumer price index), disregarding increases that are attributable to the provision of additional resources by DPI after commencement of this Plan
Promote cost efficient management	Independent review of the management arrangements for the fishery, conducted periodically at the request of the Minister, determines that management arrangements are appropriate	Independent review determines that the management arrangements for the fishery are inappropriate
Ensure the fishery remains economically viable	Standardised commercial catch rates relative to 1994 There is a buying market for quota There is a buying market for shares in the fishery Value of shares in the fishery is maintained or increased	Standardised catch rates fall by more than 15 % of 1994 benchmark 20 % (or more) of quota available for trading cannot be traded 15 % (or more) of shares available for trading cannot be sold Value of share packages for a fishing period decreases by more than 10 % (using 1999 value as a benchmark)
Ensure appropriate research and monitoring in the fishery	Necessary data are available for assessment of abalone stocks	Insufficient data are available for the purpose of setting the total allowable catch for abalone
Ensure the number of endorsements in the fishery does not increase significantly	There is no significant increase in the number of persons eligible for an endorsement after the commencement of this Plan	Number of persons eligible for an endorsement exceeds 42
Minimise the number of offences committed by commercial divers and fish processors	Number of offences relating to abalone committed by divers annually, as indicated by quality inspections conducted by DPI, indicates substantial compliance with the Act, this Plan and the other regulations under the Act	Overall rate of compliance with the Act, this Plan and other regulations under the Act (estimated annually by the Director) is less than 70%

B1.5 Catch, Effort and Value Information

B1.5.1 Catch, Effort and Catch Rate

After quota management was introduced to the Abalone Fishery in August 1989 the TACC remained steady at 333 t, until 1999, but since then has been reduced almost every year (Section B1.3.1) so that it was set at 206 t for the 12 month fishing period from June 2004 and recently at 130 t the current fishing period. The six regions of the NSW fishery were originally established to provide about equal catch and resource to the fishery, but they no longer provide this, mainly due to the decline in Region 1. Prior to 1995 the catch of abalone in Region 1 was equivalent to most of the other 5 regions but since 1995 it has declined to < 5 t in 2003 (Table B1.9). Although most of the decline can be attributed to *Perkinsus*, some can be attributed to divers preferring to work in Regions 5 and 6 during the period between 1998 and 2002 when catch rates there were very good (see also Section B1.1.3.3.1). A total closure of the commercial, recreational and Indigenous fisheries for abalone has been enforced for five years from 2002 between Port Stephens and Jervis Bay in an attempt to facilitate recovery of stocks that have declined following mortality related to infection by *Perkinsus* (Section B1.1.3.3.1). The TAC Committee is now concerned about the population in Region 2 as the stock assessment indicated declining abundance of abalone there and that it appeared not to receive the elevated recruitment seen further south (TAC Committee 2004a). In its recent determination for 2004-5, the TAC Committee recommended catch for this region be reduced. The decrease in catch in Regions 1 and 2 has put more pressure on the southern regions, the apparent source of most of recent current catch (Table B1.9). The TAC Committee has also emphasized this point (TAC Committee 2002, 2004a). In 2001-2 catches in Regions 5 and 6 increased whereas catches in the other 4 regions generally declined. This was due to more divers preferring to fish in Regions 5 and 6 because abalone were more abundant relative to the other regions during this period (TAC Committee 2004a).

Changes in the dynamics of the fishery are not obviously seen in catch rates. Catch records for the Abalone Fishery are based on the catch reported through the daily logbook system and monthly catch returns. Data for catch weight and fishing effort (diving time) are recorded separately for each day and for each of 72 sub-zones in the fishery and then are combined to estimate commercial catch rates (kg per hour). Catch rates are standardised for the effects of diver experience, and used as an index of the abundance of legal sized abalone.

Performance measures in the share management plan include a 'trigger reference point' of

+/- 15% of the 1994 catch rate, below which there should be a review of the causes of the discrepancy from management intention and remedial action should be initiated as necessary (Section B1.4.1).

The standardised commercial catch rates are shown in Figure B1.3. Key features are:

- The standardised commercial catch rates have decreased steadily and rapidly since 2001 in all regions that have been substantially fished (i.e. all regions other than Region 1). Note, however, that large declines have also occurred in some regions previously (i.e. decline from 1989 in Region 6). The 2001 catch rates in each region, except Region 1, were the highest they had been for many years, and the highest since 1987 in regions 4, 5 and 6;
- Commercial catches in Region 1 during 2002 and 2003 were affected by closure of most subregions because of *Perkinsus*; and
- The standardised 2003 commercial catch rate in Region 1 was close to the 1994 reference level. The 2003 catch rates in regions 2, 3, 4, 5 and 6, which received most of the fishing effort and provide most of the catch, fell below the 1994 reference level and are approaching the lower bounds of what has been identified as desirable.

It is notable that a reasonably steady and high catch rate has been maintained in Region 1 since 1986 (Figure B1.3) despite catch records (Table B1.9) and fishery independent surveys that indicated large declines in the stock occurred between Port Stephens and Jervis Bay since 1994 (TAC Committee 2004a). It is clear that, at the scale of the region, the fishery can maintain a high catch rate even though the resource in that region is decreasing or has collapsed. This is achieved by targeting the remaining high-density areas at local scales in an otherwise severely depleted region. This strongly implies that regional commercial catch rate can be a poor indicator of regional stock abundance. Note that regional catch rates are a performance indicator for the fishery. Specifically, Region 1 demonstrates that catch rate in this fishery can be 'hyper-stable' at the scale of the region. That is, catch rate can remain high even though the average abalone density in a region is decreasing or low. Because of this phenomenon catch rate should be treated cautiously as an index of abalone abundance, and given reduced weight or credibility if trends in catch rate are in conflict with trends in other indicators.

The productivity and state of the stocks in the different regions are now quite different to previous years and the TAC Committee believes it is inappropriate to manage them as if they were a single unit with an aggregate catch limit (TAC Committee 2002, 2004). To help prevent effort concentrating in the far south, and the risk of overfishing that this may cause, the Committee recommended regional catch targets for the last two fishing periods. The Committee also recommended that no more than 5 t be taken from Region 1 in 2004-5, and that this be done in accordance with a program approved by DPI of experimental fishing in the region.

The strategy in place (devised by DPI and endorsed by the MAC) for managing the amount of catch coming out of each region is that the distribution of catch is monitored, reviewed and assessed quarterly and reported to ABMAC (TAC Committee 2002). A trigger point of 90% of the recommended catch is set for Regions 3 & 4 and Regions 5 & 6. That is, the trigger would be activated if the catch reaches 90% of the recommended target in any quarter of the fishing period. A trigger point of 75% of the recommended catch is set for Region 2. That is, the trigger would be activated if the catch reached 75% of the recommended target in any quarter of the fishing period. For Regions 3 & 4 and 5 & 6 the target is limited to 110% of the TAC Committee's recommended catch targets. For Region 2 the target is limited to 100% of the TAC Committee's recommended catch targets. Overall catches are limited by the state-wide TAC, despite the possibility of, in unusual circumstances, regional target summing to more than the state-wide TAC. Under the strategy, if a trigger point is reached, ABMAC is to review the potential causes and consider appropriate action. The process is that review would be completed by the MAC at its next scheduled meeting or by out-of-session consultation if an immediate response is necessary. Following review and discussion by ABMAC written advice is to be provided to the Director and/or Minister if appropriate, providing ABMAC's explanation of the trigger had been activated and a suggested management response.

Table B1.9. Commercial catch of abalone (tonnes) for each of the six stock assessment regions. (Source: NSW Fisheries 2004).

Year	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	Quota
	North of Wreck Bay	Wreck Bay to Tuross Lake	Tuross Lake to Mimosa Rocks	Mimosa Rocks to Eden	Eden to Green Cape	South of Green Cape		
1983	128	79	121	103	103	99	633	No limit
1984	131	120	98	100	99	101	649	No limit
1985	109	110	75	66	97	116	573	No limit
1986	118	87	76	61	72	118	533	No limit
1987	90	65	49	37	39	66	346	No limit
1988	76	67	47	41	52	78	362	370
1989	54	52	46	48	42	73	316	370
1990	46	54	58	59	67	71	355	370
1991	50	40	41	65	57	64	318	370
1992	58	32	39	52	45	67	293	333
1993	58	37	42	52	52	72	313	333
1994	61	36	42	47	50	85	322	333
1995	51	47	64	47	52	72	333	333
1996	36	53	66	53	56	73	337	333
1997	28	63	66	48	49	76	330	333
1998	11	53	64	57	48	84	317	333
1999	15	39	65	56	56	93	324	333
2000	19	30	67	57	53	78	305	305
2001	19	24	55	58	60	88	305	305
2002	5	22	47	47	57	99	277	300
2003*	4	33	35	46	47	73	238	281

* 2003 data are preliminary and the fishing period changed from calendar year to financial year

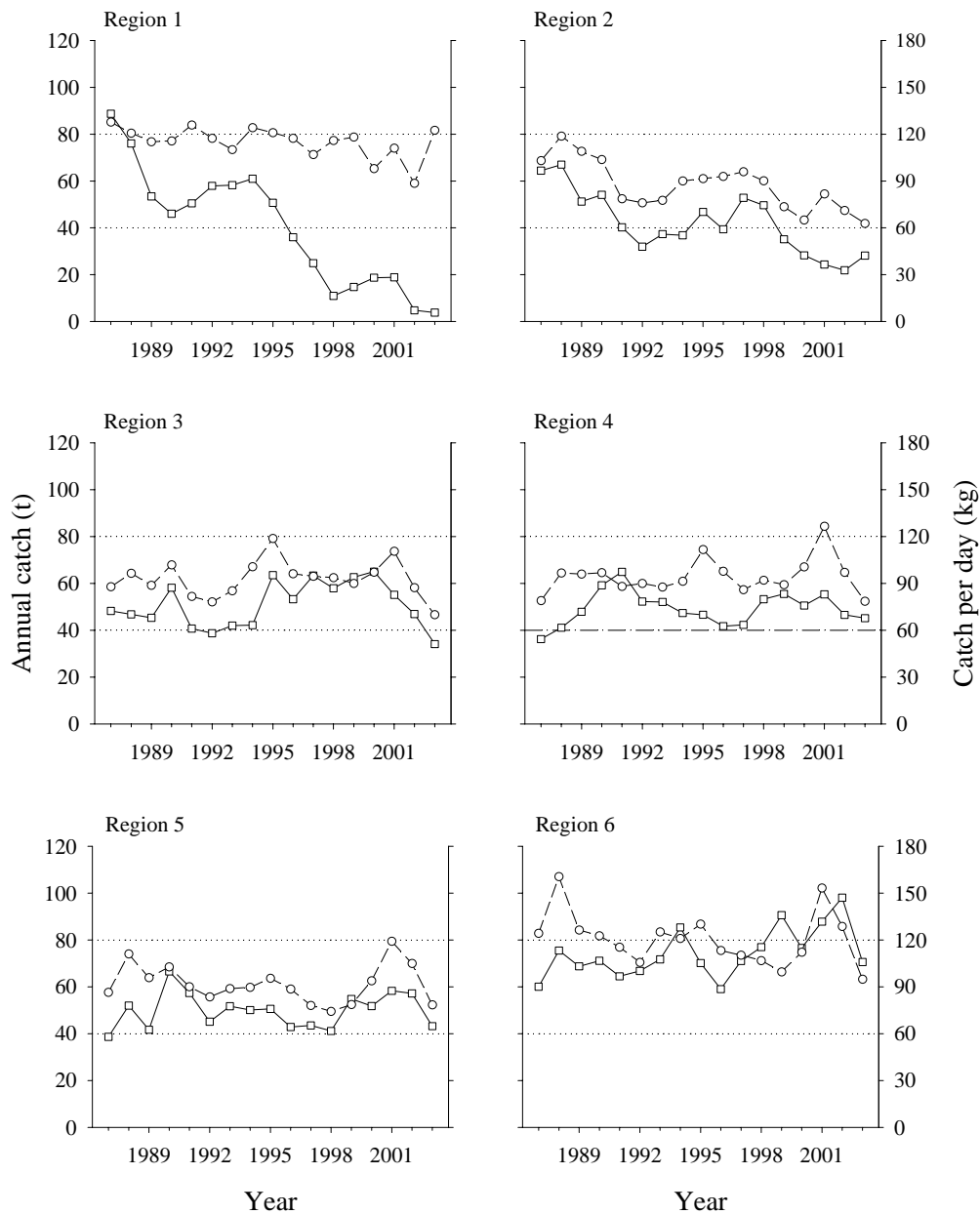


Figure B1.3. Annual catch (squares) and average daily catch (circles) for each region since 1987. Dashed lines are for reference. (Source: DPI).

B1.5.2 Value

The Australian abalone industry is predominantly an export industry with its principal markets in north-east Asia. The bulk of the Australian catch comes from Tasmania. New South Wales is a minor contributor.

Australia is the dominant source of world exports of wild abalone. In 2001 it supplied 82% by volume and 78% of the value of world exports of abalone. Australian abalone production in 2002/03 was \$212.5 million, of which \$10.63 million, or about 5%, came from New South Wales (TAC Committee 2004a). Australia exported 4,193 tonnes of abalone in 2001-2002, of which about 59% was canned and the remainder fresh, chilled or frozen. Of these exports, about 80% went to China, Hong Kong, Taiwan and Japan. Hong Kong took 60% of this total, an increase of about 10% on the previous year.

As shown in Table B1.10, the volume of production in the State declined from 1999-2003, while its value rose and fell over the same period. The value of production has decreased since 2000 because of a combination of reduced quota, the inability of some operators to catch their allocated quota and declining beach price for abalone (Table B1.11, Figure B1.4). Assuming all the 2003 catch was sold at the average price for that year of \$33/kg, total industry revenue for NSW in 2003 was approximately \$7.8 million. This compares with higher values in 2002, 2001 and 2000 when prices, the catch and the TACC were all higher. Revenue from the commercial fishery in 2003 was at its lowest in 7 years.

Table B1.10. Volume and value of production of abalone in New South Wales, 1999-2003. (Source: TAC Committee 2002, 2004).

Fishing season	1999	2000	2001	2002	2003
Production (tonnes)	325	305	305	277	238
Value (\$'000)	12,680	15,200	12,373	11,911	7,854

Table B1.11. Total Allowable Commercial Catch, TACC Taken, and Catch Rates. (Source: NSW Fisheries 2003, DPI 2005).

Fishing season	TACC (tonnes)	Total catch (kg)	TACC taken (%)	Divers with >50kg unused **	Annual average catch rate (range) (kg per hour)
1996	333	331,438	99.5	8	20.6 (13-28)
1997	333	327,056	98.2	11	19.8 (13-29)
1998	333	321,406	96.5	19	19.1 (12-28)
1999	333	322,212	96.8	18	17.7 (11-30)
2000	305	304,553	99.9	4	19.1 (11-32)
2001	305	304,354	99.8	0	24.6 (17-37)
2002-3*	450	413,450	91.8	No data	19.7 (16-23)
2003-4	281	251,987	89.7	No data	No data

* 2002-3 data are based on an 18 month fishing period

** Refers to divers who fell short of their quota for a year by more than 50kg

Average beach prices of abalone peaked in 2000 at \$52 per kg, but have since been declining and were \$33 per kg in 2003 (Figure B1.4). They were still higher in 2003 than in 1998, 1999 and similar to 1997. Apparently, the decline in beach price since 2000 has been due to poor economic conditions in Asia, increased competition due to rising supplies of ‘ranched’ abalone imports from South America, the SARS virus and a strengthening Australian dollar (TAC Committee 2004a). This decline in beach price, in conjunction with decline in TAC has led to a risk to the economic viability of the fishery (Section B3).

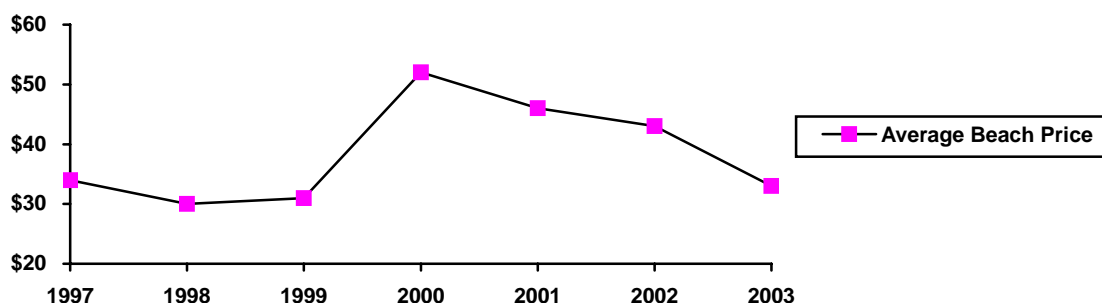


Figure B1.4. Average beach price of abalone (per kg) in New South Wales, 1997-2003 (Data from processors of abalone harvested in NSW). (Source: TAC Committee 2004a).

B1.6 Research

Under the share management plan the major objectives for research in the Abalone Fishery are to: i) collect information necessary to complete an annual assessment of abalone stocks in NSW; and ii) investigate techniques for increasing the productivity of the abalone stocks in NSW. To achieve these major objectives, a strategic plan was developed (Table B1.12).

Table B1.12. Existing strategic plan for abalone research. (Source: SMP 2000).

Objective: Maintain or increase the biomass of mature and legal sized abalone	
Strategies	Describe and analyse patterns in commercial catch, effort, catch rate and the size of abalone caught
	Complete annual independent surveys to provide an index of the relative abundance of abalone of different sizes
	Incorporate all data sources into a formal modelling framework to assess the current state of the stock, and the risk and performance of future TAC
	Release hatchery-produced larval and juvenile abalone to depleted reefs
	Investigate interactions between the fisheries for abalone and sea urchins, with particular reference to the potential for enhancement of the abalone fishery
	Complete surveys of the infection rate by <i>Perkinsus</i> , with the potential of minimising losses caused by mortality
	Provide a description of the impact of fishing practices upon the mortality of under-sized abalone
	Complete experiments and analysis of meat-weight : shell-length relationships and provide the information to Compliance
Objective: Ensure appropriate research and monitoring in relation to the fishery	
Strategies	Consultation with the MAC, Industry, community, Department, other agencies and users of the information
	External review of existing strategies and their cost-effectiveness

Many of the projects listed under the research strategy in the share management plan have been completed (i.e. 'Release of hatchery produced abalone to reefs', 'Interactions between the fisheries for abalone and sea urchins' and 'Analysis of meat-weight: shell-length relationships'). The Stock assessment project remains ongoing. Investigations of the effects of the *Perkinsus* parasite continue as it regarded as a high priority for research.

B1.6.1 Stock Assessment

The basis for the ongoing stock assessment program was initiated by DPI and Industry in 1993 through a Fisheries Research and Development Corporation (FRDC) grant and it has been fully-funded by Industry since 1996. The program has undergone considerable development and expansion over the past 11 years (Andrew *et al.* 1996, Worthington *et al.* 1997, 1998, 1999 and 2001) and is highly regarded for its rigour and applicability (Sainsbury 2000). The annual assessment is presented to the TAC Committee and forms the basis for their determination of the TACC for each fishing period.

Table B1.13. On-going 'stock assessment' research projects. (Source: SMP 2000).

Research Projects	Objectives and Comments
Fishery independent surveys	Involves researchers counting abalone in three size classes annually between July and December in fixed areas in each of the 6 stock assessment regions.
Size structure of commercial catch	Fishery-dependent data collected from catch return sheets. The average length of abalone in commercial catches is calculated. The number of individuals and weight of each catch is used to calculate the average length of abalone in individual catches. This is used to estimate the frequency distribution of sizes of abalone in the commercial catch.
Analysis of commercial catch and effort data	Fishery-dependent data collected from catch return sheets. Spatial and temporal trends in catch and effort are estimated. Currently done annually.
Stock assessment of abalone	Fishery-dependent and fishery-independent data are fed into a length-structure model with spatial components and used to make predictions that would result from various changes to management (TACCs in particular). This information is presented to the TAC Committee annually.

Assessment of the stock involves combining sources of data from a number of research projects to estimate biomass (Table B1.13). Fishery-independent surveys of the abundance of abalone in each of the regions provide a key source of information for assessment of the stock. Each year a number of fixed sites are surveyed for the number of small (less than 60

mm), medium (60-115 mm) and large (greater than 115 mm) abalone present. About 400 sites are surveyed each year, in comparison to about 100 sites when the surveys began (TAC Committee). The 1994 abundance of abalone (i.e. the first year of the surveys) is used as a 'benchmark' or target for desired performance under the share management plan, and +/- 15% from that level is treated as a limit of the desirable performance and a 'trigger for review' (Table B1.8).

The second source of data used in the stock assessment is the size-composition of the catch. Prior to 1993 there were occasional samples taken of the catch to determine its size-composition (TAC Committee 2004a). Measuring a sample of the catch through a fishery independent catch-sampling program provided size-composition of the catch from 1993 to 1999. Since 1999, the size-composition of the catch has been measured from fishery records of the total weight and number of abalone in every bin caught – from which the average weight of abalone in each bin is calculated. The frequency-distribution of the average weight of abalone per bin is used to indicate the mean size of the abalone in the catch, and hence the population of abalone above the MLS accessed by the fishery.

The third source of data used in the assessment is the catch and effort data. Catch weight and harvesting effort (diving time) data are recorded separately for each day and for each of the 72 sub-zones in the fishery. The commercial catch rates (kg/hour) are then standardised for the effects of diver experience, and used as an index of the abundance of legal sized abalone (Section B1.4.1). Performance measures in the share management plan include a 'trigger reference point' of +/- 15% of the 1994 stock abundance, below which there should be a review of the causes of the discrepancy from management intention and initiation of remedial action as necessary (Table B1.8).

The information is combined into a model of the dynamics of the population to estimate stock abundance and harvesting mortality rates. The model is length-based and incorporates information on the growth, natural mortality and size at maturity of abalone (TAC Committee 2004a). It includes a relationship between the number of young abalone recruited to an area and the weight of mature abalone in that area. The model is fitted in a Bayesian framework so as to match as well as possible the time-series of observations on five quantities – four abundance indices (i.e. commercial catch rate and the fishery independent survey of abundance of each of the three size classes of abalone) and the size-composition of

the catch. The weight or relative credibility of each of these quantities is fixed prior to fitting the model.

The model is used to predict the stock level of legal and mature abalone in the near future based on different assumptions about the intervening catches (i.e. TACCs). That is, the stock assessment is used to estimate the risk of harvesting to the population of abalone. The TAC Committee reviews these risks and makes its determination of TACC according to the 'precautionary principle' (Section B1.8.3). Thus, the model is a cornerstone in minimising the risk of harvesting to abalone. The predictions are used to calculate a number of performance measures for the fishery, including those emphasized in the share management plan. That is, the probability of being above the 1994 biomass (treated as a target) and being above 85% of the 1994 biomass (treated as a limit to be avoided with high probability). These performance measures are calculated for both the legal biomass and the mature biomass. The stock assessment model also has a spatial component. Mature and legal biomass is calculated for Regions 2, 3 & 4 and 5 & 6. These groupings are appropriate to the resolution of data used in the model.

B1.6.2 Other Research

A revision of research priorities in late 2002 indicated the following research priorities, ranked in order of importance from 1 (highest priority) to 3 (lowest priority).

Ecological Processes:

Development of the sea urchin fishery to enhance abalone populations Rank 2

Impacts of Management and Manipulation

Utility of alternative size limits and fish-downs for abalone Rank 3

Reporting, Managerial and Policy Methodologies

Estimation of the illegal catch of abalone Rank 1

Disease and Pollution

Effects of *Perkinsus* and water quality on abalone Rank 1

Post-harvest and Value-adding

Development of improved tanking and marketing of abalone Rank 2

Socio-economics, Education and Communication

Economic assessment of the impact of the Abalone Fishery Rank 2

Some of these priorities have been, or are currently being, addressed. For example, the FRDC projects entitled 'Research to develop and manage the sea urchin fisheries of NSW

and eastern Victoria' and 'Enhancement of populations of abalone in NSW using hatchery-produced seed' have been completed. The project entitled 'Investigating and managing the *Perkinsus*-related mortality of blacklip abalone in NSW' is underway. Industry has partly funded these projects, as well as many others.

B1.7 Compliance

B1.7.1 Structure, Activities and Cost

Compliance Services aim to protect and ensure long term sustainability in the Abalone Fishery through an effective and cost efficient advisory and enforcement program consistent with the Strategic Plan for Abalone Compliance, as detailed in the share management plan and shown here in Table B1.14. The fishery receives services as part of the general duties of fisheries officers based in ports on the coast of NSW and additional services from a small number of officers whose duties are focused more directly upon abalone.

DPI has approximately 90 fisheries officers responsible for coordinating and implementing compliance strategies in NSW. These strategies include:

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

Approximately 65 of these fisheries officers are located in coastal areas of NSW, including ports from which the Abalone Fishery operates. Thirty-four officers performed abalone compliance and advisory duties to varying degrees in the 2003 calendar year. The general duties of these fisheries officers include conducting patrols, inspecting commercial divers and fishing gear, and recording rates of compliance.

Table B1.14. The Strategic Plan for Abalone Compliance. (Source: SMP 2000).

Objective: Maintain or increase the biomass of mature and legal sized abalone	
Strategies	Positive input into DPI team management approach with regard to the Abalone Fishery
	Attendance at ABMAC meetings
	Fisheries magazine articles
	Regular liaison with stakeholders to discuss concerns and trends
	Information given to the Total Allowable Commercial Catch committee
Objective: Minimise the number of offences committed by divers and processors	
Strategies	Maintain dedicated officers in the Fisheries Investigation Unit identified through program budgeting tasked with abalone compliance duties
	Maintain equipment needed for response capability
	Overt patrol of coastal waters targeting recreational and commercial and illegal diving activities
	Extended abalone compliance patrols targeting organised abalone thieving operations
	Covert patrols targeting abalone theft and the illegal trade in abalone
	Extended covert patrols targeting abalone theft and illegal trade
	Prosecution of persons involved in the theft and illegal trade in abalone
	Accurate and relevant information provided to Magistrates to assist in sentences which reflect potential damage to the resource
	Increase profile of overt patrols
	Continue public awareness programs through information packages and advisory functions
	Submit information reports for inclusion in a database of illegal fishing activity
	Supply specialist equipment and officers to assist other departmental staff during abalone compliance programs
	Continue implementation and management of the Statewide Abalone Compliance Plan

DPI manages compliance service delivery for each significant fishing or target program through a district compliance planning process administered within the Fisheries Services Division. 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, 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 Abalone Fishery 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 direct and indirect compliance benefits for the Abalone Fishery.

In addition to compliance services received as part of the general duties of fisheries officers stationed at ports along the coast, the Abalone Fishery receives services from officers more dedicated to abalone. The Fisheries Investigations Unit (FIU) is a separate unit within the Department that integrates intelligence and fish receiver functions with the abalone and lobster compliance functions, forming an operational unit consisting of 11 officers stationed at Batemans Bay, Merimbula, Sydney metropolitan area, The Entrance and Maclean. Shareholders in the Abalone Fishery contribute directly to the FIU by funding two officers stationed at Batemans Bay and two in Merimbula. These officers conduct the majority of the dedicated abalone compliance functions and work in both covert and overt roles, with an emphasis on proactive targeted operations. The FIU and District Fisheries Officers conduct many other activities specific to abalone compliance, including targeted operations, vehicle and vessel patrols, apprehending abalone thieves, market inspections, gathering intelligence and the compliance activities associated with recreational and commercial abalone divers and processors (NSW Fisheries 2004).

Although some of the duties of the four dedicated abalone officers in the FIU are directed towards potential theft of abalone by the commercial sector, a proportion of their duties involve investigation of abalone theft occurring outside of the commercial harvesting sector. As such, the services of the four dedicated abalone officers benefit the wider community as well as the commercial sector. There is debate within industry as to whether these officers are considered a core service and whether the commercial sector should pay the full costs of funding their activities (see also Section B1.3.2.3).

The FIU receives valuable information on abalone theft from various sources with hundreds of information reports received during 2003. Shareholders in the Abalone Fishery also fund a reward scheme which pays up to \$1,000 for information leading to the conviction of abalone thieves.

Throughout 2003, compliance staff continued to network with other Government Agencies including the NSW Police, the Australian Federal Police, Australian Customs Service, the Australian Taxation Office, Centrelink, National Parks and Wildlife Service, the National Crime Authority, the Waterways Authority and other interstate Fisheries Agencies. This cooperation allows a whole of Government approach to address abalone related crime.

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.'

The compliance rates for the commercial and recreational sector, as a percentage of the total number of inspections, are given in Table B1.15. As noted previously (Section B1.2.5), breaches by the commercial sector have been minor only (e.g. logbook infringements). Compliance rates are considered acceptable according to the performance indicators in the share management plan (NSW Fisheries 2004).

The current expenditure of effort on compliance in the industry is substantial in order to reduce the risk that increased illegal activity would have to the sustainability of the fishery. Expenditure on salaries and operating expenses in 2002/2003 was \$437,332. The total value of an illegal catch of, say, 145 tonnes (i.e. at about the upper limit of estimation for 2002/3), at a beach price of \$33 per kilogram, is of the order of \$4.8 million. The compliance expenditure was, therefore, about nine percent of the value of the assumed illegal catch and about six percent of the value of the estimated commercial catch in 2003. Despite the expenditure, it is thought that further reduction of illegal catch would be of substantial benefit to industry as it would reduce the risks illegal activity poses to sustainability (TAC Committee 2004a). Thus, an increase in compliance expenditure (as recommended in the

Palmer Report on Illegal Fishing (Section B1.2.5.2) could be a profitable investment for the industry. Given the assumed level of illegal activity, the response to such increased expenditure could be substantial and could potentially increase the TACC (TAC Committee 2004a). The TAC Committee believes it would be in the industry's interest to explore ways of funding such increased activity in the fishery management strategy, in place of, or in addition to, other expenditure options.

Table B1.15. Compliance rates for commercial and recreational abalone divers for 2000-03. (Source: NSW Fisheries 2004).

Year	Compliance rate (%)	
	Commercial divers	Recreational divers
2000	75	84
2001	81	85
2002	89	86
2003	89	84

B1.7.2 Penalties

An abalone offence constitutes an offence against the share management plan, the *FM Act* or the Regulations relating to the taking of abalone. The share management plan designates the contravention of provisions of the plan as shareholder offences or endorsement holder offences.

The Abalone Fishery has designated share forfeiture offences (Table B1.16). If a shareholder or nominated fisher of a shareholder is convicted of a share forfeiture offence all shares may be forfeited to the Minister for Primary Industries.

Table B1.16. Share forfeiture offences in the Abalone Fishery. (Source: SMP 2000).

Share forfeiture offence	Description
Contravention of cl. 16 of the share management plan Regulation	Contravention of quota
Contravention of cl. 31 of the share management plan Regulation	Steps to be taken after landing of abalone
Contravention of cl. 33 of the share management plan Regulation	Monthly reconciliation
Contravention of cl. 107 of the <i>FM (General) Regulation</i>	Interference with set fishing gear
Any offence under the <i>FM Act</i> or Regulation that is punishable by imprisonment	

Note. Clause 133 of the *FM (General) Regulation* also provides for share forfeiture for failure to pay a community contribution or other amount due under the *FM Act*.

B1.8 Consultation

There is a range of consultative bodies established in NSW to assist and advise the Minister for Primary Industries and DPI on fisheries issues. There are committees that are established to provide advice on fishery specific issues and bodies to advise on matters which cut across different fisheries or sectors.

In addition, DPI representatives from management, compliance and research undertake annual informal meetings with abalone shareholders and divers at various locations along the NSW coast. This provides an opportunity for shareholders and divers to raise issues and for Fisheries staff to provide up-to-date information direct to the stakeholders in the fishery. Increasingly, industry representatives are taking a greater role in organising industry meetings to consider key issues.

B1.8.1 The Management Advisory Committee

Management advisory committees (MACs) were established for each commercial fishery in NSW under Section 230 of the *Fisheries Management Act 1994*, to provide advice to the Minister for Primary Industries, regarding the management of each fishery. MACs provide a forum for meaningful discussion, negotiation and conflict resolution in each fishery. The outcomes of these deliberations determine the recommendations the MAC will make to the Minister for Primary Industries.

The functions of a fishery MAC are:

- to advise the Minister on the preparation of any management plan or regulations for the fishery;
- to monitor whether the objectives of the management plan or those regulations are being attained;
- to assist in a fishery review in connection with any new management plan or regulations; and
- to advise on any other matter relating to the fishery.

MACs consist of elected Industry members and non-Industry members appointed by the Minister to represent other interest groups such as Indigenous, recreational and conservation groups. Departmental representatives also sit on MACs, providing expertise on fisheries management options and policy considerations. DPI considers that a co-operative approach to MAC discussion is essential.

B1.8.2 Ministerial Advisory Councils

Three 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.

The Ministerial Advisory Councils currently established are:

The Seafood Industry Advisory Council (SIAC); and

The Advisory Council on Recreational Fishing (ACoRF).

The Abalone Fishery and each of the other new share management and restricted fisheries have representatives on the SIAC. These representatives are nominated by each of the respective MACs and appointed by the Minister.

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

B1.8.3 Total Allowable Catch Setting and Review Committee

The process for assessing the status of and pressure on abalone stocks will ultimately include the Total Allowable Catch Setting and Review Committee (TAC), which is empowered to make 'determinations' under Division 4 of Part 2 of the *FM Act*.

As required by the share management plan, this committee makes determinations about the total level of fishing effort to apply in the harvesting of abalone in connection with this fishery. The TAC Committee consists of at least four members appointed by the Minister, including:

- (a) the Chairperson of the TAC committee, being a person who is neither engaged in the administration of the *FM Act 1994* nor in the commercial fishery;
- (b) a natural resource economist not employed by the Government;
- (c) a fishery scientist not employed by the Government; and
- (d) specialists with appropriate fisheries management qualifications.

The composition and role of the TAC committee are set by the *FM Act* and its regulations. It is not subject to the control or direction of the Minister for Primary Industries but in reaching its decision it is required to have regard to:

- all relevant scientific, Industry, social and economic factors;
- the need to ensure that the exploitation of abalone resources is conducted in a manner that will conserve abalone stocks in the long term;
- the impact of fishing activities on all species of fish and the aquatic environment, and
- the Precautionary Principle.

The TAC Committee incorporates harvest estimates from other sectors, including recreational and illegal catch estimates when setting the TACC. Recreational and illegal catches are two of the greatest uncertainties in the TACC setting process. The TAC Committee regards the best estimate of recreational catch to be 52 tonnes, as taken from a survey in 1997 (Section B1.2.3). The Committee considers (TAC Committee 2002, 2004) it prudent to use the upper limit of the compliance estimate as the best indicator of the magnitude of the illegal catch (i.e. 40% of the TACC in 1997; Section B1.2.5). More precise estimates of recreational and illegal catch would presumably change the allocation to the commercial sector, depending on whether estimates were over- or under-estimated. Before

the TAC Committee makes a determination, it is required to call for public submissions and have regard to the submissions received within the timeframe fixed for the making of submissions.

B1.9 Conclusions

The foregoing sections describe the extent and operations of the Abalone Fishery in NSW. Key features are the share management nature of the fishery; the current structure of management, as prescribed in the share management plan; the setting of catch quotas by an independent body, the TAC Committee; and a strong foundation of stock assessment and compliance. These factors make the Abalone Fishery one of the most highly structured primary industries in NSW.

The remainder of this chapter on the existing fishery places the fishery within a natural, economic and social context and then summarises the risks identified to the fishery at this time.

B2.0 BIOPHYSICAL ISSUES

B2.1 Introduction

The guidelines for the Environmental Impact Assessment of the Abalone Fishery (DIPNR 2003) state that the environmental assessment should test the sustainability of proposed fishing activities (Appendix A2). The first step in doing this is to assess the risk from current activities so that the proposed Fishery Management Strategy can be modified accordingly. The aim of this section of the EIS is to describe the biophysical context of the Abalone Fishery and to assess the potential impacts arising from the way in which fishery currently operates. A risk analysis, considering biological, ecological and physical components of ecosystems and large-scale ecological processes, is used to identify those aspects of the existing operation of the fishery (Section B1) that could affect biophysical aspects of the environment.

Operations of the current fishery that could affect the ecological sustainability of the environment are identified and addressed through the draft FMS. The recommendations arising from the risk analysis are incorporated into the draft FMS, as described in Chapter D, to improve the performance of the fishery. The draft FMS is evaluated in Chapter E to determine if proposed management measures would effectively reduce the risk to the biophysical environment and ensure that the fishery operates in an ecologically sustainable manner.

B2.1.1 An Outline of the Process of Risk Analysis Used to Examine the Operation of the Abalone Fishery

EISs for fisheries in NSW were written against a specific legislative framework. Although broadly consistent with the guidelines for ESD reporting for Australian fisheries (i.e. the 'How to Guide' for Wild Capture Fisheries by Fletcher *et al.* 2002) there are inevitably some differences. The major elements recommended in the 'How to' Guide are:

- compilation of summary background material on the fishery (including species affected and environments affected);
- identifying the issues;
- prioritising these issues; and

- completing suitable detailed reports on the performance of the fishery for each issue.

All of these elements are covered under the specific legislative framework to which this assessment for the Abalone Fishery is written.

The general model of risk analysis for the Abalone Fishery is based on a modified version of the Australia/Standards New Zealand (2000) risk analysis framework. The framework used in this EIS is generally similar to what has been used for environmental impact assessments for other fisheries in NSW, but in contrast to the other fishery assessments, the approach advocated in the 'How to' Guide has been used for analysis at the finest level of detail. In general terms, sources of risk from activities of the Abalone Fishery were identified at the broad level of the whole biophysical environment. Subsequently, finer-scale analyses were done on particular components of the target species and aspects of the biophysical environment of concern. As indicated, finer-scale analyses were based on the risk assessment process for wild fisheries developed by Fletcher *et al.* (2002, Appendix B5). The Fletcher approach is more simplistic than what has been done for environmental impact assessments for other fisheries in NSW but is appropriate for the Abalone Fishery because the fishery is based on the hand-gathering of a single species only and there is no byproduct and virtually no bycatch. In addition, the Fletcher approach has the flexibility to assess risks to specific sub-components of the target species and other aspects of the biophysical environment. This could not be readily done with the approach used in assessments of the other fisheries. A description of the risk analysis framework and the definitions of terms used are provided below.

RISK ANALYSIS (EIS)

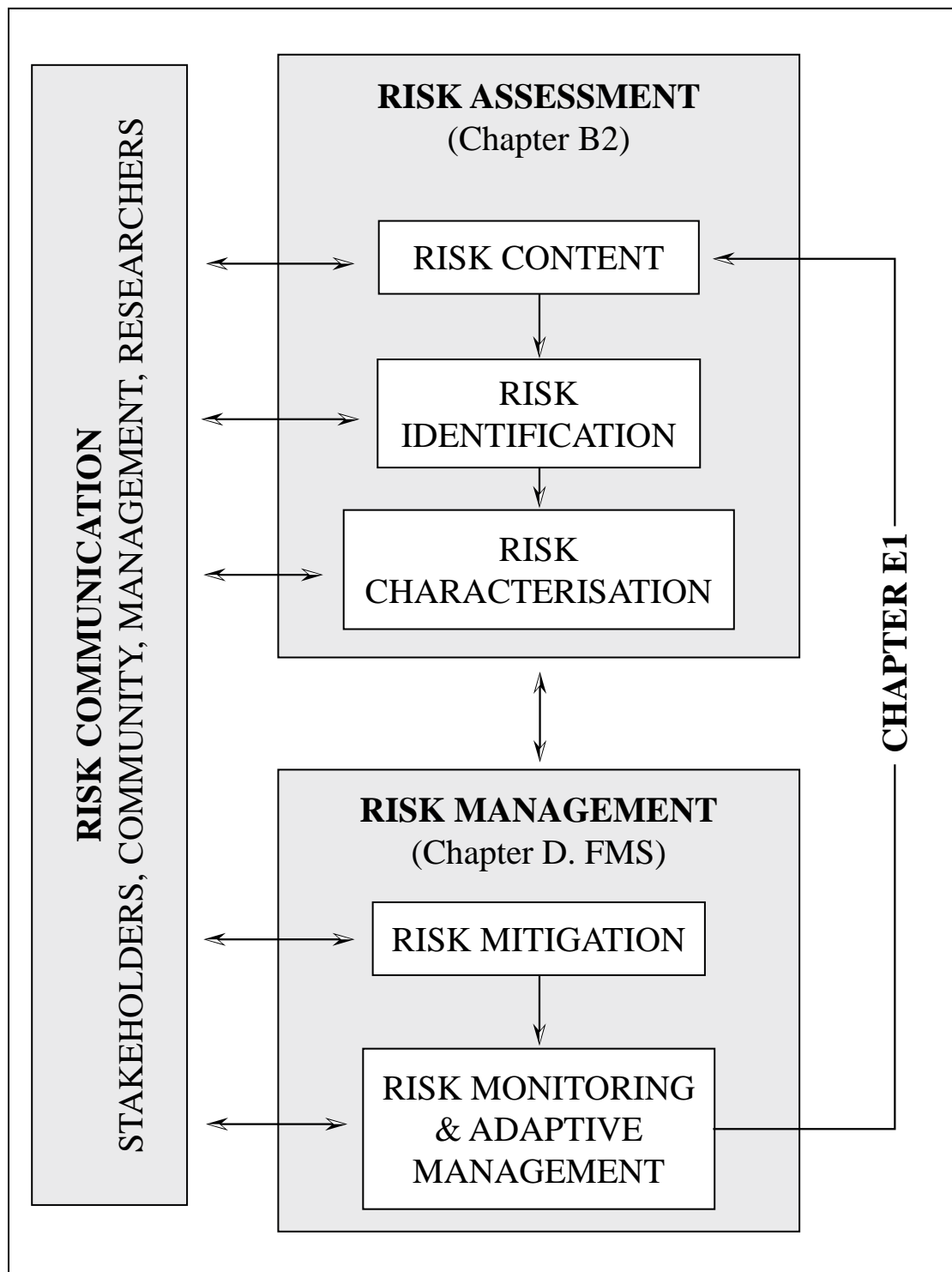


Figure B2.1. Framework of the risk analysis used for the Abalone Fishery. (Source: DPI 2004).

Risk analysis is an iterative process that has three main steps: risk assessment, risk management and risk communication (Figure B2.1). The process of risk analysis aims to provide insights about sources of risk and their potential impacts, which then enables managers to take mitigative action against undesirable outcomes.

Risk is the probability or likelihood of an undesirable event (also often termed a 'hazard') happening. 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.

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

1. *Risk context*. The scope or context of the risk analysis can be defined clearly by specifying three main elements: (1) the risk that is to be analysed (eg. 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); 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).
2. *Risk identification* aims to generate a comprehensive list of potential sources of risk. This is done using literature reviews, examination of historical records, expert panels, brainstorming, consultation meetings with stakeholders, etc. The results of this risk identification step are often presented as lists, tables or as component trees (Fletcher *et al.* 2002).
3. *Risk characterisation* aims to estimate the probability or likelihood (or 'odds') that the various sources of risk (identified in Part 2) will cause the undesirable event that has been defined. Risk characterisation is an iterative process that involves:

- the integration of qualitative and/or quantitative information, including the associated uncertainties, about the sources of risk;
- the separation of the sources of risk into categories according to their estimated probability or likelihood of causing the previously specified undesirable event;
- the acceptance of negligible risks with a justification supporting the conclusion reached (these negligible risks are now eliminated from the subsequent risk analysis); and
- the rejection of the remaining sources of risk that have been estimated to be above the threshold of negligible 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 analysis, risk is often defined as 'lower', 'moderate' or 'higher'. 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 three categories – low, moderate, high – implies each category accounts for one third of the total risk).

Risk characterisation is achieved iteratively by stepping down through a series of hierarchical levels. For example, risk can be characterised initially at the broad ecosystem level to examine large-scale ecological processes and biodiversity, and then at a finer resolution for the target species or other ecological components affected by the fishery. This approach is used in the risk analysis of the effects of the Abalone Fishery, under current operations, to the biophysical environment. A qualitative risk assessment done at the broad ecosystem level is presented in Section B2.2 and used to identify specific aspects of the ecosystem for finer-scale analysis. Finer-scale risk analyses of the effects of activities on sub-components of the target species, bycatch, other species, assemblages and habitat, based on the method described by Fletcher *et al.* (2002) (Appendix B5), are done in subsequent sections and used to describe overall risk to a sub-component. The scientific literature, abalone fishery status report and the expert opinion of fisheries managers and scientists were used to obtain information on the exploitation of abalone and the biology and ecology of abalone and relevant components of the biophysical environment that were needed to undertake the finer-scale risk analyses. This information was used to construct a qualitative risk matrix that integrated the main factors contributing to the risk to key sub-components of the

target species and other aspects of the biophysical environment. In doing this, the 'consequence' (horizontal axis) of a hazardous event and 'likelihood' (vertical axis) of it occurring were combined in a matrix to estimate overall risk as one of five categories: negligible, low; moderate; high; and extreme. Fletcher *et al.* (2002) suggests the appropriate management responses for each category of risk are:

0. Negligible - No management response;
1. Low – No specific management response;
2. Moderate –Specific management needed;
3. High – Possible increases to management activities needed; and
4. Extreme – Likely additional management activities needed.

To assist in the consistency of the approach, Fletcher *et al.* (2002) provides a series of ecological consequence tables (Appendix B5) that cover:

1. Target species/major non-retained species;
2. By-product/minor non-retained species;
3. Protected species (*EPBC Act*);
4. Habitat issues; and
5. Ecosystem effects.

The risk of activities to species listed as threatened, endangered or protected under State or Commonwealth legislation was assessed using the 'eight-part test' (i.e. a series of questions that address whether a planned action will significantly affect the ecology of a species) as required under Section 5A of the *EP & A Act*.

Risk management is the second step in the risk analysis process. Risk management contains two main components: (1) risk mitigation; and (2) risk monitoring (Figure B2.1).

1. *Risk mitigation* aims to minimise the risk of any undesirable events identified. This is done by evaluating and implementing regulatory and/or non-regulatory (e.g. code of practice) management responses. Such responses are identified in detail in the draft FMS (Chapter D).
2. *Risk monitoring* and *adaptive management* aims to collect information to determine whether if the management initiatives implemented in response to predicted risks

previously were effective in minimising these risks. Thus, 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 and adaptive management should be regarded as a practical appraisal of management initiatives and an opportunity to modify management plans in a timely manner. It can also be considered in a more formal sense as an environmental audit of the process (e.g. Buckley 1990, Ambrose *et al.* 1996).

Risk communication is essential to the risk analysis process because it provides the basis for information flow among stakeholders, fisheries managers, scientists and consultative committees (Figure B2.1). Risk communication should occur continuously during risk analysis in order to assist in adaptive management and achieve a transparent process.

B2.2 Risk Analysis for the Current Operation of the Abalone Fishery – Broad Ecosystem

In this section the risk analysis framework described in Section B2.1.1 is applied to the Abalone Fishery. This is done iteratively by:

- a) defining the context for the risk analysis;
- b) identifying and assessing the sources of risk at the broad level of the whole biophysical environment; and,
- c) providing justification for eliminating sources of negligible risk from subsequent analyses.

Remaining sources of risk are then analysed at a finer scale by examining risk to specific sub-components of the target, bycatch species, other species and assemblages and habitats.

B2.2.1 Context for the Risk Analysis

The risk being assessed is that the current fishing activity is unsustainable. In this context, risk can be defined as:

- a) the likelihood that the current activities of the Abalone Fishery will lead to the widespread degradation of major ecological processes, biodiversity and habitats; and

- b) the likelihood that the current activities of the Abalone Fishery will lead to ecologically unsustainable impacts on populations of target and bycatch species, other related species, assemblages and habitats and protected and threatened species.

These broad definitions of risk are used to define the parameters of the risk analysis and to explicitly describe the consequence that is being adopted at each step of the risk assessment. That is, the consequences for which risk is to be mitigated are: (a) widespread degradation of major ecological processes, biodiversity and habitats; and (b) ecologically unsustainable levels of populations and communities of target, bycatch species and protected and threatened species.

B2.2.2 Risk Identification

To identify areas of risk the Abalone Fishery was divided into its individual activities (e.g. harvesting levels for retained species (i.e. only blacklip abalone), bycatch, physical impact of harvesting operations, etc., (Table B2.1). The links between these activities and the biophysical environment were examined and levels of risk assigned (Table B2.2). It is important to note that the activities of the fishery can affect the ecology of the biophysical environment either directly and/or indirectly and the risks of all of each of these effects need to be considered in the risk analysis.

Table B2.1. Description of activities of the Abalone Fishery that interact with the biophysical environment.

Activity	Description
Harvesting	Removal of abalone and any bycatch from reefs, including movements of divers
Discarding	Returning of under-sized abalone or unwanted bycatch
Boat movements during fishing and to and from fishing grounds	Boat movements during travel and while diver is harvesting
Boat and compressor maintenance and emissions	Tasks involving fuel, oil, noise or other boat or compressor engine related activities that could result in spillages or leakages into the sea or air
Loss of fishing gear	Catch bags or other diving equipment

B2.2.3 Risk Characterisation

Apart from the potential effects of harvesting, most activities associated with the fishery were considered to pose no or negligible risk to the ecological sustainability of components of the biophysical environment (Table B2.2). Justifications of the broad levels of risk from each activity to individual components are given below.

Table B2.2. Levels of risk from activities of the Abalone Fishery to components of the biophysical environment. H =high risk, M = moderate risk, L = low risk, - = negligible risk, blank = not applicable. Where more than one level is listed, this represents there is a range of risk as some sub-components are at different risk to others.

Component of the biophysical environment	Harvesting target species	Discarding of target species	Boat movements	Engine emissions	Loss of gear
Target species (stock)	L-H	L-M		-	
Bycatch species	L-M	-		-	
Other species	L	-	-	-	-
Assemblages of species	L	-		-	
Threatened species	L	-	L	-	-
Protected areas			-	-	-
Habitat	L	-	-	-	-
Diseases	L	-	L		
Water quality				-	
Noise	-		-	-	
Air				-	
Light					
Energy/greenhouse gas			-	-	

Due to the scale of operations the removal of abalone as a direct consequence of harvesting would be a risk to populations of the target and bycatch species. The level of risk, however, would vary for different sub-components of the target species (e.g. mature stock, non-retained abalone etc.) and bycatch (i.e. those living only upon abalone or more generalist species). Bycatch is restricted to small plants and animals living upon the shell or in the mantle of abalone. The risk to particular sub-components of the target species and bycatch

were considered in greater detail in the finer-scale risk analysis (Sections B2.3.4 and B2.4). It is considered that there would only be a low risk from harvesting to threatened and other species, assemblages of species and habitat as the method of harvesting causes little physical damage or disturbance to the biophysical environment (Section B1.1.2, Jenkins 2004). These are considered in greater detail in Sections B2.5 and B2.6

Discarded abalone may have reduced growth and reproduction or die (Gibson *et al.* 2002) and hence discarding may cause some risk to the target species. Gibson *et al.* (2002) suggested that such mortality would have a relatively minor impact on the productivity of the total population. Risk at local scales, however, may be greater. The potential risk is assessed in more detail in Section B2.3.4.

Discarding of target species poses negligible risk to threatened, bycatch and other species, assemblages of species and habitat. This is because, in most cases, abalone are measured immediately after they are gathered by the diver, and, if determined to be under the MLS, returned to the reef immediately and undamaged (Gibson *et al.* 2002). Biota living on discarded abalone would have a good chance of survival, if returned immediately with the abalone. In addition, biota are not present on all abalone, particularly smaller (undersized) individuals.

Travel to, from and within fishing grounds would pose no risk to target and bycatch species as there is no overlap between this activity and these species. However, as there are some threatened, and other, species that live in, or travel through, areas used by abalone vessels there would be a low risk of injury or disturbance to these species. The risks to protected areas and habitat from movement of boats would be negligible because of the small number of vessels and the lack of contact between vessels and the bottom (Section B1.1.2). Travel by sea to and from abalone grounds has a small potential to contribute to the risk of spreading disease (i.e. *Perkinsus*) between populations of abalone if infected animals are onboard, as water potentially contaminated with *Perkinsus* may be discharged overboard during bilge purges. This issue is mostly concerned with the potential of spreading *Perkinsus* to healthy populations of abalone within Region 1, or populations at the northern boundary of Region 2.

Based on current operation, the commercial Abalone Fishery has limited potential to affect water quality, noise, air and light regimes. Boats are generally small (Section B1.1.2.1) and do not use anti-fouling paints on the hulls. The effects of individual abalone boats on water

quality are therefore similar to those of many other small, recreational vessels. There are only 39 boats in the fishery, representing < 0.022% of the 180,000 vessels registered in NSW. Divers work about 70-100 days per year meaning that commercial abalone boats are used for about 4000-6000 trips in total per year.

Boats carry oil and petrol for running the boat motors and the compressor motors. All boat motors release small quantities of pollutants into the water and air through the exhaust but as the fishery operates mostly in open coastal waters there is a large capacity for dilution of pollutants. Furthermore, 4-stroke outboards are now replacing many of the 2-stroke motors; these are less polluting, quieter and more fuel efficient. Fuel and oil are stored in sealed tanks on board to minimise the chance of accidental spillage in rough seas. The potential for the Abalone Fishery to use renewable energy sources is currently limited by the availability and affordability of appropriate technology. Solar and wind powered boats capable of travelling at the required speeds are not commercially available. Electric motors produce lower emissions than petrol motors but are not viable for powering abalone boats in offshore conditions.

The bilge water in abalone boats consists of seawater, including marine organisms (plankton and epiphytic organisms which have fallen off abalone shells), and any spilt oil and fuel. Although there may be some purging of bilge water at sea, most of this water would be discharged when bungs are removed on or near boat ramps. This would contribute to hydrocarbon pollution near ramps but the amount of bilge water released would be minimal compared with the discharge from the vast number of boats using ramps in NSW. Abalone boats operate over only a limited distance from the ramp at which the bilge is emptied. As boats are not trailered with full bilges there would be little risk of spreading disease from one area to another in bilge water.

There would be little potential for emissions from outboard motors and boat-mounted compressors to effect air quality due to:

- the small number of boats in the fishery and the limited number of operating days per year ;
- the small size of the motors used;
- the dispersal of the fleet along the NSW coast; and
- the open coastal environment in which the boats work.

Sources of noise from the Abalone Fishery are:

- outboard motors; and
- boat-mounted compressors which supply air to divers.

Outboard motors are run at full power travelling to and from fishing sites and are maintained at idle power while following the diver. Compressors run continually while the diver is below. Boats start leaving port at about 8 to 9 am and return by 5 pm. Working hours are limited by light, weather, the length of time a diver can spend underwater and the abalone processors whose trucks may visit the boat ramps at set times. Generally, divers average about 4 - 5 hours diving per day but this can vary depending on weather conditions. Abalone boats operate in coastal waters close to the shoreline where background noise levels are increased by wave action. Organisms that could potentially be affected by noise from abalone boats include seabirds, shorebirds, cetaceans and seals, but it is considered that the effects would be negligible because of background noise levels. Although the fishery operates mostly in remote locations divers may occasionally harvest abalone along the coastline of urban areas. Waterfront residences, situated along rocky shorelines where abalone fishing occurs, could potentially be affected by the hum of a compressor or the noise of boat motors. ABMAC is not aware of any complaints regarding noise even when divers are working along the coastline of urban areas.

Given the small size of the motors, the size of the fleet, the limited number of days that the fishery operates and the fact that it operates in well-flushed coastal waters, the impact of emissions from boat engines and compressors are a negligible risk to primary and bycatch species, habitat and other species and assemblages, including threatened species, water quality, noise and air and light regimes. As such the Abalone Fishery does not have, or need, any specific management measures in this area.

Commercial abalone diving occurs only during daylight hours although navigation lights are fitted to vessels. No lights are used in the Abalone Fishery and therefore no animals or humans would be affected by light. In contrast, much illegal harvesting is thought to occur at night, which draws a sharp distinction to commercial activities.

Since no bait is used, there are no nets or hooks and as abalone are not processed on board there would be little potential for debris from the fishery. Accidental loss of gear, such as floating mesh bags, could occur but is thought to be extremely rare. Debris would be

limited to general boating waste, such as food scraps; similar to that produced by recreational boats. The small number of abalone boats, limited number of trips and the fact that each boat carries only 2 or 3 people indicates that the amount of debris produced would be small. Abalone shareholders and divers do not sleep on board and the potential for release of sewage is similar to that of small recreational boats. Hence, the potential risk of lost fishing gear, or debris, to species, protected areas and habitat is considered to be negligible.

Those components of the biophysical environment identified as having no or negligible risk (Table B2.2 and discussion above) will not be considered further in the finer scale risk analysis. The remaining components of the biophysical environment which have a risk level that is greater than negligible are examined below in more detail to determine the extent and types of risks posed by the Abalone Fishery.

B2.3 Risk Analysis for the of the Current Operation of the Abalone Fishery on the Target Species (*Haliotis rubra*)

B2.3.1 Biology and Ecology of Abalone, Distribution and Spatial Structure of the Stock

The fishery targets the gastropod *Haliotis rubra*, which is commonly referred to as blacklip abalone (here after referred to as abalone). Abalone are or have been found on coastal rocky reefs throughout NSW, most commonly from the intertidal zone to depths of 40 m. Abalone are most abundant on the far south coast of NSW, while in areas further north, they become progressively less abundant and more patchily distributed. Few abalone are found north of Coffs Harbour. Outside of NSW, blacklip abalone are abundant in all the southern states of Australia. Because of the limited dispersal or movement of abalone, patches of abalone separated by relatively small distance (e.g. hundreds of metres to kilometres) can be reproductively isolated to some extent (Prince *et al.* 1987, McShane *et al.* 1988). The distance over which patches of abalone can be isolated appears to be related to oceanographic patterns affecting larval dispersal and the topography or habitat available on reefs that affect any movement of adults (McShane 1992). Despite the potential of reproductive isolation little distinct genetic variation has been found among different populations of abalone in NSW (Brown and Murray 1992, Conod *et al.* 2002).

Whilst there is little distinct genetic variation among populations, there is considerable spatial structure to abalone populations. Abalone are gregarious and the distribution of

their preferred habitats is patchy, so individuals are aggregated at a range of spatial scales. Smaller abalone are particularly gregarious and live in cryptic habitats, but individuals become less gregarious and emerge from crypsis as they grow. Although small and large individuals can move large distances in short periods (i.e. 10-100 m within days), this is unusual and movement of individuals is generally limited. There can also be considerable variation in the demography of abalone at a range of spatial scales. For example, rates of settlement, growth and mortality can vary significantly over very small distances (i.e. <10 m; Worthington *et al.* 1995). Rates of growth appear related to the availability of food, but variation in other demographic rates appears related to a variety of factors including habitat. Despite the potential for intense small scale variation, a large component of the variation in demography, and rates of growth in particular, occurs among aggregations separated by greater distances (i.e. >100 m).

Larval abalone settle to coastal reefs when they are ~0.5 mm in size. The larvae settle and metamorphose into juvenile abalone that grow rapidly reaching ~20 mm after one year (Prince *et al.* 1988). Rates of growth are variable and appear to be related to environmental conditions, such as the availability of food and exposure (Day and Fleming 1992). In good conditions, most abalone can grow to 90-100 mm (i.e. when ~50% are mature) within 4-5 years, and reach the minimum size limit of 115 mm within a further 2 years (Worthington *et al.* 1995, Worthington and Andrew 1996, 1997). Above 115 mm, average growth rates continue to slow, although some individuals can reach 200 mm and may live for >20 years (Day and Fleming 1992, Nash 1992). When environmental conditions are less favourable, rates of growth can slow and individuals may not grow above the minimum size limit. Substantial variation in growth can occur among individuals separated by very short distances (i.e. <10 m), although a large component of the variation in growth occurs among sites separated by hundreds of meters (Worthington *et al.* 1995). Variation in growth among years also appears to influence the rate of recruitment to the fishery. Rates of natural mortality also appear to be variable, although rates are generally high for smaller abalone (e.g. instantaneous rate $M > 1.0$ per year for individuals <60 mm) and appear to decline as individuals grow (e.g. $M < 0.3$, Shepherd and Breen 1992, Worthington and Andrew 1997).

Abalone are dioecious and spawn throughout their distribution during a prolonged season from early spring to autumn, with peaks in early spring and late summer. There appears to be some synchronicity to spawning, suggesting the influence of local environmental conditions. Larger abalone are generally much more fecund than smaller individuals, but

there is some evidence that smaller individuals may spawn more often and release a greater proportion of their eggs (Nash 1992, McShane 1992, Babcock and Keesing 1999). Following spawning, eggs are fertilised in the water, with rates of successful fertilisation related to several factors including the availability of sperm, which may also be related to the local density and sizes of abalone (McShane 1995, Babcock and Keesing 1999). The eggs hatch after ~24 hr to produce neutrally buoyant, swimming larvae, which appear to be able to remain within the shelter of the reef habitat where the adults spawned (McShane *et al.* 1988). Several days to a week after hatching, depending on several factors including water temperature, larvae settle to the reef and metamorphose. Coralline algae induce settlement and metamorphosis of larvae, and high densities of post-larval abalone have been observed in such habitats (McShane 1991). Dispersal of larvae away from their parents prior to settlement may be limited (Prince *et al.* 1987). The likelihood of most larvae being dispersed a short distance suggests there could be a strong relationship between the mature stock and subsequent settlement to the reef. This is confirmed by the slow recovery of areas where the mature stock has been heavily depleted. Despite that, a variety of compensatory factors (e.g. density-dependent growth or mortality, McShane 1991) may operate during the early life history of abalone to reduce any direct relationship between the adult stock and recruitment of easily observed individuals (i.e. >20 mm).

B2.3.2 Status of Exploitation

A stock assessment is applied to the Abalone Fishery each year (Section B1.6.1) to understand the status of exploitation and manage harvesting accordingly. The commercial fishery affects the population by removing a proportion of the individuals that grow above the minimum legal size (MLS) of 115 mm. The proportion of individuals at a site that will grow above the MLS and be directly affected by the fishery is related to rates of demography (e.g. settlement, growth and mortality) that can vary at a range of spatial scales. The current state-wide MLS (along with quota management and the stock assessment process) has been important to the management of commercial harvesting of abalone and protection of the majority of individuals on reefs. Although it is not clear how common individuals above 115 mm were in the population before exploitation, in most areas individuals above the MLS currently represent only a small proportion of the population (~5%) and the mature stock (~33%) (Worthington *et al.* 2001). Importantly, under the current operation of the fishery, the MLS effectively protects at least ~95% of the population, allows the majority of abalone

in populations at least two years of spawning before being harvested (see Section B2.3.1) and prevents over-fishing of mature stock by the commercial fishery.

Some individuals below the MLS are removed from the reef, handled and replaced. The proportion of these individuals that may die (i.e. estimated to be ~500 kg in 2000) or be damaged and suffer reduced growth and reproduction is minimal (Gibson *et al.* 2002). Disturbance to individuals not handled is likely to be negligible.

The proportion of individuals above the MLS that are removed each year (i.e. exploitation rate) is one of the key uncertainties of the stock assessment with estimates for different regions ranging from 30-60% (Andrew *et al.* 1997, Worthington *et al.* 2001). Several areas have been closed to the fishery, but the fishery affects that part of the population above MLS over all available coastal reef. Areas of reef with populations that do not currently appear commercially viable are used by the fishery when strong local recruitment increases the size of the population.

Depletion of the population is the result of the combined effect of fishing from two sectors (i.e. commercial and recreational), illegal catches and other factors external to the fishery (e.g. the parasite *Perkinsus*, water pollution, sea urchins; Section B2.3.3). Because of this, effects of the commercial fishery are difficult to distinguish from those caused by other factors. As the MLS restricts access by the commercial fishery, however, to only a small proportion of the population (~5%) and mature stock (~33%), the effects are relatively less than many external factors which can affect a much greater proportion, if not all, of the population (Section B2.3.3). Nevertheless, it is likely that the commercial fishery contributes to some over-fishing of the population in some areas.

There is a high likelihood that the fishery causes growth over-fishing at sites where individuals grow quickly to large sizes (e.g. much of the reef south of Wonboyn in the far south of the state). Growth over-fishing occurs when too many small abalone are taken, and therefore too few grow to a size that provides the greatest yield for the fishery. In contrast, at sites where individuals grow more slowly and few reach the MLS, growth over-fishing is very unlikely. There is also a high likelihood that the fishery has contributed, together with other factors such as mortality related to *Perkinsus* and illegal catches, to the over-depletion of mature stock at a local scale in some areas (i.e. recruitment over-fishing), although, again, the contribution of the commercial fishery relative to the external factors would be minor because of the MLS.

The depletion of mature stock at local scales has the potential for causing recruitment over-fishing of local populations, which, in turn, can lead to over-depletion of the broader population. Recruitment over-fishing occurs when fishing greatly reduces the number of mature (breeding) individuals 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. Reductions in catch in areas outside those that are already heavily depleted are unlikely to facilitate recovery of the heavily depleted areas because of the generally limited dispersal of larval abalone. Given the external influences and variation in depletion across the state, DPI describes the stock as 'fully fished' (NSW Fisheries 2001). However, sustainable increases in catch should be possible through reduction in the illegal catch and the recovery of heavily depleted populations.

Whilst there does not appear to have been any contraction of the range of abalone in NSW, changes in distribution within that range have occurred at a variety of spatial scales. Within reefs, there is anecdotal evidence of an expansion in the area inhabited and maintained free of macro-algae by sea urchins. Few abalone inhabit these areas, but there is likely to have been an associated decline in their population simply due to a reduction in the amount of optimal abalone habitat. Mortality of abalone related to *Perkinsus* (see below) may also have affected the distribution of abalone within the area from Port Stephens to Jervis Bay, although the actual extent of any change in distribution is unclear. It is difficult to determine the influence of the fishery on these contractions in the range of abalone, but again, the contribution of the commercial fishery relative to external factors would be minor because of the protection the MLS gives to the population in most areas, the exception being those few places where growth rate and maximum size are inhibited by natural processes.

In response to the decline in stocks related to *Perkinsus*, the proportion of the catch taken by the fishery from areas in the south of the state increased in 2002-3 (Section B1.5.1). During the 1980s, less than 40% of the total catch was taken south of Eden, but this increased to 40-50% of the catch during the 1990s and >50% in 2002-03. The TAC Committee (2004a) stated "Sequential depletion, at both regional and very local scales, is a strong feature of all abalone fisheries worldwide and has proved to be a very difficult process to practically manage and prevent". The six regions of the NSW fishery were originally established to each provide an equivalent proportion of the catch of the fishery, but this no longer occurs. The increasing proportion of catch in Regions 5 & 6 in 2002-3 was of concern to the TAC Committee which led to the specification of voluntary regional catch targets (Section B1.5.1). In addition to the

decline and closure of stocks in the north, the increased concentration of catch in the south may have been caused by nominated divers choosing to catch abalone there because abundance were relatively greater at the time, hence more cost effective to catch. Despite this, it is likely that the fishery, together with external factors such as *Perkinsus*, increasing numbers of sea urchins and an increasing illegal catch, have contributed to changes in the distribution of abalone. In comparison to impacts from these external factors, however, the effects of the commercial fishery are likely to be small due to the targeting of individuals above the MLS, and the cryptic behaviour of abalone (Officer *et al.* 2001), which reduces the economic viability of fishing areas with over-depleted populations.

B2.3.3 Factors External to the Fishery Affecting the Stock

A variety of factors external to the Abalone Fishery can affect on the stock. External factors can affect abalone of all sizes and devastate populations at a variety of spatial scales.

B2.3.3.1 Illegal and Recreational Harvesting

Catches of abalone by recreational divers (including Indigenous participants) and illegal harvest can affect the stock (see also Sections B1.2.3, B1.2.4 and B1.2.5). Recent estimates of a combined illegal and recreational catch suggest it could range between about 65 and 165 t of abalone per year in NSW (TAC Committee 2002, 2004a). Estimates of the illegal catch have ranged up to 340 t (Prince 1989) but the most recent estimate by Compliance Services is that it is likely to be in the 40 to 60 tonne range or about 20 to 30% of the current TACC (Section B1.2.5; DPI pers. comm.). Estimates of the recreational catch range between 5-78 t (Andrew *et al.* 1998, Worthington *et al.* 2001, Henry and Lyle 2003).

Many aspects of the biology and ecology of abalone make them very susceptible to recreational and illegal harvest. As abalone are found on shallow reefs, often in aggregations, adjacent to the shore, access is easy for shore-based divers. Although a catch limit of 10 abalone is applied to recreational divers, and the MLS of 115 mm also applies, there is no total limit to the recreational catch. The effect of illegal harvest to local populations of abalone is potentially much more devastating as there is a general disregard for the MLS and recreational catch limits by illegal operators ('poachers'). Consequently, illegal catches often contain a large proportion of abalone below the MLS, including immature individuals, and often involve intense and abrupt impacts on localised aggregations of abalone (Prince 1989). Entire aggregations of abalone are known to have

been removed, on occasion, by abalone thieves. Recolonisation of such areas is slow because most larvae disperse over short distances (See Section B2.3.1).

Some information is available about the spatial distribution of the recreational catch. The majority of the recreational catch is thought to occur south of Sydney (Andrew *et al.* 1998). In addition, since 1999 recreational divers have not been allowed to use SCUBA diving equipment and consequently would have limited access to populations in deeper waters. Little is known of the spatial distribution of illegal catches, or perhaps most importantly, how illegal catches are changing through time. The majority of thieves, however, are thought to work without SCUBA and, as for recreational divers, would mostly affect populations in very shallow water. Hence, although most abalone are found in shallow areas of reef adjacent to the shore (Section B2.3.1), some proportion of the general population of abalone in deeper water would be in 'refuge' from the effects of the majority of recreational and illegal fishing, but still subject to commercial harvesting.

B2.3.3.2 *Perkinsus* Parasite

Perkinsus is a genus of single-celled, protistan parasite that infects molluscs around the world. *Perkinsus olseni* can infect abalone and may produce abscesses in the flesh that can reduce marketability. Abscesses grow and become brown and spherical up to 8 mm in diameter and severe infections may kill abalone (Bower 2000). Infection can be detected by a simple test that involves incubation and culture of abalone gill tissue. It is believed that at death of the abalone, a life-history stage of the parasite is released from the abalone into sea-water enabling infection of the next host (Bower 2000).

Many abalone died on reefs adjacent to Sydney and the Central Coast in the late 1980s and early 1990s. It is understood that DPI first detected abalone heavily infected with *Perkinsus* in 1992. The infection and mortality spread north from Sydney to Newcastle, and south to Wollongong and Kiama by 1995. This decline was observed in surveys independent of the fishery completed by DPI (Andrew *et al.* 1996, Worthington *et al.* 1997, 1998, 1999), and several small collections of live and moribund abalone again confirmed infection by *Perkinsus*. By 2002 the infection and mortality had spread to abalone around Jervis Bay and Port Stephens, with declines in abundance of > 90% on some reefs (Worthington *et al.* 2001). It appears that infection and mortality has not extended beyond these areas since 2002.

The consequences of infection by *Perkinsus* at a local scale are similar to the effect of illegal harvesting. That is, a large proportion of populations, including abalone below the MLS (the majority of which are immature) are killed. Recolonisation of such areas is slow because of the short larval dispersal of abalone (Section B2.3.1). Further, infection by *Perkinsus* appears to have occurred over a large scale, thereby causing widespread mortality, although small pockets of healthy abalone remain within infected areas (Worthington *et al.* 2001).

Evidence from studies of oysters in the USA suggests that healthy individuals can produce an immune response that kills *Perkinsus* (Chu and Hale 1994). In contrast, individuals stressed by other factors (e.g. poor water quality, including temperature, salinity, pollution from sewerage, anti-fouling paint, etc, cannot produce a strong immune response to *Perkinsus*, and hence may die. A variety of factors may have led to increased stress on abalone in NSW and the subsequent spread of mortality, although no causal link has been found. For example, the spread of mortality associated with *Perkinsus* occurred at about the same time as the deepwater ocean outfalls off Sydney were built (Section B2.3.3.5.1). Warm water temperatures are also known to stress abalone (Friedman *et al.* 1997, Hobday and Tegner 2002). Abalone held in aquaria with appropriate water quality have been shown to be able to produce a strong immune response that can kill the parasite (Goggin and Lester 1995). Finally, it is not clear to what extent the mortality of abalone observed is caused by *Perkinsus*, or what role other factors might have (e.g. *Perkinsus* only opportunistically infecting abalone already stressed and dying from other factors). A major research project has been commissioned by Industry to investigate the likely causes of the *Perkinsus*-related mortality of abalone in NSW. The project is designed to study the histo-pathology of moribund abalone to determine the actual cause of death, the development of diagnostic tests for *Perkinsus*, and investigate methods to monitor and slow any further spread of infection.

Management responses to the mortality of abalone associated with *Perkinsus* were initially limited to a series of fishing closures along the coast from The Entrance to Kiama. These closures were interspersed with areas that remained open to fishing in an attempt to estimate the effect of closure. It is understood that after approximately five years there was little difference in the population of abalone between the open and closed areas, probably because little fishing had occurred in the open areas. In late 2002, the area closed to fishing was expanded to cover reefs from Port Stephens to Jervis Bay (Section B1.1.3.3.1).

Importantly, there is evidence that *Perkinsus* spreads only at the death of an abalone (Bower 2000) and hence is unlikely to be spread by normal operation of the fishery.

B2.3.3.3 Changes to Habitat

Changes in the coastal environment can have significant effects on abalone. There is some evidence that the area of habitat preferred by abalone may change through time (Andrew and O'Neill 2000) possibly due to changes in the area of reef inhabited by dense populations of sea urchins, known as 'barrens' (Andrew *et al.* 1998b). Sea urchins can maintain the reef free of macroalgae and few abalone inhabit these barrens areas. There are many studies that indicate abalone and sea urchins compete for food and space (e.g. Shepherd 1973, Lowry and Pearse 1973, see also Section B2.6.3) and that the decline of some species of abalone (from commercial fishing) may have led to increased abundances of sea urchins (reviewed by Jenkins 2004). As a result, a decline in the abalone population in NSW could occur concurrently with any expansion in the amount of barrens habitat created by sea urchins. Experiments with abalone of a size that is currently abundant in NSW show no evidence for such an effect (Andrew *et al.* 1998b) although this may have occurred in the past when the fishery presumably removed much larger abalone. These experiments, however, clearly demonstrated the potential enhancement to abalone populations through the removal of sea urchins (Andrew *et al.* 1998b). Large increases in the abalone populations appear possible by increasing areas of their habitat by removal of sea urchins. Sea urchins need only to be removed from very small areas of reef to gain significant improvements in the productivity and sustainability of the local abalone population (Andrew *et al.* 1998b).

B2.3.3.4 Other Environmental Influences

Other factors, such as inundation of reef by sand and natural changes in macroalgal populations (Kennelly 1987), can affect the area of habitat preferred by abalone. For example, many areas of reef in Regions 3, have been inundated with sand in recent years (TAC Committee 2004a). In some cases the mortality of abalone increased, but it is not known what proportion, if any, of affected abalone were able to emigrate from inundated reefs.

Abalone are also known to be vulnerable to increases in water temperature (Friedman *et al.* 1997, Hobday and Tegner 2002). Water temperature, and possibly pollution (B2.3.3.5.1) may

have contributed to the increased mortality of abalone and spread of *Perkinsus* in parts of NSW (Sections B1.1.3.3.1, B1.5.1, B2.3.3.2).

Natural fluctuations in large-scale environmental factors may also affect the abalone stock. Worthington *et al.* (2001) suggested that there may be a relationship between large-scale patterns of the settlement and growth of abalone and factors related to phenomena such as El Nino (i.e. less biomass becomes available to the fishery during or just after El Nino events). There is potential that such large-scale environmental changes drive the fishery by providing the necessary conditions for large cohorts to appear in the fishery and be harvested over a number of years.

B2.3.3.5 Coastal Development

There are many aspects of coastal development that are likely to have affected, or have the potential to affect populations of abalone. The effects, however, are not obvious as they are most likely to manifest over long periods of time co-incident with the time-scale of urban development. This is in contrast to the more obvious effects of disease or illegal fishing which can be seen over relatively shorter periods of time (Sections B2.3.3.1 & B2.3.3.2). The aspects of coastal development that are potentially the most harmful to abalone are described below.

B2.3.3.5.1 Sewage and Runoff

Abalone are vulnerable to pollution (Hobday *et al.* 2001). Pollution from sewage and urban runoff is a consequence of coastal development, although it can be dispersed to some extent by ocean currents. Commercially viable populations of abalone were once harvested around NSW's most urbanised areas (Central Coast, Sydney metropolitan area and Wollongong area) but populations have declined significantly in the last decade (Andrew *et al.* 1996, Worthington *et al.* 1997, 1998, 1999). Although many factors potentially affect populations of abalone around urbanised areas (e.g. there are probably more recreational divers) the declines are thought to be mainly due to *Perkinsus* (Section B2.3.3.2). It is possible that pollution-induced stress makes populations vulnerable to infections by *Perkinsus*.

B2.3.3.5.2 Aquaculture

Aquaculture of abalone and other species have the potential to have adverse effects on wild populations of abalone. For example, escape from on-shore facilities of larval abalone or

disease, or the spread of invasive species, could affect abalone. Presently, there are no commercial hatcheries or grow-out facilities for abalone, although an experimental hatchery with land-based grow-out facilities was operating at Port Stephens in recent years and a larger commercial facility is planned for the area.

There are a number of risks associated with abalone aquaculture facilities. Abalone can be produced in hatcheries in vast numbers, and individuals may have little genetic diversity (depending on the amount of broodstock used to produce batches of larvae and the intended use of the juvenile abalone). Presumably, land-based commercial aquaculture operations for abalone would be situated on the coast and release water into the ocean. The accidental release of vast numbers of larvae with low genetic diversity, or with a different genetic composition to local, wild populations, could affect those wild populations. Similarly, the accidental release of disease from aquaculture facilities (through outlet water or accidentally released infected larvae) could have devastating effects. In addition, aquaculture businesses could choose either alien or hybrid species, which could pose a greater risk should they be released into the wild.

Mussels can affect wild populations of abalone by settling in large numbers on reefs, which may result in crevices (used by abalone for shelter) being filled and significantly reduced cover of algae (which abalone eat). The establishment of a mussel farm in recent years in Twofold Bay has co-incided with colonisation by mussels of nearby reefs between Merimbula and Green Cape (ABMAC pers. comm.). There is debate as to whether mussels on the farm have contributed to the settlement on nearby reefs. At this stage, the link between the farm and colonisation of natural habitat cannot be proven because no monitoring has been done.

Regional Development Strategies for aquaculture have been developed in some parts of NSW but none have been developed for the NSW south coast as yet. The plan for the south coast should consider the potential sensitivity of the Abalone Fishery to impacts occurring from aquaculture.

B2.3.3.5.3 Urban and Residential Infrastructure

Subtidal areas are occasionally reclaimed to facilitate the construction of breakwalls, wharves, roads and other structures. This has the potential to affect populations of abalone when subtidal reef is removed or covered to make way for such structures. Although

reclamation of subtidal reef is usually on a small scale, the cumulative effect to abalone of many small reclamations are likely to be significant over time. It is noteworthy that shareholders were compensated when sanctuary zones (which contained abalone fishing grounds) were created for the Jervis Bay Marine Park (Section B1.1.3.3.2).

B2.3.3.5.4 Other Introduced Species

Introduced species have potential to affect populations of abalone by invading reef habitat and displacing abalone or their food. Introduced species can become established in NSW if ballast water from ships containing the larvae of alien species is released. Presently, there are no introduced species in NSW with potential to threaten abalone but there is some risk of this occurring in the future.

B2.3.4 Risk Assessment for the Current Operation of the Abalone Fishery on the Target Species

The guidelines provided by the National ESD reporting framework for Australian fisheries were used to assess the risk from the operation of the fishery to components of the target species (Fletcher *et al.* 2002). A large amount of literature is available about the biology and fisheries for abalone. This, combined with the flexibility of the Fletcher *et al.* (2002) model, allows the levels of risk from harvesting to be confidently assigned to different sub-components of the target species. Risks are considered at the level of detail of the distribution, abundance, population structure and non-retained individuals of the target species (Table B2.3). The assigned levels of 'consequence' and 'likelihood' of consequence arising from existing operations to sub-components are taken from Tables A1 and 3 respectively in Appendix B5. The reporting framework recommends the risk assessment should be scaled to the size of the reproductive unit stock. As most reproductive exchange is limited, the risk is assessed, in most cases, at both a generic local scale and a fishery-wide, general scale. As described in previous sections, there are also substantial risks to the target species from factors external to the fishery. While the assessment presented here considers the risk from the operation of the fishery to the target species in the context of external factors, it does not provide an assessment of the risk from the external factors. As a result, risk to the target species from the combination of the fishery and external factors is likely to be greater than those described here.

The current MLS prevents access from the commercial fishery, on average, to two-thirds of the mature stock (Section B2.3.2). Variation in demography at smaller (local) scales indicates access by the commercial fishery to mature stock could be greater, and in some cases less, than one-third of the mature stock in many areas (Section B2.3.2). It is unknown, however, what proportion of individuals within populations do not grow above the MLS or indeed, what proportion of the total abalone fishing grounds contain populations of abalone that do not grow above the MLS. Regardless, the fishery has the potential to have an impact on the local and general abundance of mature abalone so that the capacity of the population to increase is affected (i.e. the worst case consequence). Hence, using the Fletcher *et al.* (2002) model, removal by the commercial fishery, of potentially a large amount of mature stock would have 'severe' consequences (i.e. affect recruitment levels of populations/or their capacity to increase; Table A1 in Appendix B5) to local aggregations and to the general population (Table B2.3) because of the limited capability of abalone to recolonise areas if parent stock are not close by (Section B2.3.1). As variation in demography would make only some local populations susceptible, the likelihood of impacts to mature stock would be 'occasional' (i.e. it may occur; Table 3 in Appendix B5) at local scales (Table B2.3). As such, the overall risk to mature stock at local scales would be 'high'. As demography in the general population varies, the likelihood of the general abundance of mature stock being affected is 'unlikely' (i.e. uncommon, but known to occur elsewhere; Table 3 in Appendix B5), making the overall risk 'moderate' (Table B2.3).

Existing management to mitigate risk from the commercial fishery to the abundance of mature stock relies on several factors: the MLS; the TACC; and voluntary regional catch targets. The TAC Committee employs a rigorous process to review the stock assessment of abalone (Section B1.6.1) and by taking into account the 'precautionary principle' it provides an important safeguard against the risk of overfishing from the commercial sector. It is noteworthy, however, that despite using the most up to date information there is still a delay of about 6 months between when the data is collected and when a determination is applied.

Undesirable concentrations of fishing effort could exacerbate the risk to mature stock at regional scales. Arrangements for voluntary regional catch targets recommended by the TAC Committee and monitoring of the spatial distribution of catch seek to reduce the risk of overfishing at regional scales. The arrangement has a number of advantages in terms of safeguarding against overfishing at a regional scale. Some flexibility in regional catch allows

divers to catch their quota in other regions if environmental conditions within a fishing period reduce the availability of abalone for commercial harvest in a particular region (e.g. as occurred in 2003 when Region 3 was inundated by sand (TAC Committee 2004a). This flexibility in regional catch targets could also safeguard against potential imprecision in the process of determining an appropriate catch at such a small-scale. In recent years the TACC has not been caught (Table B1.12) and since the strategy for controlling regional catch has been implemented the agreed regional targets have rarely been breached. However, it should be noted that despite the TACC not being caught in the 18 month fishing period from January 2002 to June 2003 the catch for Regions 5 and 6 exceeded the recommended regional catch target by slightly more than 10%. Hence, the current regional strategy has a risk associated with it of exceeding regional targets, particularly if catches above the regional targets occur in a specific region(s) over a series of years. This is exacerbated by the recent trend of divers apparently preferring to work in Regions 5 and 6. In 2002 and 2003, Regions 5 and 6 accounted for 57% and 50% of the total catch for the fishery.

In making its determination, the Committee is limited in its ability to safeguard against adverse effects of the environment or the effects of harvesting at scales smaller than the scales to which recommendation of catch are applied (i.e. at the scale of regions). At local scales existing management relies on the MLS, the cryptic behaviour of abalone and reduced economic viability of fishing low densities. Further, an overall high risk to mature stock at local scales has the potential to affect the general population through the serial depletion of stocks and, hence affect the distribution and size-structure of stock.

Harvesting poses a risk to the distribution of abalone at all scales. Although the consequence of a change to distribution would be 'moderate' as long-term recruitment and dynamics would not be adversely affected as generally a large proportion of the mature biomass is protected by the MLS (Section B2.3.2), the likelihood of the consequence is 'possible' (i.e. there is some evidence for this, particularly at local scales). Hence the overall risk would be 'moderate' (Table B2.3).

There is a risk that harvesting could affect the population structure of abalone at all scales. As abalone are broadcast spawners there would only be, at worst, a 'minor' consequence to sex-structure (i.e. possibly detectable but minimum impact on population size and none on dynamics; Table A1 in Appendix B5). In addition, there is no evidence that there are differences in growth rates between male and female abalone. Hence, the likelihood of

harvesting affecting sex-structure is 'remote' as both sexes would be equally vulnerable to harvesting at sizes > MLS. Therefore, the overall risk to sex-structure would be 'low' (Table B2.3).

In terms of size-structure, an adverse consequence from harvesting could potentially occur is that removal of all abalone > MLS could cause growth overfishing. Growth overfishing would have a 'severe' consequence (i.e. affecting the capacity of populations to increase; Table A1 in Appendix B5) at all scales. The likelihood of this occurring at general scales would be 'unlikely' (i.e. uncommon, but known to occur elsewhere; Table A3 in Appendix B5) because the TACC and MLS are set to protect an appropriate proportion of legal biomass in the general population. Hence, the overall risk at general scales would be 'low'. The likelihood at local scales would be 'possible' (i.e. some evidence to suggest this is possible here; Table A3 in Appendix B5). Hence, the overall risk at local scales would be 'moderate'.

The fishery has potential to impact on non-retained abalone as some discarded abalone may die (Gibson *et al.* 2002). In 1999, Gibson *et al.* (2002) estimated that 500 kg of discarded abalone in NSW would have died from wounds suffered as a result of being checked by divers. It was suggested that such mortality had a relatively minor impact at the time on the productivity of the total population. Gibson *et al.* (2002) also discussed the potential for discarding to cause substantial mortality to undersized (non-retained) abalone in particular areas. He argues that this would be related to the experience of divers and small-scale variation in the demography of abalone. Some populations of abalone are dominated by individuals close to the MLS (Andrew *et al.* 1997) while at other places, limitations to growth cause few, if any, individuals from ever reaching the MLS (Worthington *et al.* 1995). As such, discarding in both of these types of areas would be great. Gibson *et al.* (2002) suggested that experienced divers would avoid such places but inexperienced divers may work in such places at times. Gibson *et al.* (2002) found inexperienced divers to discard more abalone, on average, than experienced divers.

Since the Gibson research, the dynamics of the fishery have changed. There are now more nominated divers in the fishery. Although not all of these would be inexperienced as many nominated divers have been working for more than five years. Catch rates in general have declined in recent years and all divers (experienced and inexperienced) may have been forced to work in areas where discarding rates may be high. Although catch rates have been reduced in recent years (Section B1.5.1), there has been fewer abalone of all sizes (less than

and greater than the MLS) on reefs (DPI 2005) and the TACC has been reduced accordingly (Section B1.5.1). Hence, although divers may have required more time to catch a given quantity of abalone in recent years than they did when more abalone were on reefs, the rate of discarding may be less (although there is no evidence to support this). If this were the case, however, decreases to the limit of catch in recent times may have compensated for potentially increased discarding.

Because of a lack of evidence it is precautionary to assume that in the worst case, discarding may be at a level at some places that may cause significant mortality to populations. At the worst case this would have a 'severe' consequence to populations at general and local scales as significant mortality may affect the capacity of populations to increase. The likelihood of discarding having this consequence at general scales would be 'rare', as discarding is unlikely to be at dangerous levels over the whole area of the fishery. Therefore, the overall risk at general scales would be 'low' (Table B2.3). The worst case likelihood of discarding having this consequence at local scales would be 'possible'. This would give a 'moderate' risk overall (Table B2.3).

Table B2.3. Summary of the risk from the operation of the Abalone Fishery on key sub-components of the target species. Definition of the terms in the table can be found in Fletcher *et al.* (2002) – Appendix B5.

Issue	Spatial scale	Consequence of activity	Likelihood of activity	Overall risk
Distribution of stock	All	Moderate	Possible	Moderate
Abundance of mature stock	Local	Severe	Occasional	High
	General	Severe	Unlikely	Moderate
Population structure				
Size-structure	Local	Severe	Possible	Moderate
	General	Severe	Unlikely	Low
Sex-structure	All	Minor	Remote	Low
Non-retained	Local	Severe	Possible	Moderate
	General	Severe	Rare	Low

According to the risk assessment methodology used by Fletcher *et al.* (2002), the assessment of risk presented in Table B2.3 suggests that specific management responses are needed to

address the 'moderate' risk of the fishery on the distribution, general abundance, size-structure and non-retained individuals (discards) of the target species. Presently, management needs are addressed adequately for all of these components except non-retained individuals through arrangements for a minimum legal size, TACC and regional catch targets. The draft FMS will need to address the risk to discards at local scales. Further, the 'high' risk to the local abundance of mature abalone suggests that possible increases to management activities are needed. No specific management responses are required for managing impacts of the fishery on the sex-structure or non-retained individuals of the target species at the general scale, or size-structure of individuals at the general scale.

B2.4 Risk Analysis for the Current Operation of the Abalone Fishery on Byproduct and Bycatch Species

There is no byproduct in the Abalone Fishery as no commercial species other than abalone are allowed to be retained in commercial catches. As such, no risk assessment is required.

In assessing the risk of commercial harvesting of abalone on bycatch, the consequence categories used were those described in the 'How to' guide in Table A2 of Appendix B5. In making the assessment, four conditions were considered, based on the 'likelihood' of abalone (hence bycatch) being disturbed:

1. Abalone that are obviously below the MLS. These abalone will not be disturbed and neither will biota associated with them;
2. Abalone just below the MLS. These individuals will either be measured by the diver and placed back on the reef (hence with minimal disturbance to associated biota) or removed from the water, measured by the deckhand and then returned to the reef. Impacts to both the abalone and associated biota may occur in this situation but legal requirements indicate that the abalone would be disturbed as little as possible. ;
3. Abalone above the MLS which are not found by the diver and hence are not disturbed. Bycatch issues are not relevant here; and
4. Abalone above the MLS that are harvested. In this case, biota associated with abalone would be removed from the reef environment.

In considering this 4th condition, it is known that many biota associated with abalone (Shepherd and Breen 1992) simply use the shell as part of the reef habitat and can survive elsewhere on the reef (e.g. on rocks, shells of other molluscs, etc). These are known as

'generalists' and the consequence of harvesting abalone with these species upon them would be 'minor' (i.e. the take and area of capture is small (< 20%), compared to the known area of distribution) (Table B2.4). On the other hand, there are some species that are considered 'obligate' on abalone, that is, abalone form an important part of their habitat (e.g. Thomas and Day 1995). For these species, many would occur on the large proportion (~95%) of the stock below the MLS and hence not available for commercial harvest. There is also a possibility that larger abalone support different types of 'bycatch' compared to smaller abalone. The consequence of taking these species at all scales was considered to be 'moderate' (i.e. the relative areas of the distribution of these species, or susceptibility of capture, is suspected to be < 50%) (Table B2.4). The likelihood of harvesting affecting generalist and obligate species upon abalone is 'rare' (i.e. may occur in exceptional circumstance), except at local scales for obligate species. In this case it is 'possible', as although there is no evidence of this in NSW, there is some evidence in other states of obligate species living on abalone (Thomas and Day 1995). The overall risk of removal of abalone in that situation would be 'moderate' (Table B2.4

Table B2.4. Summary of the risk from the operation of the fishery on bycatch. Definition of the terms in the table can be found in Fletcher et al. (2002).

Issue	Spatial scale	Consequence of activity	Likelihood of activity	Overall risk
Generalist species	All	Minor	Rare	Low
Obligate species	Local	Moderate	Possible	Moderate
	General	Moderate	Rare	Low

B2.5 Risk from the Current Operation of the Abalone Fishery on Threatened and Protected Species

For this assessment, 'threatened or protected species' refers to any species, populations or ecological communities listed under Schedules 4 or 5 of the *Fisheries Management Act 1994*, Schedules 1 or 2 of the *Threatened Species Conservation Act 1995* or Part 2 Division 1 Subdivisions C or D, Part 13 Division 4 Subdivisions A and cetaceans referred to in Part 13 Division 3 of the *Environment Protection and Biodiversity Act 1999*. This assessment also includes any species of fish listed under Sections 19 (totally protected – not to be taken) or 20 (not to be taken by commercial fishers) of the *Fisheries Management Act 1994*.

B2.5.1 NSW Legislation

The *Threatened Species Conservation Act 1995* (TSC Act) provides for the protection of all threatened plants and animals native to New South Wales (with the exception of fish and marine plants). This Act amended the *National Parks and Wildlife Act 1974* and *Environmental Planning and Assessment Act 1979* (EP& A Act) and integrates the consideration of threatened species into the planning process. The *Fisheries Management Act 1994* (FM Act) was amended in 1997 to incorporate provisions to protect threatened marine and freshwater species. The FM Act also provides protection for marine and estuarine habitats including seagrasses, mangroves, and seaweeds, all of which occur in NSW. All mangroves and seagrasses and most seaweeds are protected from harvesting and damage.

Both the TSC Act and the FM Act contain lists of species, populations and ecological communities which have been classified as threatened in NSW. The Acts also list key threatening processes. In addition to the Threatened Species Schedules, Part 2(19) of the FM Act allows for the declaration of 'protected species'. There are 6 marine species that are totally protected in NSW waters as well as all sygnathiformes (i.e. seahorses, seadragons, pipehorses, pipefish, ghostpipefish and seamoths).

A Section 5A assessment under the EP & A Act must be applied to threatened species, populations and ecological communities listed under the TSA Act or the FM Act to determine whether the Abalone Fishery is likely to have a significant impact on them or their habitat. If the fishery is found to have a significant impact, a Species Impact Statement must be prepared and exhibited. The impact of the Abalone Fishery on species listed as 'protected' under the FM Act is considered, although no formal assessment is required under the EP & A Act.

B2.5.2 Commonwealth Legislation

The Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) commenced in July 2000 and is administered by Environment Australia. The EPBC Act applies to matters of National Environmental Significance including:

- World Heritage Properties;
- RAMSAR wetlands of international significance;
- Nationally threatened species and ecological communities and threatening processes;

- Migratory species protected under international treaties;
- Commonwealth marine areas, and
- Nuclear actions (including uranium mining).

Of the matters described above only the matters of 'nationally threatened species and ecological communities and threatening processes' and 'Migratory species protected under international treaties' are relevant to the Abalone Fishery. If a Proponent believes that a proposal may have a significant effect on any matter of National Environmental Significance, a referral must be made to Environment Australia. Environment Australia is responsible for assessing the referral, determining whether further assessment is required under the *EPBC Act* and granting or refusing an approval on matters of National Environmental Significance.

In addition, there are penalties for any harm caused to other listed marine species (i.e. those species listed under Part 13 Division 4 Subdivisions A of the *EPBC Act*) and cetaceans. For listed species, however, this applies only to 'Commonwealth waters' (i.e. waters outside of the state's three mile limit and in a small part of Jervis Bay). Cetaceans are protected in Commonwealth marine areas under the *EPBC Act* and in NSW State waters under the *National Parks and Wildlife Act*.

B2.5.3 Sources of Risk from the Abalone Fishery to Threatened and Protected Species

Compared to other fishing methods (e.g. trawling, netting and line fishing) the ecosystem effects of dive fisheries (such as the Abalone Fishery) are intuitively relatively benign (Jenkins 2004). Given that the method used to collect target species is by hand, very selective, and there is virtually no bycatch in the Abalone Fishery, there is likely to be little adverse interaction between the fishery and threatened or protected species, or threatened ecological communities. The potential sources of risk to threatened or protected species are limited to the possibilities that:

- divers may disturb threatened or protected species inhabiting areas where abalone are harvested;
- that the harvesting of abalone may reduce a potential source of food for some threatened or protected species;

- that all boats used in the fishery are a potential vector for dispersing marine pests that have the potential to jeopardise the ecology of threatened and protected species in NSW waters; and
- that vessels used by divers in the Abalone Fishery may disturb or injure threatened or protected species during transit between port and fishing grounds or during harvesting operations.

Disturbance to the seabed by divers is minimal. Abalone boats rarely anchor (Section B1.1.2) hence physical damage to the habitat of threatened and protected species is most unlikely. The fishery does not use bait so the introduction of pests or diseases from bait cannot occur. There is no indication from diver reports or DPI of any significant interactions of vessels and divers with protected or threatened species, apart from sightings of some species during transit between port and fishing grounds and while divers are harvesting. However, no known strikes between abalone boats and threatened or protected species have been recorded to date.

B2.5.4 Threatened and Protected Species of Relevance to the Abalone Fishery

A search of the Fishfiles Pilot database held by DPI was done to determine which threatened and protected species listed under the *Fisheries Management Act (FM Act) 1994* have been recorded in coastal habitats of NSW. A search of the Atlas of NSW Wildlife database maintained by DEC for scheduled species in coastal habitats of NSW listed under the *Threatened Species Conservation Act 1995 (TSC Act 1995)*. A further search of the Australian Museum online fish database was made to get more information about the occurrence of threatened and protected species recorded within the area of operation of the Abalone Fishery. A search was also made for threatened and protected species with relevance to the proposal, listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*.

Threatened and protected species scheduled in the *TSC Act*, *EPBC Act* or the *FM Act* and a threatened population are shown in Table B2.5.

Table B2.5. List of scheduled marine species and populations listed under the *Fisheries Management (FM) Act*, *Threatened Species Conservation (TSC) Act* and the *Environment Protection and Biodiversity Conservation (EPBC) Act* where species or species habitat may occur within the area of operation of the NSW Abalone Fishery. CE = critically endangered, E = endangered, V = vulnerable. M = migratory, L = listed, P = protected and Cet = cetacean. Relevance to the Abalone Fishery is indicated by High, Mod (Moderate) or Low and NEG = negligible relevance and not considered further.

Scheduled Species:	Common name	Ecosystem	Status under TSC/FM Act	Status under EPBC Act	Relevance to the Abalone Fishery
Marine Reptiles					
<i>Caretta caretta</i>	Loggerhead turtle	Marine	E	E, M	Low
<i>Chelonia mydas</i>	Green turtle	Marine and bays	V	V, M	Low
<i>Dermochelys coriacea</i>	Leathery turtle	Marine and bays	V	V, M	Low
	Sea snakes	Marine and bays		L (3 spp.)	NEG
Marine Mammals					
<i>Balaenoptera musculus</i>	Blue whale	Marine	E	E, M	Low
<i>Eubalaena australis</i>	Southern right whale	Marine	V	E, M	Low
<i>Megaptera novaeangliae</i>	Humpback whale	Marine	V	V, M	Low
<i>Physeter catadon</i>	Sperm whale	Marine	V	M	Low
<i>Dugong dugon</i>	Dugong	Marine, bays and estuaries	E	M	Low
	Other migratory marine mammals	Marine		M (5 spp.)	NEG
	Other cetaceans	Marine		Cet (29 spp.)	NEG
<i>Arctocephalus pusillus doriferus</i>	Australian fur-seal	Marine	V	L	Low

<i>Arctocephalus forsteri</i>	New Zealand fur-seal	Marine	V		Low
Fish					
East coast population of <i>Carcharias taurus</i>	Grey nurse shark	Marine and bays	E	CE	Mod
<i>Carcharodon carcharias</i>	Great white shark	Marine, bays and estuaries	V	V	Low
<i>Rhincodon typus</i>	Whale shark	Marine, bays and estuaries	V	V	Low
<i>Pristis zijsron</i>	Green sawfish	Marine, bays and estuaries	V		Low
<i>Epinephelus daemeli</i>	Black cod	Marine, bays and estuaries	V		Low
<i>Epinephelus lanceolatus</i>	Giant Queensland grouper	Marine, bays and estuaries	P		Low
<i>Epinephelus coioides</i>	Estuary cod	Marine, bays and estuaries	P		Low
<i>Anampses elegans</i>	Elegant wrasse	Marine, bays and estuaries	P		Low
<i>Paraplesiops bleekeri</i>	Eastern blue devil	Marine and bays	P		Low
<i>Chaetodontoplus ballinae</i>	Ballina angelfish	Marine, bays and estuaries	P		Low
<i>Achoerodus viridis</i>	Blue groper	Marine, bays and estuaries	P		Low
<i>Makaira mazara</i>	Black marlin	Marine	P		NEG
<i>Makaira indica</i>	Blue marlin	Marine	P		NEG
<i>Tetrapturus audax</i>	Striped marlin	Marine	P		NEG
	All seadragons, pipehorses, pipefish, ghostpipefish and seamoths	Marine, bays and estuaries	P	L	Low

Birds

Manly Pt. pop. of <i>Eudyptula</i> at Manly	Little Penguin	Marine and bays	E		NEG
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	Marine, bays and estuaries	V		Low
	Other sea birds (predominantly oceanic)	Marine	E (3 spp.) V (9 spp.)	E (2 spp.), E&M (4 spp.), V (2 spp.), V&M (14 spp.), M (1 sp.) L (3 spp.)	NEG

There are no threatened ecological communities within the area of operation of the Abalone Fishery. The habitat of each listed species and the potential for interactions with commercial operations of the Abalone Fishery were considered in determining the relevance to the fishery. On preliminary assessment, a number of scheduled marine fish, birds, reptiles and mammals do not require further assessment because of the very small probability of their interacting with the Abalone Fishery (i.e. relevance is 'negligible'). Justifications of the relevance of species to the Abalone Fishery are given below. Species of relevance to the Abalone Fishery are considered further in Section B2.5.5.

Marine Reptiles

Three species of scheduled marine turtle have potential to interact with the Abalone Fishery (Table B2.5). These species are likely to occur in NSW coastal waters in warmer months and require consideration. Marine reptiles listed as vulnerable under the *TSC Act* are the green turtle, *Chelonia mydas* and the leathery turtle, *Dermochelys coriacea*. The loggerhead turtle, *Caretta caretta*, is considered endangered under the *EPBC Act*. In addition, sea-snakes are listed under the *EPBC Act* (Section B2.5.2). These species occur occasionally in NSW coastal waters in warmer months but as the Act applies to Commonwealth waters only, they are not considered further as the fishery operates close to the coast in State waters (Section B1.1.2 & B1.1.3).

Scheduled Marine Mammals and Other Cetaceans

There are many species of scheduled marine mammals which may potentially interact with the Abalone Fishery (Table B2.5). Many are not considered further as they are rarely occur in NSW waters or are found mostly further out to sea than where Abalone harvesting occurs (Section B1.1.2 & B1.1.3). Cetaceans that are known to come close to the coast at times are considered relevant to the Abalone Fishery (Table B2.5).

There are no breeding colonies of seals in NSW but the New Zealand fur-seal, *Arctocephalus forsteri* and Australian fur-seal, *Arctocephalus pusillus*, are common in some remote areas of the coast (e.g. Green Cape) and Montague Island and need to be considered as these are areas where abalone divers operate.

Fish

Of the species of fish listed under the *FM* or *EPBC Acts* potentially relevant to the Abalone Fishery (Table B2.5) the grey nurse shark (*Carcharias taurus*) is considered to be the most relevant as there are many known aggregations of this species within the area of operation of the fishery that are likely to be encountered by divers. Other threatened species are also likely to be encountered by divers, particularly the great white shark and black cod, and there is potential for abalone boats to occasionally encounter whale sharks (*Rhincodon typus*) and for divers to encounter green sawfish (*Pristis zijsron*).

Some species of marine fishes protected under the *FM Act* have potential to interact with the fishery (Table B2.5). Of these, the blue marlin (*Makaira indica*), black marlin (*Makaira mazara*) and striped marlin (*Tetrapturus audax*) are not considered further as they are fast swimming, pelagic species that are unlikely to be encountered. The other protected species listed in Table B2.5 can be found in habitats where abalone divers work and need to be considered.

Marine Birds

There are many sea-birds listed under the *TSC Act* and *EPBC Act*. Many of these species (including a number of albatrosses, petrels and the streaked shearwater) are found mostly in offshore areas and as such are not likely to interact with the Abalone Fishery, which operates very close to the coast (Section B1.1.2 & B1.1.3). These birds were therefore not considered for further assessment (Table B2.5). Some sea birds, however, require consideration as they are associated with coastal habitats. The sooty oystercatcher (*Haematopus fuliginosus*) feeds

exclusively on rock platforms and as such is likely to interact with the Abalone Fishery. There is also an endangered population of little penguins, *Eudyptula minor*, at Manly Point. Although individuals in this population range along the coast around Sydney it is not considered relevant because it occurs in an area currently closed to abalone diving. If this area were to reopen to abalone divers the disturbance by divers is considered to be negligible compared to the current disturbance levels from shipping, transport and recreational activities in the area.

B2.5.5 Threatened Species Assessments under the EP&A and EPBC Acts

An assessment under Section 5A of the *EPBC Act* has been undertaken for each threatened species potentially affected by the Abalone Fishery. The Section 5A assessment answers a series of questions in what is termed the '8-part test' (see below) to assist in determining whether a planned action will significantly affect threatened species, populations, ecological communities or their habitats, whether any mitigation measures or Species Impacts Statements (SISs) are required and if the activity requires the concurrence of the Director of the Department of Primary Industries. As has been the case for other fisheries in NSW, which have already been through an assessment process, the 8-part test was also used to determine whether the Abalone Fishery has a significant effect on 'nationally threatened species'.

B2.5.5.1 The Eight-Part Test

A summary of the eight-part test for threatened species is provided below. Here, the eight-part test is used to assess the likely outcome of the Abalone Fishery under current operations³.

The eight-part test considers the following factors:

- a) *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;*
- b) *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;*
- c) *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;*

³ Changes to the eight-part test will come into effect in 2005. These changes, however, are understood to be minimal and would not effect conclusions drawn from the eight-part tests used as part of the Abalone EIS.

- d) *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;*
- e) *Whether a critical habitat would be affected;*
- f) *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;*
- g) *Whether the action proposed is of a class of action that is recognised as a threatening process; and,*
- h) *Whether any threatened species or ecological community is at the limit of its known distribution.*

B2.5.5.2 Assessments Under the Eight-Part Test

Nine species of marine mammal (blue whale, southern right whale, humpback whale, sperm whale, dugong, Australian fur seal, New Zealand fur seal, Indo-Pacific humpback dolphin and the long-snouted spinner dolphin), three species of cartilaginous fishes (grey nurse shark, great white shark and whale shark), two species of fish (green sawfish and black cod) and three species of marine reptile (loggerhead turtle, green turtle and leathery turtle) and one sea bird (sooty oyster catcher) in the endangered or vulnerable species schedules of the *TSC Act*, *EPBC Act* or the *FM Act* were identified for assessment (Section B2.5.4). A summary of the eight-part tests for species are presented Table B2.6 and the full eight-part test for each species can be found in Appendix B6.

In each case, the eight-part test determined that it is highly unlikely that the current operation of the Abalone Fishery would affect species and, as such, no Species Impact Statement or referrals to the Federal Minister of the Environment are recommended nor any special management measures. Notwithstanding this, as abalone divers are known to interact with some threatened species occasionally (i.e. grey nurse sharks and Australian and New Zealand fur seals), the draft FMS could be used to further safeguard against potential incidents occurring (for example, by including provisions to ensure compliance of the Abalone Fishery with Recovery Plans for threatened species that are known to occur in areas where abalone are collected).

Table B2.6. Summary of eight-part tests for the impacts of the Abalone Fishery on threatened species listed under the *FM Act*, *TSC Act* and/or *EPBC Act*. Complete eight-part tests can be found in Appendix B6. 'no' indicates the impact of the Abalone Fishery was not significant. 'n/a' indicates the particular factor is not applicable to the species.

Species name and scheduled category	Common name	Act	Factors considered in the eight-part test							
			a	b	c	d	e	f	g	h
Endangered species: Marine reptiles										
<i>Caretta caretta</i>	Loggerhead turtle	<i>EPBC/TSC</i>	no	n/a	no	no	n/a	no	no	no
Marine mammals										
<i>Balaenoptera musculus</i>	Blue whale	<i>EPBC/TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Eubalena australis</i>	Southern right whale	<i>EPBC</i>	no	n/a	no	no	n/a	no	no	no
<i>Dugong dugon</i>	Dugong	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
Fish										
<i>Carcharias taurus</i>	Grey nurse shark	<i>EPBC</i>	no	n/a	no	no	no ⁴	no	no	no
Vulnerable species: Marine reptiles										
<i>Chelonia mydas</i>	Green turtle	<i>EPBC/TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Dermochelys coriacea</i>	Leathery turtle	<i>EPBC/TSC</i>	no	n/a	no	no	n/a	no	no	no
Marine mammals										
<i>Arctocephalus pusillus doriferus</i>	Australian fur-seal	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Arctocephalus forsteri</i>	New Zealand fur-seal	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Megaptera novaeangliae</i>	Humpback whale	<i>EPBC/TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Physeter catadon</i>	Sperm whale	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Sousa chinensis</i>	Indo-Pacific hump-backed dolphin	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
<i>Stenella longirostris</i>	Long-snouted spinner dolphin	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
Birds										
<i>Haematopus fuliginosus</i>	Sooty oystercatcher	<i>TSC</i>	no	n/a	no	no	n/a	no	no	no
Fish										
<i>Carcharodon carcharias</i>	Great white shark	<i>EPBC</i>	no	n/a	no	no	n/a	no	no	no
<i>Rhincodon typus</i>	Whale shark	<i>EPBC</i>	no	n/a	no	no	n/a	no	no	no
<i>Pristis zijsron</i>	Green sawfish	<i>FM</i>	no	n/a	no	no	n/a	no	no	no
<i>Epinephelus daemeli</i>	Black cod	<i>FM</i>	no	n/a	no	no	n/a	no	no	no

⁴ Harvesting abalone is permitted in many of the designated critical habitats for grey nurse shark. Abalone diving, however, has very little potential to significantly alter the critical habitat of grey nurse sharks as hand-gathering of abalone has very little effect on other biota or the environment.

B2.5.6 Summary of Risk from the Current Operation of the Abalone Fishery on Threatened and Protected Species

B2.5.6.1 Threatened Species

It is considered that all threatened species of relevance to the Abalone Fishery (Table B2.5) are at low risk from current operations. The risk of the Abalone Fishery impeding the conservation and recovery of threatened marine mammals and reptiles, seabirds and fish is considered low. This is based on the fact that:

- abalone are the only species harvested and there is no byproduct and virtually no bycatch (Section B2.4);
- none of the relevant threatened species rely on abalone for food (Section B2.6.2);
- divers are unlikely to damage or disturb near-shore reef habitats (Section B2.6.4); and
- abalone boats can easily avoid collision with large marine animals (Section B1.1.2).

Detailed information supporting this assessment can also be found associated with eight-part tests in Appendix B6.

B2.5.6.2 Protected Species

The protected status reflects more a susceptibility of these species to capture (for food, sport or display in aquariums) rather than known susceptibility to other types of disturbance or known rarity. Although divers may interact regularly with some of the protected species relevant to the fishery (Table B2.5) by collecting abalone in areas where protected species live, protected species are unlikely to be harmed as they are not collected and their habitat is not likely to be damaged (Section B2.6.4). In addition, none of the threatened or protected species listed in Table B2.6 depend on abalone for food.

B2.5.7 Existing Mitigation Measures

A vital part of conserving biological diversity in the marine environment is managing impacts on threatened and protected species, populations and ecological communities. While there are no firm data, it is thought that the impact of the Abalone Fishery on threatened species is small. As such no measures are in place specific to abalone divers for mitigating against potential impacts on threatened and protected species.

A number of regulations exist in NSW that are generally applied to commercial and recreational divers, boat operators and divers to mitigate against potential impacts on threatened and protected species. Marine reserves restrict commercial fishing operations in recognised sensitive areas (Section B1.1.3.3.2), which may contain threatened and protected species. There are also ten areas in NSW that have been identified as critical habitat for grey nurse sharks, although abalone diving is permitted. General diving rules within critical habitat for grey nurse sharks apply to abalone divers.

Abalone fishing operations are required to remain clear of cetaceans according to general regulations for vessels and divers. Following the recommendations of the Frost Inquiry into Whales and Whaling in 1978, the Australian Parliament passed the *Whale Protection Act 1980*. This Act provided for the preservation, conservation and protection of all cetaceans in Commonwealth waters (3- 200 nautical miles from the coast). Complementary legislation in Australian States and Territories protects all cetaceans in coastal waters (less than 3 nautical miles from the coast). The provisions of the *Whale Protection Act 1980* were strengthened by the *EPBC Act 1999*, which came into effect on July 16 2000. The Act designates all Australian waters as the Australian Whale Sanctuary. The Act also provides for the addition of coastal waters to the Sanctuary if a State or Territory agrees. As with the *Whale Protection Act 1980*, the *EPBC Act* prohibits Australian citizens from killing, capturing and interfering with cetaceans anywhere in the world.

The Australian National Guidelines recommend that vessels operate a caution zone of 300 m around whales and 150 m around dolphins. An intentional approach in a vessel should not occur within 100m of whales and 50 m of dolphins. If in the water a swimmer, snorkeller or diver should not approach a cetacean closer than 30 m. If marine mammals approach closer than the recommended distances or a vessel is operating in a restricted bay, strait, or passage, a vessel should steer a steady, safe course and speed, and avoid sudden changes in engine speed, direction or the use of bow thrusters.

Consideration around marine birds is also to be taken into account, by avoiding scaring the nesting birds off by yelling or horn blowing.

B2.6 Risk Analysis for the Current Operation of the Abalone Fishery on Other Species, Assemblages and Habitat

The Abalone Fishery may affect a variety of other species, assemblages and habitat. Few of the effects occur directly (Section B2.2), as abalone harvesting is highly selective. Abalone

interact with a wide variety of plant and animal species, and the removal of abalone by the fishery may indirectly affect these species and assemblages. In general, the fact that the commercial fishery has the potential for removing only about 5 % of the population (Section B2.3.2) suggests the impacts of the commercial fishery on other species, assemblages and habitat are likely to be limited.

The consequence categories used in the assessment of the effects of the fishery on other species, assemblages and habitat are taken from the '*How to' guide for Wild Capture Fisheries* (Appendix B5). Consequence categories for habitat can be found in Table A4 of Appendix B5 and consequence categories for all other components were taken from Table A5. While the risk assessment presented here considers the risk to other species and species assemblages from the operation of the fishery in the context of external factors, it does not provide a formal assessment of the risk from the external factors. As a result, risk to other species and species assemblages from the combination of the fishery and external factors are likely to be higher than those described here.

B2.6.1 Food Items of Abalone

The preferred food of blacklip abalone changes as they grow. Larval abalone are lecithotrophic (i.e. feed on stored yolk), but following settlement, post-larvae and early juveniles (i.e. up to ~5 mm) feed mainly on benthic diatoms. As they grow, their preferred food changes to drift macro-algae, although a small proportion of their diet may include some attached macroalgae. Whilst adult abalone prefer soft, fleshy red algae, they also consume soft or decomposing green and brown algae preferably with a limited phenolic content (e.g. species of *Pterocladia* and *Phyllospora*; Shepherd and Steinberg 1992). Impacts from the operation of the fishery would have a 'minor' consequence (i.e. as abalone do not play a keystone role in maintaining assemblages of algae). Only in exceptional circumstances (i.e. 'rare' likelihood) would harvesting affect food items of abalone. Hence, the overall risk to food items of abalone would be 'low' (Table B2.6).

B2.6.2 Predators of Abalone

Abalone are consumed by species including whelks, crabs, lobsters, octopus and fish. These species are general predators, and abalone probably represent only a small proportion of their diet (Shepherd and Breen 1992). There is no information available to suggest that any predators feed exclusively or predominantly on abalone. Removal of abalone would

therefore be 'unlikely' to affect predators of abalone and have only 'minor' consequence to predators (i.e. abalone do not play a keystone role) as many other prey species are available. Hence, the overall risk to predators of abalone would be 'low' (Table B2.6).

B2.6.3 Competitors to Abalone

Sea urchins and abalone co-occur on reefs in Australia and in other parts of the world (Shepherd 1973, Tegner and Dayton 2000, Worthington and Blount 2003) and are potential competitors for food because they both feed on drift algae (Lowry and Pearse 1973).

Abalone tend not to occur, however, where densities of urchins are great as these areas are often devoid of macroalgae (termed 'barrens'). This implies that urchins are competitively dominant when food is limiting (Lowry and Pearse 1973, Andrew and Underwood 1992 and reviewed by Jenkins 2004). When food is not limiting there is evidence from studies overseas that abalone may be superior competitors for space (Lowry and Pearse 1973) and that the decline of abalone may have led to increased abundances of sea urchins (reviewed by Jenkins 2004). Thus, the removal of abalone by the commercial fishery may potentially increase the abundance of sea urchins in NSW (see also Section B2.3.3.3). Experiments where abalone of a size that is currently abundant in NSW were added to areas showed no evidence for such an effect (Andrew *et al.* 1998b). As the potential for abalone to affect competitors is known to occur elsewhere, according to Fletcher *et al.* (2002), the likelihood of similar circumstances occurring in NSW to what has been observed overseas would be considered 'unlikely' (i.e. uncommon, but known to occur elsewhere) (Table B2.6).

According to Fletcher *et al.* (2002), the consequence of harvesting affecting competitors would be 'minor' (Table B2.6) as it would potentially cause only minor changes in relative abundance of competitors (i.e. potentially only to sea urchins which are already in great abundance in many places). Hence, the overall risk to competitors would be 'low' (Table B2.6).

B2.6.4 Habitat

Diving for abalone is highly selective with minimal physical disturbance of the habitat or reef. Moreover, divers do not need to shift boulders or damage crevices to collect abalone, hence they do not damage the reef structure. At a small-scale, divers may accidentally damage algae during rough conditions. The consequence, however, would be 'minor' (Table B2.6) relative to the large amount of kelp and other seaweeds intermittently removed

from the reef during storms, and rapid recovery would occur. Although the likelihood of small-scale damage to habitat is 'possible' during harvesting (i.e. there is some evidence to suggest this may occur), the overall risk of direct effects to habitat would be 'low' (Table B2.6).

There are possibly some indirect effects on habitat from the commercial fishery, based on the potential for competition between abalone and sea urchins and the fact that fluctuations in the abundance of sea urchins lead to alternating states between 'barrens' dominated by urchins and crustose coralline algae, and kelp dominated systems (Tegner and Dayton 2000). Several factors have been implicated in the fluctuations of sea urchin abundances, including the harvest of abalone (reviewed by Jenkins 2004). This is based on evidence that abalone may be superior competitors for space (Lowry and Pearse 1973). Thus, the removal of abalone by the commercial fishery may have increased the abundance of sea urchins in the past (thereby increasing the area of barrens habitat), although this is difficult to determine as, in general, fisheries for abalone pre-date those for sea urchins (Tegner and Dayton 2000). In southern California, however, there is some evidence that the apparent explosion in the sea urchin population in the 1950s and 1960s may have partially resulted from reduced competition with abalone (North and Pearse 1970). As a result, the consequence would be 'minor' at all scales (i.e. as < 5% of the total area of habitat would be affected). The likelihood of this occurring at local scales would be 'occasional' (i.e. it may occur) with a low risk overall (Table B2.6). As abalone are not harvested in all places the likelihood of this occurring at general scales is 'possible' (i.e. there is some evidence to suggest this may occur) and the overall risk is 'low'.

B2.6.5 Translocation of Species

When abalone are returned to the boat by divers, deckhands remove excess fouling from shells prior to storage and transportation. Generally, the fouling material is returned to the sea at the site of collection. It is possible, however, that deckhands wait until the boat travels to subsequent sites to clean the shells. In such cases, the fouling material would be translocated, and may become established at sites other than where it was collected. Although possible, this action is considered of 'minor' consequence because:

- a) Most material is returned to the site of collection;

- b) Boats would not be expected to travel large distances from the collection site to the sites of returning material to the sea; and
- c) The biota within the fouling material is probably widespread.

Hence, the overall risk of translocation is considered to be 'low' (Table B2.6).

NB. the risk of translocating *Perkinsus* would be minimal because abalone are transported live. It is believed a life-history stage of the parasite is released from the abalone into sea-water only at the death of infected abalone (Bower 2000, see also Section B2.3.3.2).

Regardless, the draft FMS could further safeguard against the potential for translocation of *Perkinsus*.

Table B2.6. Summary of the risk from the operation of the fishery on several aspects of other species, assemblages and habitat. Definition of the terms in the table can be found in Fletcher et al. (2002).

Issue	Spatial scale	Consequence of activity	Likelihood of activity	Overall risk
Food of abalone	All	Minor	Rare	Low
Predators of abalone	All	Minor	Unlikely	Low
Competitors	All	Minor	Possible	Low
Translocation	All	Minor	Possible	Low
Habitat - Direct effects	Local	Minor	Possible	Low
- Indirect effects	Local	Minor	Occasional	Low
	General	Minor	Possible	Low

The assessment of risk to other species from the current Abalone Fishery is low (Table B2.6) suggesting that no specific management measures are required for impacts of the fishery on other species or assemblages.

B3.0 ECONOMIC ISSUES

Governments intervene in fishery operations because the total social cost of commercial fishing activity is not captured in the markets for fish products. This is because while commercial fishers expend labour and capital in capturing wild fish stocks, other costs associated with this activity, such as the impact of fishing effort on the environment, reduced fishing opportunities for other non-commercial fishers and the loss of amenity suffered by groups which would prefer the animals to be left in the sea, are not imposed on commercial fishers. Theoretically, this means that, in the absence of government intervention, commercial fishers will maximise their profits by exploiting the resource until the costs of capturing the last fish caught is only just covered by the income they receive for that fish. Conversely, consumers will continue to demand fish until their willingness to pay equals the cost of capturing the last fish marketed. This interaction between supply and demand often results in exploitation of fish stocks at levels beyond the sustainable carrying capacity of the fishery.

The first step in ensuring sustainable fishing practices is, therefore, to ensure that the hidden social costs of commercial fishing are made apparent to both fishers and consumers. This is usually achieved through the recovery of government management costs and community contributions (resource rents). However, where these measures remain insufficient to reduce fishing effort to biologically sustainable levels, input and/or output controls must be imposed on the fishery. The NSW Abalone Fishery is one such fishery, primarily because it is subject to high demand from international consumers.

B3.1 Introduction

The NSW Abalone Fishery, comprising around 5 per cent of national production (ABARE 2004), is relatively small compared to the abalone fisheries located in other Australian states. Nevertheless, the NSW Abalone Fishery is one of the State's most valuable and regionally important fisheries. Most of the landed catch is exported.

The fishery is a category 1 share managed fishery under the *Fisheries Management Act* 1994. Share management allows for investment in the fishery from people external to the fishery. The fishery directly supports shareholders, divers, deckhands and processors of abalone.

B3.2 Information sources

This section draws heavily upon a report on economic issues associated with the NSW Abalone Fishery prepared by Dominion Consulting Pty Ltd. The Dominion report was compiled from existing information augmented by economic and social surveys conducted around 2001/02, DPI reports and Australian Bureau of Statistics data on NSW fisheries and is reproduced in Appendix CR1. Much of the information presented in this section is now out of date, particularly in light of recent significant changes in abalone beach prices (Section B1.5.2) and TACC (Section B1.3.1), and this is an acknowledged shortcoming of this analysis.

B3.3 Investment in Fishing Equipment and Processing Facilities

The boats in the Abalone Fishery vary in length but are not generally in excess of 6 m (Section B1.1.2). The number of divers is regarded as a measure of 'fleet capacity' rather than boat sizes.

The economic survey of 2001-02 indicated that the capital value of a typical abalone fishing vessel and other equipment was \$106,554. In the year 2001-02, the total current value of the capital equipment used in the fishery, such as fishing vessels, engines and other fishing equipment was estimated at \$3,942,498.

There were eight abalone processors in NSW in 2001-02, with the three largest processors receiving approximately 80% of the total weight of abalone harvested. The current capital value of a typical large-scale abalone processor is approximately \$409,500. The capital value of abalone processing businesses includes the value of processing equipment, transportation facilities, and administration and marketing facilities. The total capital value of the abalone processing sector, excluding land, is estimated to be at least \$1.3M.

The total estimated current value of physical investment in the NSW abalone industry is around \$5.24 million.

B3.4 Employment in the Fishery

Direct employment in the NSW Abalone Fishery includes divers (either shareholder/divers or nominated divers) and deckhands. In 2003, there were 87 persons directly employed in the catching side of fishery; there were approximately 17 shareholder/divers, 33 nominated divers and 37 deckhands. Most shareholders and divers lived on the south coast of NSW and fishing effort tends to be non-seasonal, that is, effort is distributed throughout the year.

The abalone processing industry in NSW has about 106 direct employees attributable to the processing of NSW-sourced abalone, as distinct from abalone consigned from interstate.

It is thought that an employment multiplier of 1.5 is likely to apply to the abalone industry (Appendix CR1), although no specific studies have been conducted. If this were the case, there would be approximately 96 additional jobs indirectly dependent on the fishery.

Hence, total direct and indirect jobs attributable to the fishery would be around 289 jobs, the vast majority of which would be located in NSW.

B3.5 Economic Return from the Fishery

The primary measure of economic profitability is derived from surveys of operational accounts data for the financial period 2001-2. The survey had a return rate of 46% for shareholders or shareholder/divers (19 from a total of 41 in the fishery) and 20% for nominated divers (5 from the 25 in the fishery). The relatively low survey return rate indicates that the survey results need to be viewed cautiously, but this data is the best available at the present time.

B3.5.1 Gross Revenue

In 2002, the NSW Abalone Fishery had an estimated annual total revenue of \$12.5m – equivalent to 15% of total annual fishery production in NSW (\$81.5m). However, significant fluctuations in beach prices and decreases in Total Allowable Commercial Catch (TACC) since that time have demonstrated the highly variable nature of fishery returns.

While recent information suggests that beach price has recovered to ~\$45 - \$50 per kilogram in the second half of 2004, the TACC has been trending downward for some time, from 333 tonnes per annum in 1996, to around 300 tonnes in the late 1990s, 281 tonnes in 2003/4 to 206 tonnes in 2004/5 and 130 tonnes for the current fishing period. Any future supply contractions are likely to further erode future returns.

B3.5.2 Shares

The market mechanism is at the centre of the share management system, whereby changes to the profitability of fishing effort are reflected in changes to the value of shares. As operating costs are relatively stable, the major determinants of short-term profitability are the TACC and beach prices, which are in turn affected by a range of factors both internal and external to the fishery, such as stock health,, exchange rates, trade policies, foreign

demand, the level of management charges and competition for the resource from recreational fishers and threats due to illegal fishing. There is also indication that the number of transactions and amount of shares sold may also have an influence on share price.

Existing abalone divers received their initial provisional shareholdings for a nominal fee in 1996. However, upon the commencement of the share management plan in 2000, new investors began to acquire shares in the fishery, a trend accelerated by a decrease in the minimum shareholding required for eligibility for an endorsement (from 100 to 70 shares) and a provision for the use of nominated divers. There are now two major shareholding groups; shareholders with between 70 and 100 shares and those with lesser holdings.

This sub-division of shareholdings, coupled with rising beach prices and speculative demand for abalone shares, resulted in significant increases in the market value of abalone shares from \$9,400 each in 1996 to \$22,400 each in 2003. However, evidence suggests that share values began to decline in late 2003 and in early 2004, to a level around \$15,000 (ABMAC, pers. comm.).

B3.5.3 Profitability in the Fishery

Table B3.1 contains estimates of average returns to individual shareholder/divers, shareholders that use nominated divers, and nominated divers in 2001-02, based on a 100-share shareholding (Dominion survey). It is estimated that, in 2001-02, the performance of shareholders using nominated divers slightly exceeded that of shareholder-divers, with returns to full equity of 5.1% and 4.4%, respectively. Although not completely comparable, these estimated returns are similar to those produced for selected Commonwealth fisheries during 2003 (ABARE 2003). Table B3.1 also shows that nominated divers were estimated to have experienced a -7.9% return to their full equity (i.e. boat capital) in 2001-02, although the diver survey had only five replies and may not be sufficiently representative.

Table B3.1. Estimated operator returns for the NSW Abalone Fishery in 2001-02.

	Shareholder and Diver	Shareholder	Diver
Gross Revenue (2001-2)	350,258	339,562	107,770
Revenue net of diver payment		231,792	
Total direct costs	141,337	45,348	91,335
plus Total indirect costs	119,713	103,665	22,759
Total economic costs	261,050	149,012	114,094
Economic business profit	89,208	82,780	-6,324
Add back leasing, interest and rent	19,299	38,545	1,857
Profit at full equity	108,507	121,325	-4,467
Capital at full equity	2,454,204	2,360,022	56,248
Rate of return at full equity (%)	4.4%	5.1%	-7.9%

The economic survey indicated that 50% of shareholder/divers and all shareholder businesses had positive net returns in 2001-02. The long-term viability of the remaining operators is therefore questionable, particularly in light of TACC reductions that have taken place since 2001-02, as demonstrated by Table B3.2, which contains estimates of operator returns constructed from quota levels, prices and 2001-02 costs (direct costs are reduced in proportion to new catch quota).

Table B3.2. The projected economic performance of abalone businesses in 2003-04.

	Shareholder and Diver	Shareholder	Diver
Gross Revenue (7.69t@\$34/kg)	228,162	228,162	92,280
Revenue net of diver payment		135,882	
Total direct costs	134,183	43,052	86,712
Total indirect costs	119,713	103,665	22,759
Total economic costs	253,896	146,717	109,470
Economic business profit	25,733	10,835	17,190
Add back leasing, interest and rent	19,299	38,545	1,857
Profit at full equity	6,434	27,711	15,333
Capital at full equity	2,229,204	2,135,022	56,248
Rate of return at full equity (%)	-0.3%	1.3%	-27.3%

Another apparent risk affecting the fishery relates to the preparedness of shareholders to plan for and adjust to the 'normal' natural variations in the abundance of harvestable abalone (as reflected in the TACC) or 'normal' changes in the beach price for abalone, particularly if low TACCs and low beach prices coincide or prevail for prolonged periods. There are *potential* barriers within the industry and within the current management arrangements for the fishery that could limit the industry's ability to adjust. Little is known about the potential barriers within the industry (e.g. levels of business planning capabilities), but it warrants further exploration. With respect to management arrangements, it is possible that the current rules for adjusting shareholdings have constrained shareholders' options to adjust their businesses. In particular, the current rules requiring a minimum trade of 10 shares and specifying the maximum number of shares that any shareholder can hold as 6% are likely to impede flexibility.

B3.5.4 Productivity in the Fishery

The number of divers in the Abalone Fishery has increased in recent years because some shareholders have 'traded down' their share packages, as a result of the current minimum shareholding being set at 70 shares (Section B1.3.2.2). As a consequence, the number of endorsements (and associated divers) could potentially increase to 52 under the current minimum shareholding. Such an increase could reduce the viability of abalone businesses and the overall productivity of the fishery, given that financial returns would be dissipated among more participants in the fishery. This situation is compounded by the recent significant decreases in the TACC and lower abalone beach prices. This presents a significant risk for the fishery's future economic outlook.

B3.6 Rents, Community Contribution and Management Charges

B3.6.1 Rents

'Rent' is an economic surplus from a natural resource indicating a return above the full cost of supply attributable to the scarcity of the resource, as opposed to other components of economic surplus which may be due to a fisher's skill or information and may be competed away. 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 divers and reflect

innovation and skills in a healthy industry. Estimation of resource rent requires incorporation of effort and species considerations. 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 for the Abalone Fishery with data currently available.

In the Abalone Fishery the resource rents have been capitalised into share values. This means that any attempt to retrieve resource rent by government will affect shareholders who bought into the fishery taking account of charges that were indicated at that time. In this case, the rent exits the fishery as a windfall gain to the exiting fisher and the new shareholder is often holding debt in respect of their share purchase.

B3.6.2 Community Contribution

It is NSW Government policy that shareholders in category 1 share managed fisheries, such as the Abalone Fishery, make a periodic community contribution to consolidated revenue in respect of privileged access to a resource. The *Fisheries Management Act 1994* does not specify the form of the 'community contribution', but makes an in principle requirement to make a return to the community in respect of privileged access.

The present community contribution for the NSW Abalone Fishery is based on the number of shares in the fishery and is set as a percentage of the gross revenue in the fishery.

Following a phase in period, the contribution was set at 6% of the gross value of the fishery for year 2003/04 which is estimated annually at approximately \$210 per share, per year. However, the contribution was suspended in 2004/05 in light of concerns about fishery viability. A new structure for calculating the contribution has been implemented by government following consultation with Industry representatives (as described in Section B1.3.2.17) and this is expected to assist in improving returns in the fishery.

B3.6.3 Management Charges

Shareholders are required to pay for the management costs attributable to the fishery. Management charges, including research and compliance, are calculated based on the broad pricing principles recommended by the Independent Pricing and Regulatory Tribunal (IPART 1998 and see Section B1.3.2.3). For the 2003-04 period, the fees were:

- management charge \$242 per share;

- \$66.76 one-off environmental assessment levy;
- \$332 application fee, for a nomination with respect to a share holding,
- \$221 per share transfer;
- \$388 with respect to share mortgages;
- \$166 transaction fee payable for quota transfers; and
- a \$111 application fee for crew member registration (NSW Fisheries 2004).

Table B3.3 calculates the estimated net returns for the NSW Abalone Fishery in 2003-04. The estimated net return of around \$400,000, while modest, indicates that the fishery was a positive contributor the NSW economy in 2003-04.

Table B3.3. Estimated net returns in the NSW Abalone Fishery 2003-04.

Item	Year 2003-04
For the abalone fishery per annum:	(\$ millions)
Gross revenue from catch (284t@\$30/kg)	8.520
Economic cost of Effort*	6.390
Total economic surplus	2.13
Less Management charges to Industry	0.962
Less Community contribution**	0.516
Less Cost of FMS***	0.247
Operational economic surplus****	0.405
Plus rise or fall in abalone stocks	Unknown
Net Return	0.405

Key:

* The Dominion report included an estimated \$5.18m of opportunity cost of capital (shares and capital equipment on investment of \$2.0M licence value plus capital equipment). This does not allow the reader to determine the fishery actual return and is inconsistent with ABARE estimates and so has been removed.

** Community contribution at 6%; i.e. 4% above the economic cost of effort which included 2% community contribution. (3,700@\$139.60)

*** Second payment of 3,700@\$66.76.

**** Surplus is \$0.405M if the opportunity costs of capital is deducted

B3.7 Economic Contribution to Local and Regional Economies and Multiplier Effects

The economic significance of the Abalone Fishery can be measured in terms of direct and indirect effects. The direct effects are a measure of the value of economic output of the industry itself – that is, the value of abalone sold. Indirect effects are a measure of the flow-on benefits from the fishery, such as the creation of supporting services arising from the expenditure by operators on inputs, such as fuel and equipment, and consumer purchases by shareholders, divers, deckhands and processor employees made using abalone-related income / wages.

Economic multipliers relate to the flow-on impacts of expenditure from an industry within a closed local economy. Employment multipliers estimate the impacts on employment of expenditures from an industry to the locality. There have not been any specific studies of the multipliers associated with the NSW abalone industry. A general study of south coast fishing activities (Tamblyn and Powell 1988) indicates the ratio of all effects, are likely to be relatively small at around 1.5-2.0.

The available information for abalone suggests that economic multipliers are unlikely to exceed 1.5. That is, expenditure in the local community in addition to what is spent directly on the fishery would be no more than 50%. Employment multipliers would also likely be of this magnitude with an additional 0.5 indirect jobs being created for every direct job in the abalone industry.

B3.8 Overall Risk from Current Operations to Economic Viability

The foregoing discussion indicates that the fishery currently is economically underperforming and that there are a number of risks to its economic viability. Long run business viability will be an issue for some producers.

One of the major risks to the long-term economic viability of the abalone fishery is from a declining access to abalone stocks. As discussed in Section B2, there are a number of actual and potential reasons why this has occurred, including reductions in TACC, area closures, illegal harvesting and a reduced stock in Region 1 due to *Perkinsus*. The risks to viability have been compounded by the increase in diver numbers (and associated labour and capital equipment costs). The potential for a further increase in diver numbers is a key risk to the fishery. Additionally, it is apparent that the industry has a limited capacity to adjust to significant reductions in the TACC or beach prices, which, in part, appear to be attributable to constraints on share trading and holdings and potentially barriers within the industry.

Importantly, the management of the commercial fishery is designed to protect the stock from over-fishing through the setting of appropriate TACCs and by having a minimum legal size that protects most of the population from harvesting by commercial and recreational abalone divers. Other important risks to economic viability are from reductions in beach prices, increasing operating costs, and changes in management charges and community contributions.

B4.0 SOCIAL ISSUES

Dominion Consulting Pty Ltd have described the community values and views associated with the Abalone Fishery including social capital, skills base and transferability of skills, with a brief analysis of the basis of these views and perceptions (Appendix CR1). Umwelt Pty Ltd described Indigenous values and views associated with fishery as well as issues associated with European heritage (Appendix CR2). The reports by Dominion Consulting Pty Ltd and Umwelt Pty Ltd also identified the overall social risks from the current operational regime taking into consideration the likelihood of the impacts and their predicted consequences. The following sections are a summary of the two reports.

B4.1 Demography of Shareholders, Divers and their Families

A profile of abalone shareholders, divers, nominated divers and deckhands was prepared based on existing information and the results of social surveys (Appendix CR2). The social survey of shareholders and divers for the period 2001-2 had a total of 28 replies from abalone fishers: 4 non-diving shareholders, 13 shareholder divers and 11 nominated divers. Out of 37 deckhands contacted, 10 responded to the survey. The following analysis is largely based on these survey responses.

Most abalone shareholders and divers earn their annual income from the Abalone Fishery, with only 11% earning their income from non-industry sources. Shareholders and divers' net taxable annual income from all industries was \$80,750 and an average household income of \$102,411, indicating an overall contribution of 79% by abalone shareholders and divers to household income. The industry is male - dominated in terms of endorsements and participation of females in direct fishing is approximately 4%. An estimated 43% of abalone shareholders' and divers' partners are employed in abalone fishing businesses. Half the abalone shareholders and divers have financial dependents.

The fishing communities tend to focus around key coastal towns, though a significant number of shareholders and divers reside in smaller communities. The commercial fishery is concentrated on the far south coast of NSW with the major ports being Ulladulla, Batemans Bay, Bermagui, Tathra and Eden.

Although most shareholders and divers had limited formal education, 11% had a university degree or tertiary education and 7% had a trade or business training. Shareholders, divers

and deckhands are highly resident and have a strong association with local communities as 56% of them have lived in the same postcode area for more than 10 years and 36% more than 20 years. Shareholders have an average of 12.5 years of fishing experience and work an average of 9.9 hours per week, which is significantly lower than 42 hours per week estimated by the Australian Bureau of Statistics. Divers, however, work an average of 35.5 hours per week.

A decade ago the fishery consisted of many original divers present at the inception of the fishery. Nowadays the fishery comprises original divers, nominated divers and shareholders.

B4.2 Demography of Deckhands and their Families

Most deckhands (91%) work on a full-time basis in the Abalone Fishery. All 11 deckhands who responded to the survey are male. Most (73%) are either married or in a relationship, the rest (27%) are either single, or separated. No partners of deckhands work in the fishing industry. A majority of deckhands had a formal education, with 60% achieving year 10-12 education, 27% a TAFE certificate, 18% had a university degree and 36% business training. A total of 15 people depend on the 11 deckhands who responded to the survey. About 55% of deckhands have dependent children less than 16 years of age and 60% have other dependents such as a spouse or an elderly parent. Approximately 82% of deckhands either own or are paying off a home and the remainder (18%) either rent or live with parents.

The mean number of years of experience of deckhands is approximately 7.5, but they have lived in the same postcode for about 13.6 years. During normal and high seasons deckhands worked between 25-27 hours per week and in other seasons only 10 hours per week.

Out of 11 deckhands, five are also employed in other industries and earn about 26% of their income from building, farming and other sources. Deckhands' average individual gross income from all sources was estimated at \$27,364 and an average household income of \$41,773, indicating deckhands' income from fishing contribute 66% of household income. About 82% of deckhands thought that, if they wanted to, they could get either full-time or part-time employment in other industries.

B4.3 Community Values and Views Associated with the Fishery

B4.3.1 The Importance of Social Identity

Abalone divers in NSW are a part of the rural coastal community along the southern coastal fringe. Approximately 42% of abalone divers consider fishing as a lifestyle, rather than merely a business or job.

The Abalone Fishery has more first generation divers than the average of the NSW commercial fishing industry. Approximately 64% of abalone divers are first generation divers, and 36% have two or more generations of involvement in commercial fishing. This may indicate the level of long-term social association and integration with communities and potential to be significant contributors to social capital. It also reflects the relative newness of the fishery.

A measure of fishers' experience (i.e. shareholder or diver), which contributes to the sense of fishing industry involvement and community, is the years of involvement with the industry. Thirteen (46%) shareholders or divers have been in the fishing industry for more than 10 years (average experience – 12.4 years).

About 50% of divers travel only less than 25km per day in their diving operation, and only a quarter travel more than 50 km per day. This reflects a preference to work in areas close to their home port.

B4.3.2 Job Satisfaction

Abalone shareholder, divers and deckhands were asked about their current work and their capacity and willingness to transfer from fishing to other industries. Approximately 11% currently worked in other industries.

When asked about their capacity to consider alternative employment there was a significant number (39%) who said they would not get employed in industries other than fishing. Of these people, a total of 14% would and 25% would not consider re-training for reasons of age, lack of experience other than fishing, family business, and lifestyle.

Part of the divers life style is that actual diving takes fewer hours than the conventional 40 hour week (Section B4.1).

B4.4 Health Risks to Divers

Abalone diving is a risky and dangerous activity and can lead to injuries. The survey indicated that approximately 25% of abalone divers can be out of fishing for 2 weeks or more in any year through industrial injury. The comparison with all fishers in NSW indicates the level of industry related injuries in the Abalone Fishery is not significantly different from other fisheries in NSW, but that health problems in the longer term may be significantly different.

Any occupation involving the use of boats and diving is subject to safety issues. Divers involved with the Abalone Fishery since its inception have acquired considerable experience and knowledge of local conditions. As original divers gradually retire from the fishery, there is a possibility that nominated divers will have less experience and hence be less capable of dealing with local conditions and therefore be subject to more risk. It is therefore of increasing importance that shareholders ensure that their nominated divers have appropriate training and experience. Unlike other activities where diving is done for economic gain (e.g. commercial or scientific divers) there are currently no requirements to obtain commercial diving qualifications. On the other hand, many of the skills taught for such qualifications are not relevant to the Abalone Fishery, while some important skills required for the fishery are not part of commercial courses.

During diving activities, abalone divers may be subject to the following risks:

- Car accidents while towing boats to and from boat ramps;
- Boating accidents, including,
 - Collisions with other boats;
 - Breaching in rough seas;
 - Striking reefs (bomboras); and
 - Mechanical failures.
- Diving accidents, including,
 - Compressor failure, poor ventilation or air filter failure;
 - Decompression sickness or long term necrosis;
 - Drowning;

- Boat strike;
- Physical trauma during rough sea conditions, when divers may be battered against the rocks, the ride of their boat, etc; and
- Threats from marine animals (e.g. shark attack).

Deckhands, who are required to hold first aid qualifications, are also subject to the same risks associated with transport by car and boat. They also maybe subject to injury associated with lifting abalone and diving equipment to and from boats, inhalation of exhaust fumes, sunburn, etc.

Despite the risks identified, there have been relatively few serious injuries within the fishery. As noted above, this situation may change where shareholders are not divers and the number of nominated divers increases. In such cases, responsibilities for safety will need to be identified, for example, responsibilities associated with maintenance of vessels, compressors, 2-way radios and dive equipment, decisions regarding working under various sea conditions, etc. Whilst safety issues are outside the jurisdiction of DPI, the issue of diver safety requires more attention than it currently receives as there are legal implications for shareholders when accidents to nominated divers occur, as nominated divers are employed or subcontracted by shareholders (see Chapter C4.2.3 for further discussion). These issues have been given particular consideration within the draft FMS (Chapter D).

B4.5 Health Risks to Consumers

As food producers, participants in the fishery are bound by NSW food legislation, namely the *Food Act 1999* and the *Food Production (Seafood Safety Scheme) Regulation 2001*. Boats are included in the definition of 'vehicles' in the *Food Act 1999*. There are no specific provisions relating to seafood specifically in the context of the Abalone Fishery but general requirements about hygiene and cleanliness, keeping good records and keeping products cool apply to the handling of all foods including abalone. Given that abalone must be exported live, there is a great incentive to ensure that the product is treated appropriately.

Most seafood businesses, including those in the catching/harvest sector, are licensed with SafeFood Production NSW. Abalone diving businesses must hold such a licence. In addition, most seafood businesses must prepare a Food Safety Program in respect of their activities. In most cases, this applies from the point at which the catch is brought on board the vessel and where the same business or individual handles products on shore (after

landing). The Food Safety Program encompasses each and all of the other activities. As long as abalone divers pass only live abalone to the receiver (processor), however, they do not have to register a Food Safety Program. Thus, the Food Safety Program begins when abalone are passed to the processor.

B4.6 Indigenous Cultural Heritage and Community Issues

The following sections summarises the relevant part of an assessment by UMWELT Pty Ltd about the current operation of the Abalone Fishery to Indigenous cultural heritage and community issues. UMWELT Pty Ltd drew on two sources of information for their assessment: a review of studies of Indigenous community fishing practices and consultation with Indigenous community members about the role of fishing in their cultural responsibilities. The full report prepared by UMWELT Pty Ltd is presented in Appendix CR2.

B4.6.1 Important Indigenous Sites and Places

Indigenous sites include places which contain archaeological material (shell, stone and bone), but also places associated with traditional community stories or that are held in community lore as places that are valuable or important for various economic or social purposes. Information about recorded archaeological sites is held in the Aboriginal Heritage Information Management System database (maintained by the Department of Environment and Conservation, DEC). DEC also maintains a register of gazetted Aboriginal Places. These are places of high cultural significance (such as dreaming site) which do not necessarily have archaeological representation. Virtually all known archaeological sites are terrestrial. Middens occur along the entire NSW coast, often in relatively sheltered positions protected by headlands, or in places where fresh water is available. Middens also occur on nearshore islands accessible by canoe. Abalone shell is a common, but minor component of midden deposits.

The structure of operation of the Abalone Fishery (Section B1.3) is such that there is very limited potential for commercial abalone diving activities to impact on Aboriginal archaeological sites along the coast. Similarly, commercial abalone diving on the NSW south coast has little or no impact on gazetted Aboriginal places.

In shallow, near shore areas, commercial abalone divers access the same abalone resources as recreational and Indigenous divers. Some of these nearshore reefs may be traditional Aboriginal fishing places, but this detail is not recorded.

B4.6.2 The Interface with Traditional Fishing and Access to Fishery Resources

The species distribution in Aboriginal midden sites indicates that most of the commercially targeted fish and shellfish species in NSW, and occasionally abalone, were part of the traditional Aboriginal resource base (Egloff 1981). Harvesting by Aboriginal communities continues to maintain a preference for these species. Coastal Aboriginal communities all refer to fishing as an extremely important part of the traditional way of life. Non urban communities (i.e. outside the Sydney/Newcastle/ Wollongong area) also state that fishing continues to provide an important and healthy dietary supplement, and an opportunity to transfer traditional knowledge to younger people.

Abalone has different meanings for different areas, and even between different family groups. For many groups, however, especially on the south coast, abalone is more important as a species than any others. There is a documentary (Landline 11/7/04) that provides information about the spiritual association of Aboriginal people and abalone (mutton fish), and there is a long history of Aboriginal people collecting abalone to feed their own extended family (fishing for elders). Abalone would have been a trade item among Indigenous communities even before European settlement. Abalone is a highly valued source of food for Indigenous families (used to be known as 'black fella's tucker') before the international markets were established.

There is a history of small scale participation of Aboriginal communities in commercial abalone fishing. For example, the Wreck Bay community collected and dried abalone for sale to the Chinese market in Sydney from the 1930s (Egloff 1981). Two commercial abalone licences were held by Indigenous fishers some 20 years ago, but were sold by the proponents. Currently, no Indigenous people hold shares or entitlements in the commercial Abalone Fishery.

Fundamentally, the Indigenous community concerns associated with the operation of the Abalone Fishery are about progressive loss of access to resources, with Indigenous communities considering that their right to maintain traditional fishing practices (i.e. fishing for traditional cultural and community purposes and responsibilities), conflicts with the

current licensing system and allocation of non commercial access to abalone resources. The concerns have a history extending to the first issue of separate commercial abalone licences and reflect a combination of lost skills, lost income, poor communication, local community politics, and lost opportunity to participate in a high economic return fishery. The situation is exacerbated by high levels of abalone poaching. Although some Indigenous people have been involved in poaching, Indigenous people believe they are being unfairly targeted during enforcement action over illegal catches.

The combined demand of commercial quotas (which have declined significantly in recent years), illegal catches, recreational catches and catches for traditional purposes in the Aboriginal community, as well as disease impacting on abalone stocks, has increased competition and reduced stocks to be shared between the various legal sectors. Indigenous folk, operating on accessible shallow reefs to collect abalone for community purposes, could be seen to be relatively disadvantaged in terms of access to the resource, because of the high level of competition for these stocks and vigilant fisheries enforcement in these areas.

B4.6.3 Current Implications for Indigenous Community Well Being

During consultation with the Indigenous Fisheries Working Group (IFWG) and Aboriginal community representatives on the NSW coast, a number of social issues that Aboriginal people attribute in part to the regulation of access to abalone resources were noted. The groups also suggested ways to alleviate factors underlying the current situation, as noted in Appendix CR2. Some of the issues and remedial options involve policy frameworks that are broader than individual fishery management strategies or that cannot be resolved with reference to the commercial sector in isolation. Such an approach was also proposed by Palmer (2004) in his Review of illegal fishing in NSW. He recommended an holistic approach whereby there should be open consultation with Aboriginal stakeholders and consideration given to legislative changes to effectively and equitably protect cultural fishing practices. Under this approach, Palmer (2004) assumed that the distinction could be made between genuine, 'culturally based' fishing practices and other activities that could be considered 'commercial exploitation'. Such discrepancy has been an issue of contention in recent times.

Palmer (2004) also recommended an examination of options for more flexible penalties for Aboriginal men (including the use of penalties that are more culturally based), consideration

of a community abalone scheme (as an alternative to the current permit scheme) and more effective promotion and integration of Aboriginal representation on ABMAC.

There are a number of suggested options for consideration in the FMS, including:

- Ensure Indigenous communities are properly informed about resource status – to address concerns about unfair restriction of quotas;
- Develop an Aboriginal employment strategy for the industry. Note that Aboriginal people would value a structured training program that would give them the skills to participate effectively in commercial ventures. They would also value opportunities for partnerships (with DPI) that would further enhance business and technical skills;
- Enhance Aboriginal participation in ABMAC by modifying participation rules and providing training in meeting practices, for example, to allow more than one person to attend or hold regional meetings with community elders;
- Provide support for representatives so that they can inform their communities of matters discussed and decisions to be made; and
- Provide cultural awareness training for ABMAC. Provide administrative practices and meeting practices training for Aboriginal community representatives.

B4.7 Heritage Issues

This section summarises the report on historical heritage issues of the Abalone Fishery prepared by UMWELT (Australia) Pty Ltd (Appendix CR2). The report considers the DIPNR guidelines for Environmental Impact Assessment of draft Fishery Management Strategies (Appendix A2).

The key issue is an assessment of the relative risks presented to historic heritage sites and values by the current management strategies for the Abalone Fishery and by the proposed management of the fishery.

For the purposes of this assessment, historic heritage has been confined to the transport context, and specifically to the record of shipwrecks along the NSW coast, having regard to the operation of the Abalone Fishery in marine waters. In broad terms, the potential risks to historic heritage derive from direct impacts on historic shipwrecks by vessels and divers engaged in the collection of abalone. It is considered unlikely that other types of historic heritage (buildings, wharves etc) will have any interaction with the Abalone Fishery.

The assessment therefore considers the potential risks for current and future operations to impact on the protection of shipwrecks that have been recorded in offshore NSW and Australian waters. It is based mostly on data contained in the 'Maritime Heritage Online – NSW' database, which is maintained by the NSW Heritage Office. The database has been analysed for the Illawarra and South East regions where the Abalone Fishery is concentrated. Shipwrecks are protected under the *Historic Shipwrecks Act 1976* and the *NSW Heritage Act 1977*.

B4.7.1 Locations of Historic Shipwrecks

The analysis that is presented in Appendix CR2 demonstrates that shipwrecks are common right along the southern NSW coast in waters used by abalone divers. The shipwreck records, particularly those from the early nineteenth century, often lack accurate location details or specific information about the nature of the heritage material. However, submarine relics are by their nature fragile and any disturbance has the potential to damage them.

B4.7.2 Assessment of Risk

A qualitative assessment of the risk posed to historic shipwrecks by the activities of the Abalone Fishery indicates that the current fishery would have a low risk of affecting the conservation of historic shipwrecks (Table B4.1).

Table B4.1. Risk assessment of the Abalone Fishery on historic shipwrecks.

Aspect	Likelihood	Consequence	Risk
Boat navigation – collision with shipwrecks	Unlikely to rare	Low to moderate	Low
Divers damage shipwreck	Unlikely to rare	Low to moderate	Low
Trapping of divers in shipwrecks	Rare	High (to diver), low to heritage item	Low (to heritage item)

No large nets or other equipment that could snag on shipwrecks are used in diving operations and the boats used are also relatively small, with very limited likelihood of damage to shipwrecks due to collision. Abalone are collected by hand.

B4.8 Overall Risk from Current Operations to Social Issues

B4.8.1 Illegal Activities

Despite an improved surveillance program, illegal catches of abalone continue to pose special problems for the industry and the community (TAC Committee 2004a). In a national review of the needs of the abalone sector by Macarthur Agribusiness (1998), abalone theft was ranked as the most significant threat by all abalone producing states. Illegal activities potentially decrease the value of the community's resource, economic viability and employment opportunity and cause conflict within the community. A study by the Australian Institute of Criminology recommends that continued assessment, monitoring, and regulation and policing of the licensed and unlicensed abalone sectors are key strategies that must be used to address the threat of unsustainable harvesting to Australia's abalone fisheries. Further, Palmer (2004) considered illegal activity to be growing in NSW and suggested that it could threaten fisheries resources if not curtailed. He suggested changes to the way resources were allocated were critical to controlling illegal activity.

B4.8.2 Reduced Employment and Limited Alternative Employment

The social survey information shows that around 376 jobs are derived from the Abalone Fishery. The Abalone Fishery is very expensive, however, for those who wish to enter in the fishery and it is unlikely that nominated divers could become abalone shareholders in the future without finance from outside the fishery. The potential for rationalisation of the number of fishing businesses during times when economic conditions in the fishery are hard, such as the present, could reduce the number of people employed in the fishery. The potential for further loss of fishing grounds through the creation of more marine protected areas or from closures for other reasons could also reduce the number of people employed in the fishery. Given the close association between deckhands and abalone divers, any change in the divers' business will have a substantial economic and social impact on the deckhands, who derive two-thirds of their income from the fishery (Section B4.2). Reduced employment could affect the coastal towns where the fishery is based.

Although some divers expressed their willingness to leave the fishery there are many reasons why this is difficult. In particular, abalone diving forms the main part of most diver's income, and a third have dependents (Section B4.1). Apart from lack of alternative employment opportunities, many divers are not qualified to start other business; few divers

have a trade or business training and are not inclined, for lifestyle reasons, to leave abalone diving.

B4.8.3 Indigenous Community Well-being

The nature of the Abalone Fishery suggests commercial operators are unlikely to affect important Indigenous sites and places. There is, however, concern that the Abalone Fishery affects the well-being of the Indigenous community. Fundamentally, this is an issue about Indigenous access rights to abalone and regulations as to how Aboriginals collect abalone for community purposes. Improvements in this area require changes to policy at a broader level than in this FMS. It is also a concern that no Aboriginal people are employed in the Abalone industry. This stems from poor communication and understanding between the Indigenous community and abalone divers. To some extent this situation can be changed through the FMS.

B5.0 KEY RISKS TO THE EXISTING ABALONE FISHERY

The Review of the existing Abalone Fishery identified a variety of challenges. On the surface, the highly structured nature of the Abalone Fishery would suggest there are safeguards for reducing risks to the sustainability of the fishery. Notwithstanding this, there are concerns about the ability of some of the management arrangements to control: the shift in effort associated with the problems in Region 1; the potential for illegal activity; economic viability in the fishery; localised depletion of reef populations; and potentially adverse effects on the fishery of many external factors, such as catch from other sectors. If management arrangements are ineffective in any of the areas mentioned there could be consequences to the stock of abalone. Fundamentally, the security of the stock is the basis for the sustainability of the fishery.

The key risks to the fishery have been identified for consideration in the draft FMS (Chapter D). Risks and threats are summarised below as 'internal' risks (largely under the control of either Industry or DPI) or 'external' risks (largely beyond the control of Industry or DPI). External risks have the potential for a greater impact on the Abalone Fishery than internal risks. For example, *Perkinsus* infections have been responsible for large-scale closures to abalone harvesting. Thus, while not caused by Industry, responses to this threat are warranted by Industry in terms of marketing, management and monitoring.

B5.1 Internal Risks

B5.1.1 The Potential for Inappropriate Concentrations of Fishing Effort

The six regions of the fishery were originally established to provide about equivalent commercial yield, but they no longer provide this. These regions function quite distinctly from one another in terms of their productivity. Large-scale depletion of the stock in Region 1 in recent times due to infections by *Perkinsus*, along with an increase in the proportion of divers preferring to work in areas where catch rates are greatest, have recently led to increases in diving effort (and catch), in the far-south of the state. The TAC Committee has expressed concern about the use of a single TACC for the whole fishery, and the vulnerability of this management approach because it does not address the potential for serial depletion of the resource at smaller space scales (TAC Committee 2002, 2004). Based on the management approach of most other abalone fisheries in Australia and elsewhere,

there is wide acceptance that to manage abalone effectively requires that the scale of management should match the scale of stocks.

B5.1.2 Reduced Economic Viability

The Abalone Fishery has been economically under-performing in recent years (Sections B3.5 and B3.8). In addition, the economic outlook for the fishery in 2004-5 is of major concern. The TACC was again reduced substantially for the 2004-05 fishing period and the export market remains depressed, although there are some signs that abalone prices are beginning to recover. The TAC Committee, in view of its determination, is concerned about the possible consequences for the profitability of the industry.

The risks to viability have been compounded by the increase in diver numbers (and associated labour and capital equipment costs). The potential for a further increase in diver numbers is a key risk to the fishery. Additionally, it is apparent that industry has a limited capacity to adjust to significant reductions in the TACC or beach prices, which, in part, appear to be attributable to constraints on share trading and holdings and potentially barriers within industry.

Despite general concern about the profitability of the industry none of the economic triggers in the share management plan have apparently been reached (NSW Fisheries 2004). Revised performance indicators for assessing the economic circumstances of the industry are required, along with greater flexibility in management arrangements.

B5.1.3 Potential Increase in the Number of Divers

The number of divers in the Abalone Fishery has increased in recent years because some shareholders have 'traded down' their share packages, as a result of the current minimum shareholding being set at 70 shares (Section B1.3.2.2). As a consequence, the number of endorsements (and associated divers) could potentially increase to 52 under the current minimum shareholding. Such an increase could reduce the viability of abalone businesses and the overall productivity of the fishery, given that financial returns would be dissipated among more participants in the fishery.

B5.1.4 Insufficient Involvement of Industry in Management Arrangements

The ABMAC process provides for some negotiation regarding management arrangements between shareholders and DPI, but shareholders have limited control over the governance

of the fishery, including services currently delivered to the fishery and cost recovery. In the Abalone Share Managed Fishery there is sufficient scope to achieve a better match between responsibility and decision-making and the risks, costs and benefits of those decisions, whilst ensuring sustainability and resource sharing requirements for a community owned resource.

There are currently nine shareholders working as divers and 30 nominated divers. As the number of nominated divers increases there will be fewer shareholders directly involved in harvesting. Thus, there will be an increasing role for nominated divers to contribute to the management system and the sustainability of the fishery. Currently, there is little incentive for nominated divers to use sustainable practices and this is exacerbated by the economic conditions in the fishery. Nominated divers need to be able to receive information from managers and be given more responsibility in the stewardship of the resource.

B5.1.5 Other Ecological Impacts from Harvesting Abalone

As discussed in Sections B1.1.2 and B2.0, the Abalone Fishery is highly targeted and relatively benign with respect to the biophysical environment in which it operates. There are, however, some areas of risk that are currently considered minor, but which do require future attention. These include effects of harvesting on bycatch and continued research on the relationship of abalone, sea urchins and reef ecosystems (e.g. creation of and maintenance of barrens habitat).

B5.1.6 Potential Increases to the Rates of Discarding Abalone

The current trend in the fishery is for a greater proportion of nominated divers and reduced catch rates. There is potential for inexperienced, nominated divers to discard abalone (i.e. remove, measure and return abalone to reefs) at a greater rate than experienced divers. The current (reduced) trend in catch rates and concentration of fishing effort in the south would potentially exacerbate this problem as there are fewer abalone available and potentially more turned over close to the minimum legal size.

B5.2 External Risks

B5.2.1 Illegal Collection of Abalone

Illegal catches of abalone continue to pose significant problems for commercial, recreational and Indigenous harvesting of abalone, the community and potentially the reef ecosystem. Illegal fishing has potential to affect local populations of abalone as well as the general population. A significant proportion of abalone in illegal catches is likely to be under the MLS, hence such activities can decimate local populations. Further, the large size of the illegal catch has potential to threaten conservation objectives for the fishery (TAC Committee 2004a). A large amount of compliance resources are focused on reducing the illegal catch but the overall effectiveness is largely unknown.

B5.2.2 Competing Interests

Other groups entitled to harvest abalone include recreational and Indigenous divers. Catches by individuals in these groups are controlled by the MLS and daily bag limits, but there is no limit to the total catch, unlike the quota system operating within the commercial sector. Varying estimates for the recreational catch highlight the need for other more comprehensive data. The 1997 estimate of the recreational catch (Andrew *et al.* 1998) of 50 t probably differs from the current catch due to changing management arrangements for recreational harvesting (i.e. current closures and banning of the use of compressed air) and the current status of the stock of abalone. The total Indigenous catch is largely unknown. In addition, some Indigenous groups have made Native title claims to parts of the coast. Indigenous claims to the resource could seriously affect the commercial sector, but this is beyond the direct control of the FMS and will likely be resolved through other processes.

B5.2.3 Other Human-Induced Impacts on the Resource

Apart from harvesting, threats of serious irreversible damage to fish stocks can arise from other human activities. For example, land management practices, introduced species, aquaculture and sewage disposal may affect stocks of near-shore species, such as abalone, and elevated water temperatures are also thought to have an effect. Parts of the general population of abalone may be especially vulnerable, particularly populations found at the northern end of the species' distribution and around urbanised areas. Larger scale influences like global warming may also affect the stock in the medium to long term (e.g. by

increasing water temperature, changing sea level and altering habitat). Marine protected areas may have the potential to affect the fishery if they occur on productive abalone habitat, as has happened in parts of Jervis Bay. Although many of these are largely beyond direct control of the FMS, actions need to be considered for mediating potential threats.

B5.2.4 Diseases Affecting Abalone

Abalone stocks are susceptible to a number of diseases. Infection of abalone by *Perkinsus olseni* appears to be responsible for serious mortality in populations in northern parts of the fishery. The major risk to abalone occurs when infected animals are stressed, or the disease is introduced into a new population that has not become adapted to the disease or stressors.

The management of the spread of *Perkinsus* and the arrangements for harvesting within and around infected areas is of greater importance to long-term directions for development and optimisation of the fishery.