Volume 2

Chapters E – J

This is the second of four volumes of the
Environmental Impact Statement
on the
Ocean Hauling Fishery

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CHAPTER E. IMPACT ON THE FISH RESOURCES

The scientific names for the fish and invertebrates referred to by their common name in the following chapters can be found in Chapter B, section 1(b).

1. Retained Species

a) Species based biological assessment

i) Stock status

The current status of the main target species in the Ocean Hauling Fishery is summarised in Table E1. These species make up 97% (by weight averaged over the three years 1997/98 to 1999/00) of the retained catch in the Ocean Hauling Fishery. This table is based on information from NSW Fisheries (2001) and the NSW Fisheries Commercial Catch Database. The total number of species taken in the Ocean Hauling Fishery is not limited to the 16 species listed in Table E1, however, this assessment deals primarily with those listed in Table E1 as they are the target species of the fishery. A further 12 species are classified as "conditional target species" (Table C13), although their occurrence in catch records for the Ocean Hauling Fishery is uncommon.

It should be recognised that for most of the species taken in the Ocean Hauling Fishery, current knowledge of stock status is poor or non-existent. Whilst reasonable information is available for some of the more important target species, little is known about the majority of retained species within the Ocean Hauling Fishery. To improve the knowledge base and thus management of the various fisheries under their control, NSW Fisheries has commenced stock assessments for numerous species occurring in the State's coastal waters, including several within the Ocean Hauling Fishery. The level to which each of the target species in the Ocean Hauling Fishery has been assessed is listed below and aspects of the status of each of those species are described in Table E1. The following definitions are summaries of those provided in NSW Fisheries (2001).

Assessment reliability	Definition	Species in the Ocean Hauling Fishery
3	The assessment is completed using both fishery dependent indices of abundance and ancillary information such as age structures or independent surveys but not yet in a formal model framework	yellowfin bream, sea mullet, sand whiting, yellowtail and silver trevally
4	The assessment is still under development or is only completed at an elementary level. Data underlying the assessment may be questionable (such as the use of only fishery dependent data). Overly simple assumptions may have been used.	eastern sea garfish, luderick and blue mackerel
No assessment	No formal assessment of the stock status has been completed	Australian salmon, pilchard, sweep, sprats, dart, jack mackerel, anchovy and bonito

Even for those species about which something is known, considerable caution will be needed when making conclusions, at least until stock assessments are better developed. Only with increased monitoring and research, as proposed in the FMS, will the levels of confidence outlined in Table E1 improve for most species.

Table E1. Information on the current stock status, including stock assessment reliabilities and levels of confidence in making predictions regarding stock status for the target species of the Ocean Hauling Fishery.

Species	Exploitation status +	Stock levels (exploitable) +	Stock levels (spawning) +	Five year catch trend in the Ocean Hauling Fishery	Stock assessment reliability +	Confidence in making predictions regarding stock status
sea mullet**	fully fished	appears adequate	uncertain	decreasing	3	moderate
Australian salmon	unknown			fluctuating	no assessment	low
yellowfin bream**	fully fished	adequate	probably adequate	decreasing	3	moderate
eastern sea garfish	overfished	uncertain	uncertain	decreasing	4	low-moderate
luderick**	moderately fished	probably adequate	probably adequate	decreasing	4	low-moderate
sand whiting*	moderately fished	adequate	probably adequate	decreasing	3	moderate
pilchards	unknown			decreasing	no assessment	low
yellowtail	fully fished	uncertain	uncertain	increasing	3	moderate
blue mackerel	moderately to fully fished	uncertain	uncertain	fluctuating	4	low-moderate
sweep	unknown			decreasing	no assessment	low
sprat (at least 3 species)	unknown			fluctuating	no assessment	low
jack mackerel	unknown			stable	no assessment	low
dart	unknown			increasing	no assessment	low
silver trevally*	fully to overfished	inadequate	probably adequate	decreasing	3	moderate
anchovy	unknown			fluctuating	no assessment	low
bonito	unknown			increasing	no assessment	low

+The definition of terms is provided in the draft FMS (Table C12 in Chapter C) and in NSW Fisheries (2001)

*Information largely derived from fisheries other than the Ocean Hauling Fishery

**Information largely derived from all commercial harvest fisheries

Of the species listed in Table E1, stock assessment information on sea mullet, yellowfin bream, luderick, sand whiting, yellowtail, blue mackerel and silver trevally can be found in "NSW Fisheries – Status of Fisheries Resources 1999/2000" (NSW Fisheries, 2001). Stock assessment information on eastern sea garfish is presented in Smith (2001), and catch trends for these eight species plus Australian salmon, pilchards and sweep are provided in Appendix B1. A summary of the stock assessment information for those eight species for which it is available is provided in the following paragraphs.

Sea mullet (*Mugil cephalus*) are exploited predominantly by commercial fishers, and are taken from both estuaries and ocean beaches. For much of the last 50 years, total commercial landings

fluctuated between 2,000 and 3,000 tonnes. However, from about 1985, catches increased sharply to a peak of more than 5,500 tonnes in 1993/94 before declining to less than 2,300 tonnes by 1999/00. The increase occurred in the ocean sector of the fishery, primarily in response to a developing export market for roe. Catch per unit effort appears to have declined in recent years for both estuary and ocean hauling, although it has remained stable for estuary mesh netting. Most of the commercial catch is above the minimum legal length, particularly from ocean waters. The length structure of catches has been relatively stable since the 1940s, however, the average age of mullet in both ocean and estuarine catches has declined since age monitoring began in 1995. The spawning stock level is probably adequate, but is likely to have declined in recent years. Based on a preliminary assessment of the reported commercial catch, and of the available size and age data, the sea mullet stock is assessed as fully fished (Virgona *et al*., 1998; NSW Fisheries, 2001). It should be noted, however, that landings in excess of 4,000 tonnes may be unsustainable.

Yellowfin bream (*Acanthopagrus australis*) are exploited by both commercial and recreational fishers, and are taken by a wide range of methods and from a wide variety of estuarine and inshore habitats. Recreational catches may exceed commercial catches in some areas (West and Gordon, 1994) and preliminary data from the National Recreational and Indigenous Fishing Survey (G. Henry, NSW Fisheries, pers. comm.) confirm the significant recreational catch of this species. Approximately 400 to 600 tonnes of yellowfin bream have been harvested annually by commercial fishers, with catches being greatest in central NSW estuaries and coastal waters between Taree and Sydney. The ocean hauling component of the total commercial catch has fluctuated between 100 and 200 tonnes. Since peaking in the mid 1980s to early 1990s, reported bream catches have steadily declined; however, this has been accompanied by a corresponding decline in effort, along with changes in gear use (notably the discontinuation of pound nets). Most of the commercial catch is above the minimum legal length, with the fish mostly being between three and eight years of age. The overall size composition of commercial landings has remained relatively stable since the early 1950s. The spawning stock level appears to be adequate, and it is likely that a relatively high proportion of bream spawn before being harvested in the fishery. Based on a preliminary assessment of the reported commercial catch, and of the available size and age data, the yellowfin bream stock is assessed as fully fished (Gray *et al.,* 2000a; NSW Fisheries, 2001; Gray *et al*., in review).

Eastern sea garfish (*Hyporhamphus australis*) are exploited primarily by commercial fishers. They are taken from both coastal and estuarine waters, particularly during spring and summer. Between 1953 and 1979, annual commercial catches were relatively stable and averaged nearly 40 tonnes. Several changes in both the method of collection and the development of export markets from the early 1980s saw catches increase to a peak of almost 280 tonnes in 1992/93. However, the commercial catch has since declined significantly, with only 37 tonnes recorded in 1999/00. It is not possible to determine trends in length composition as data are only available since 2000/01. No estimate of spawning stock level is currently available. Based on the sharp declines in commercial catch and catch-per-unit-effort between 1992/93 and 1999/00, it is likely that the eastern sea garfish stock is overfished (NSW Fisheries, 2001; Smith, 2001).

Luderick (*Girella tricuspidata*) are exploited by both commercial and recreational fishers, with the majority of the commercial catch being taken in estuaries. The commercial harvest of luderick from ocean waters has remained relatively stable over the past 40 years, fluctuating around 80 tonnes per annum. Most of the commercial catch is between 25 and 35 cm Fork Length (legal minimum approx. 23 cm FL), with fish sampled from commercial catches in the Clarence River found to be mostly between two and seven years of age. The spawning stock level appears to be adequate.

Based on a preliminary assessment of the reported commercial catch, and of the available size and age data, the luderick stock is assessed as moderately fished (Gray *et al.,* 2000a; NSW Fisheries, 2001).

Sand whiting (*Sillago ciliata*) are exploited by both commercial and recreational fishers, and are taken from estuaries and ocean beaches. Recreational catches may exceed commercial catches in some areas (West and Gordon, 1994), and preliminary data from the National Recreational and Indigenous Fishing Survey (G. Henry, NSW Fisheries, pers. comm.) confirm the significant recreational catch of this species. Estuarine landings dominate the annual catch, with the Ocean Hauling Fishery contributing less than 10% of the total commercial catch. Most of the catch taken in haul nets is above the minimum legal length, with most fish between two and five years of age. The spawning stock level is probably adequate, and it is likely that many sand whiting spawn before being harvested in the fishery. Based on a preliminary assessment of the reported commercial catch, and the available size and age data, the sand whiting stock is assessed as moderately fished (Gray *et al.,* 2000a; NSW Fisheries, 2001).

Yellowtail (*Trachurus novaezelandiae*) are caught by a variety of methods in several different fisheries, although about 80% of reported landings are taken by purse seining in ocean waters. Recent annual landings have averaged approximately 420 tonnes, with most caught south of Sydney, particularly near Wollongong. Total landings (all methods) within the Ocean Hauling Fishery have been increasing since the late 1980s. Preliminary data from 1996/97 indicate that most of the commercial catch consists of fish two or three years old, with ages ranging between one and eleven years. The spawning stock level is uncertain. Based on a preliminary assessment of the reported commercial catch and age data, the yellowtail stock is assessed as fully fished (NSW Fisheries, 2001).

Silver trevally (*Pseudocaranx dentex*) are exploited by both commercial and recreational fishers, and are taken by wide range of methods and from a variety of estuarine and inshore habitats. The annual recreational catch has been estimated at approximately 250 tonnes (G. Henry, NSW Fisheries, pers. comm.), as compared with the 400 tonnes reported by the various commercial fisheries. Approximately six tonnes of silver trevally have been harvested annually by ocean hauling fishers in recent years. Since peaking in the late 1980s, overall reported trevally catches have declined from around 1,500 tonnes to about 400 tonnes. The modal age of trevally in commercial catches has been estimated to have declined from 7-8 years in the late 1980s to only 3-4 years in recent years, and preliminary modelling suggests that silver trevally are often being caught at well below the optimum size (Rowling and Raines, 2000). The spawning stock level is rated as "probably adequate", and recent recruitment levels appear to have been reasonably stable. Based on a preliminary assessment of commercial and recreational catches, and of the available size and age data, the silver trevally stock is assessed as fully to overfished (Rowling and Raines, 2000; NSW Fisheries, 2001).

Blue mackerel (*Scomber australasicus*) are harvested by both recreational and commercial fishers. Reported landings of blue mackerel were about 20 tonnes per annum up until the 1980s, when catches by the purse seine sector increased. Since then, landings have been highly variable and have averaged about 350 tonnes. Most of the commercial catch is comprised of fish of 1-2 years of age, and Stewart *et al.* (1999) found the oldest individuals in the catch to be less than ten years old. However, work in New Zealand on the same species suggests longevity in excess of 20 years (Morrison *et al*., 2001). Based on a preliminary assessment of the reported commercial catch and of the available size and age of commercial landings, the blue mackerel stock is assessed as moderately to fully fished.

Based on the information in Table E1, the level of confidence in making predictions regarding stock status is low for half of the target species taken in the Ocean Hauling Fishery. At best, the confidence levels are only moderate for five of the target species and low to moderate for three species. Improvements in the confidence level associated with the stock assessments are dependent on the implementation of proposed monitoring and assessment programs (draft FMS, Table C11).

ii) Species risk assessment

Likelihood of over-exploitation

Determining the likelihood of a species being over-exploited involves a risk assessment. There are many forms of risk assessment (e.g. Francis and Shotton, 1997), and they can be either quantitative or qualitative (Harding, 1998; Handmer, 1995). The purpose of risk assessment is to use various categories of information about a fishery to determine the likely effects of current and/or alternative management options (Francis and Shotton, 1997). Harding (1998) sets out five logical steps in risk management – risk context, identification, analysis, assessment and treatment. This section of the EIS concentrates on the last three steps, as the draft FMS and Planning NSW guidelines provide the context and identification of the risks. Analysis of the risks (e.g. overfishing) examines the levels of risk involved for a species or habitat (i.e. extreme, high, medium and low). Assessment of risk determines whether a risk level is acceptable or unacceptable. The risk treatment examines what options are available to manage the different levels of risk.

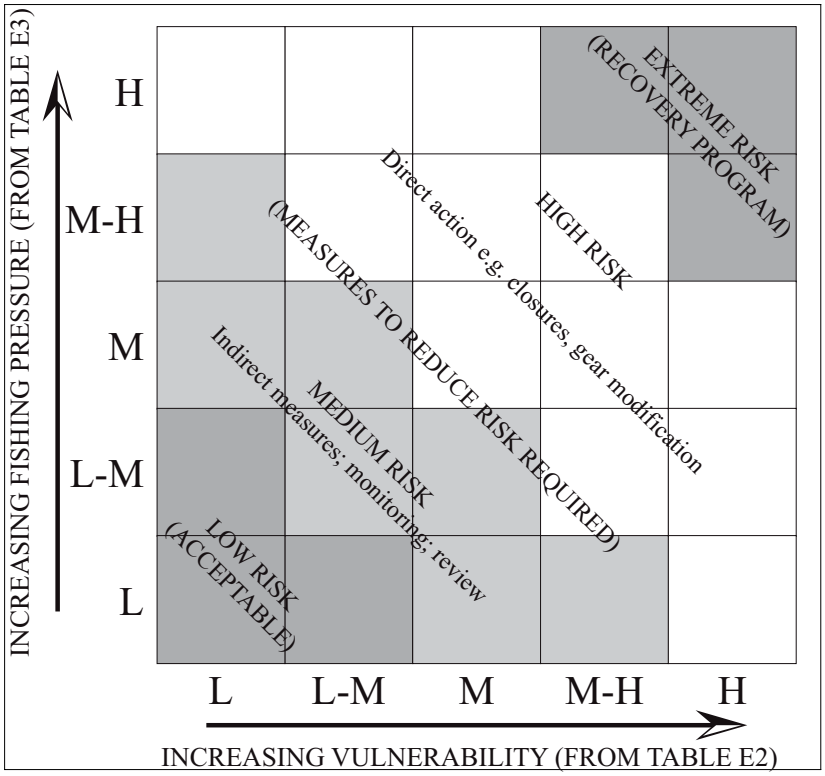

Figure E1. Diagrammatic framework for risk assessment of the target species in the Ocean Hauling Fishery.

(Source: adapted from Harding, 1998)

Figure E1 shows the framework for risk analysis and assessment that was used for determining the likelihood of overfishing of the target species in the Ocean Hauling Fishery. As a precautionary measure, there are more possible combinations that result in a "high risk requiring direct action", as

opposed to the alternative of concluding that a species was "medium risk requiring indirect action". A species' vulnerability to overfishing (determined in Table E2) is matched against the fishing pressure induced by the Ocean Hauling Fishery (Table E3) to determine the overall risk of overfishing by the fishery (Table E4). As numeric data are not available to estimate likelihood, a qualitative risk analysis was undertaken. This risk assessment assumes equal weighting of the vulnerability and fishing pressure axes in Figure E1.

For the Ocean Hauling Fishery, the vulnerability of the species to fishing pressure based on species' biological and habitat attributes was assessed using the species information and references in Appendix B1 of the EIS, with additional expert opinion from fisheries scientists (Table E2).

Table E2. Life history and habitat vulnerability of species taken by the Ocean Hauling Fishery.

Explanations of ratings within each of the specific aspects are given in the following text.

	Vulnerability									
Species/group	**Fishing pressure - life history and behaviour**				**Habitat preference**					**Overall vulnerability**
Specific aspect of vulnerability	reproductive strategy	tendency to aggregate	size (age) when fished	position in food web	preferred habitat.	sensitivity to pollution	likelihood of encountering pollution	fish passage issues	proportion of habitat fished	
sea mullet	l	h	m	l	m	l	h	h	m	M
Australian salmon	l	h	m	h	l	h	l	l	m	M
yellowfin bream	l	m	m	m	h	m	m	h	m	M
eastern sea garfish	m	h	m	l	h	h	l	m	m	M-H
luderick	l	m	m	l	h	m	m	m	m	M
sand whiting	l	m	m	m	m	m	m	m	m	M
pilchards	l	h	m	l	l	h	l	l	m	L-M
yellowtail	l	h	l	l	m	m	m	l	l	L-M
blue mackerel	l	h	m	l	l	h	l	l	m	L-M
sweep	l	h	h	m	l	h	l	l	h	M
sprat (at least 3 species)	l	h	m	l	l	m	l	l	m	L-M
jack mackerel	l	h	m	l	l	h	l	l	h	M
dart	l	m	m	m	l	h	l	l	m	L-M
silver trevally	l	h	h	m	l	m	m	l	m	M-H
anchovy	l	h	m	l	l	m	l	l	m	L-M
bonito	l	h	m	h	l	h	l	l	l	M

Reproductive strategy

Broadcast marine spawners with high fecundities and long pelagic larval stages (most species in the fishery) have been classed as "low". Species or groups believed to spawn exclusively within estuaries (most garfish) have been classed as "medium". None of the target species taken in the Ocean Hauling Fishery have such limited reproductive capacities as to warrant a classification of "high" (an example of "high" would be some sharks, which produce one or two pups every second year).

Tendency to aggregate

Those species which often form large dense schools, whether for spawning, migration, or any other reason (e.g. sea mullet), have been classified as "high". Species that form loose aggregations

have been classified as "medium", whilst those that do not normally school or aggregate have been classified as "low".

Size (age) when fished

Species mostly retained near or before their size (age) of first maturity are classified as "high" (e.g. silver trevally). Those mostly taken above their size (age) of first maturity are classified as "low" (e.g. yellowtail) and those typically taken at a wide ranges of sizes (ages) with respect to first maturity are classified "medium" (e.g. yellowfin bream and luderick). Classifications with respect to this factor are based on available size and age-based catch data and information on life histories (SPCC, 1981; NSW Fisheries, 2001; Scandol and Forrest, 2001; Appendix B1; Appendix E1).

Position in food web

Species that primarily consume detritus, algae, sessile invertebrates and/or very small (typically planktonic) animals are classified as "low". Those species mainly eating fish and/or large invertebrates (i.e. predatory species) are classified as "high", whilst those species with broad diets, or which prey on small invertebrates such as worms and molluscs, are classified as "medium".

Sensitivity of preferred habitat

Species that usually occur in association with marine vegetation for a large portion or a critical period of their lifecycle are classified as "high". Those species that infrequently utilise vegetated habitats are classified as "medium", and the more pelagic species are classified as "low".

Sensitivity to pollution

There is no readily available literature for the species in the fishery to provide a definitive classification for this subsection. For the purposes of this assessment, species that regularly enter brackish or freshwaters, where water quality is often poor in comparison to marine waters, are classified as "low". Whilst it may not necessarily follow that those species normally only found in marine waters are highly sensitive to pollution, as it is only meant as an indicative guide, that scenario is applied in Table E2. Species that fall between these extremes are therefore classified as "medium".

Likelihood of encountering pollution

Continuing with the scenarios described above, those species that regularly utilise brackish or freshwaters are considered more likely to encounter waters of lower quality, and are thus classified as "high". Conversely, those species with predominantly marine life histories are classified as "low", and those species that regularly enter the lower reaches of estuaries are classified as "medium".

Fish passage issues

The Ocean Hauling Fishery focuses on the capture of species in an open marine environment. As a consequence, the passage of fish during time of harvest is not considered an issue. Some of the species within the fishery, however, spend part of their life cycle in estuarine and/or freshwaters (e.g. yellowfin bream and sea mullet) and may therefore be impacted upon by barriers to fish passage. Species that regularly enter tributary rivers, streams or channels are classified as "high". Species that only occasionally enter such confined waters are classified as "medium", while those that rarely or never enter such waters are classified as "low".

Proportion of habitat fished

Species that are likely to be sought throughout most of their usual habitat range are classified as "high"; these species tend to remain confined to a single habitat niche and/or are easily accessible to fishers throughout their adult life. Those that often utilise habitats that are inaccessible or difficult to fish intensively are classified as "low". Most species fall between these extremes and are classified as "medium".

Table E3. Overall assessment of the fishing pressure associated with each of the target species in the Ocean Hauling Fishery.

Species/group	Fishing pressure					
	Average harvest (tonnes*) in the Ocean Hauling Fishery	Estimated average commercial and recreational harvest in NSW (tonnes*)	Ocean Hauling harvest as a percent of total harvest	Codified level of harvest by the Ocean Hauling Fishery	Codified stock status (from Table E1)	Overall fishing pressure by the Ocean Hauling Fishery
sea mullet	1483	3358	44	m	m	M
Australian salmon	265	393	67	h	u	H
yellowfin bream	48	800	6	l	m	L-M
eastern sea garfish	85	103	83	h	h	H
luderick	67	754	9	l	m	L-M
sand whiting	8	182	4	l	m	L-M
pilchards	177	186	95	h	u	H
yellowtail	402	495	81	h	m	H
blue mackerel	444	524	85	h	m	H
sweep	37	100	37	m	u	H
sprat (at least 3 species)	62	68	91	h	u	H
jack mackerel	15	85	18	l	u	H
dart	10	35	29	m	u	H
silver trevally	6	372	2	l	h	M
anchovy	13	20	65	h	u	H
bonito	5	242	2	l	u	H

Note: in other fishery EIS, this table includes a column describing the level of bycatch for each species in the fishery. That information could not be included in this EIS, as there is no quantitative information, although anecdotal reports suggest it is low. * see text for explanation of data sources.

To maintain consistent terminology between tables E3 and E1, a codified stock status was used in Table E3 based on the status described in Table E1. The equivalent phrase from Table E1 for "m" in Table E3 is moderately or fully-fished; "h" is fully to overfished; and "u" is unknown or uncertain. As a precautionary measure, wherever the stock status of a species is unknown, this assessment has determined that the overall fishing pressure by the Ocean Hauling Fishery must be high, irrespective of the harvest level by the fishery. For example, the fishery only accounts for 2% of the total bonito harvest for the State, but as there is no information about the stock, fishing pressure is considered to be high and in need of direct action within the FMS. For the codified level of harvest, "l" is ≤20%, "m" is 21-49%, and "h" is ≥50%.

The fishing pressure on the species and the relative contribution of the Ocean Hauling Fishery (Table E3) are based on the commercial fish catch database harvest tonnage averaged for the years 1997/98, 1998/99 and 1999/00 (NSW Fisheries, 2000). The estimated total harvest by all sectors is derived from the commercial fish catch database harvest tonnage averaged for the years 1997/98, 1998/99 and 1999/00, preliminary data from the National Survey of Recreational and Indigenous

Fishers (G. Henry, NSW Fisheries, pers. comm.) and data from Anon (1981), Henry (1984, 1987), Henry and Virgona (1980), Henry *et al.* (1987), Steffe *et al.* (1996a and b), Steffe (2001), West and Gordon (1994) and Williams *et al.* (1993). The preliminary recreational harvest data from the National Survey of Recreational and Indigenous Fishers are estimates of the total number of kept fish by species, unweighted for the statistical divisions of the State's population. These estimates were converted to weights using data on the median length or weight of retained fish for individual fish species from the above referenced recreational fishing surveys. Where necessary the fish and invertebrate lengths were converted to weight using the length/weight conversion keys in Steffe *et al.,* (1996a).

The overall stock status of target species within the Ocean Hauling Fishery (Table E1) is based on information derived from the Ocean Hauling Fishery and from other commercial sectors. The vulnerability of each species (Table E2) was determined independently of the Ocean Hauling Fishery. The fishing pressure associated with each species (Table E3) was determined based on the impact of the Ocean Hauling Fishery relative to all other harvest sectors (commercial and recreational). The information in Tables E1, E2 and E3 are the basis for the risk assessment presented in Table E4.

This risk assessment (Table E4) shows that of the 16 target species in the fishery, one is an extreme risk of overfishing and 12 are a high risk of overfishing without immediate management measures. Three species are a medium risk and may only require indirect management measures. Of the 12 species considered as high risk, seven were included due to the precautionary approach adopted in this assessment, i.e. by considering all species with an unknown stock status to be under high fishing pressure by the Ocean Hauling Fishery. Table E4 also suggests that the draft FMS proposes appropriate management responses, and the degree of that adequacy is discussed in section b.

Table E4. Risk assessment for each of the target species in the Ocean Hauling Fishery.

"Overall risk" based on the intersection of vulnerability and fishing pressure as per Figure E1 above. "Direct action" refers to management approaches such as fishing closures, gear modifications and size limits; "Indirect measures" refers to approaches such as monitoring and review.

Species/group	Vulnerability (Table E2)	Fishing pressure (Table E3)	Overall risk for each species (Figure E1)	Required management (Figure E1)	FMS match to required management
sea mullet	M	M	High	Direct action	Yes
Australian salmon	M	H	High	Direct action	Yes
yellowfin bream	M	L-M	Medium	Indirect action	Yes
eastern sea garfish	M-H	H	Extreme	Recovery Program	Yes
luderick	M	L-M	Medium	Indirect action	Yes
sand whiting	M	L-M	Medium	Indirect action	Yes
pilchards	L-M	H	High	Direct action	Yes
yellowtail	L-M	H	High	Direct action	Yes
blue mackerel	L-M	H	High	Direct action	Yes
sweep	M	H	High	Direct action	Yes
sprat (at least 3 species)	L-M	H	High	Direct action	Yes
jack mackerel	M	H	High	Direct action	Yes
dart	L-M	H	High	Direct action	Yes
silver trevally	M-H	M	High	Direct action	Yes
anchovy	L-M	H	High	Direct action	Yes
bonito	M	H	High	Direct action	Yes

b) Assessment of retained species management measures in the draft FMS

i) Adequacy of the draft FMS for the different categories of stock exploitation

External factors likely to affect stock status

Before discussing the various categories of stock exploitation within the fishery, it is important to highlight that the stock assessments are at various levels of development. Furthermore, whilst the draft FMS may improve upon the assessments, there are external factors affecting stocks, which are generally beyond the control of the FMS. They include stock resilience and external environmental influences, both human-related and natural (see Chapter F, section 10). Whilst such factors are beyond the direct control of the fishery, they do need to be considered within the draft FMS, both in terms of allowing for any potential negative influences on stock status, and in terms of their indirect control.

The resilience of a stock refers to that stock's ability to recover after having been affected by previous fishing pressure (Underwood, 1989; Skilleter, 1995). For the species taken in the Ocean Hauling Fishery, there is no specific information on resilience. The aspects of vulnerability presented in Table E2, however, would provide some indication of resilience for each of the target species, as recovery potential is likely to be strongly tied to these aspects, and especially to reproductive strategy. On the basis of the limited information available (Table E3), it is likely that most of the target species are fairly resilient to fishing pressure, with the possible exception of eastern sea garfish, which may spawn wholly within estuarine environments. Most of the target species are broadcast marine spawners, with high fecundity and a long pelagic larval stage, features that would assist any recovery, particularly in the case of localised and/or short term depletion (Skilleter, 1995).

Species within the Ocean Hauling Fishery that utilise sensitive estuarine habitats (such as seagrass) for at least part of their life cycle (particularly as juveniles) are potentially more vulnerable to external influences. These may include yellowfin bream, luderick, eastern sea garfish, sand whiting and sea mullet. The threat is two-fold, for not only can stock numbers be directly affected in the event of major habitat loss, but so can the recovery ability (i.e. resilience) of dependent species. Even if a depleted species can still produce large numbers of widely dispersed larvae, its harvestable population would be unlikely to recover if there was insufficient habitat available to support the settlement of larvae and growth of juveniles.

Other external factors that affect stock status are weather and oceanographic conditions, pollution attributable to point sources and commercial and recreational uses of nearshore waters. These factors, particularly weather and oceanographic conditions, can significantly affect the distribution, abundance, behaviour and recruitment of fish, and can include short term changes, such as wind patterns, and longterm changes, such as El Nino and the Eastern Australian Current. These factors, whilst external to the fishery, need to be considered during the formulation and analysis of stock assessments, as they can account for significant variations in fish catch beyond the effort or technology associated with the fishery. The role that these factors have in affecting the fishery as a whole is discussed in section 10 of Chapter F.

Categories of stock status in the Ocean Hauling Fishery

The classification of all target species in the Ocean Hauling Fishery is provided in Table E1, and the management responses proposed in the draft FMS to address each of those groups are provided in Tables E5-E7. The classifications and appropriate tables of management responses are summarised as:

Moderately fished: luderick and sand whiting; Table E5

Moderately to fully fished: blue mackerel; Table E6

Fully fished: sea mullet, yellowfin bream and yellowtail; Table E6

Overfished/depleted: eastern sea garfish and silver trevally; Table E6

Unknown: Australian salmon, pilchards, sweep, sprat, jack mackerel, dart, anchovy and bonito; Table E7

It should be noted that overfished species can be either 'growth overfished' and/or 'recruitment overfished' (NSW Fisheries, 2001). Growth overfishing refers to the excessive harvesting of relatively young individuals of a stock, such that the biomass yield is reduced. Recruitment overfishing refers to a situation in which fishing pressure has caused a significant reduction in a stock's reproductive success, such that the recruitment of young fish into the fishery is reduced.

As previously stated, conditional target species (Table C13) have not been considered under this assessment or in previous stock assessments of this fishery. The Commonwealth and other State fisheries that are the primary harvesters of those species will be responsible for the overall management and development of stock assessments for those species. Leadenall and diamondfish are primarily harvested by the Ocean Hauling Fishery, but are unlikely to receive formal stock assessments in the near future due to current low catch levels.

Moderately fished species

Within the Ocean Hauling Fishery, two species (luderick and sand whiting) are classified as being moderately fished according to the latest stock assessments by NSW Fisheries, which were based on data from this and other fisheries in NSW. These species are believed to be able to support only a limited increase in catch without facing the threat of decline (NSW Fisheries, 2001). The risk assessment for these species also suggests that there is only a moderate risk of overfishing within the Ocean Hauling Fishery (Table E4), and that the draft FMS proposes appropriate, indirect management responses. In fact, for both of these species, the draft FMS proposes some direct responses, foremost of which are those relating to the development and/or improvement of stock assessments for the target species within five years (Table E5). Given the low-moderate confidence associated with the current level of stock assessments for these species, the responses are seen both as adequate and suitably precautionary. They aim to prevent such species facing pressures similar to those faced by overfished or depleted species.

Other responses important for the moderately fished species include the continuation of gear and size restrictions, further protection of key habitat such as seagrass beds, other measures to improve our knowledge of the biology of target species and the level of bycatch from current fishing methods. These measures will improve our knowledge of these species and assist in the review and refinement of future management strategies to ensure sustainability.

Table E5. Direct measures within the FMS most relevant to moderately fished species.

FMS Measures (Chapter 3)			Summary of purpose/action	Likely outcomes from implementation of responses
Goals	**Objectives**	**Responses**		
1			Conserve biological diversity	
	1.1		Minimise impact on non-retained fish	
		1.1a	Implement scientific observer program	bycatch quantified
		1.1b	Modify practices to reduce bycatch	bycatch reduced
		1.1c	Use best practice for handling bycatch	mortality reduced
	1.2		Minimise impact on habitats	
		1.2a	MAC contributes to habitat policy development	available habitat increased
		1.2b	Modify damaging practices	available habitat increased
		1.2c	Prohibit vegetation damage esp. hauling over seagrass beds	habitat protected
2			Maintain fish populations at sustainable levels	
	2.1		Avoid overfishing; control size, age, amount etc.	
		2.1a	Monitor length, age and sex composition of landings	risk of change in catch composition reduced
		2.1b	Stock assessments for target species	stock dynamics and size
		2.1c	Gear restrictions continued and expanded	risk of overfishing reduced
		2.1d	Size limits	juvenile mortality reduced
	2.2		Manage levels of active effort	
		2.2d	Implement minimum share holdings to determine access	active effort better known and controlled
	2.3		Manage levels of latent effort	
		2.3a	Establish minimum entry requirements at business level	catch sustainability improved
4			Appropriately share the resource	
	4.2		Share resource among commercial fisheries	
		4.2a	Monitor catch rates outside NSW jurisdiction	health of, and pressure on total stock understood
		4.2b	Monitor catch rates within other fisheries	total effort understood
8			Improve knowledge of species	
	8.1		Promote scientific research	
		8.1a	Monitor quantities of all species by each net	targeting practices understood

Moderately to fully fished and fully fished species

Within the Ocean Hauling Fishery, blue mackerel are classified as being moderately to fully fished and three species (sea mullet, yellowfin bream, and yellowtail) are classified as being fully fished according to the latest stock assessments. In line with the precautionary principle, the assessment of draft FMS objectives has considered blue mackerel to be fully fished. All of these species, except for blue mackerel, have a moderate confidence level associated with their stock assessments, which have been assessed to stage three (Table E1). The confidence associated with blue mackerel is low to moderate as a stock assessment for that species is incomplete.

For fully fished species, current catches are thought to be sustainable and close to optimal levels, although any significant increase in fishing effort may lead to overfishing and stock depletion (NSW Fisheries, 2001). For these species, the goals, objectives, performance measures and trigger points of the draft FMS include measures to prevent overfishing (by means such as limiting gear dimensions and the sizes at which individuals can be taken), monitoring of total harvest, and the consideration of review triggers against historic harvest levels.

Table E6. Direct measures within the FMS most relevant to fully fished and overfished species.

FMS Measures (Chapter 3)			Summary of purpose/ action	Likely outcomes from implementation of responses
Goals	**Objectives**	**Responses**		
1			Conserve biological diversity	
	1.1		Minimise impact on non-retained fish	
		1.1a	Implement scientific observer program	bycatch quantified
		1.1b	Modify practices to reduce bycatch	bycatch reduced
		1.1c	Use best practice for handling bycatch	mortality reduced
	1.2		Minimise impact on habitats	
		1.2a	MAC contributes to habitat policy development	available habitat increased
		1.2b	Modify damaging practices	available habitat increased
		1.2c	Prohibit vegetation damage esp. hauling over seagrass beds	available habitat increased
	1.4		Prevent the introduction of marine pests and diseases	
		1.4a	Implement NSW marine pest or disease management plans within OHF	habitat condition mortality and reduced competition
2			Maintain fish populations at sustainable levels	
	2.1		Avoid overfishing; control size, age, amount etc.	
		2.1a	Monitor length, age and sex composition of landings	risk of change in catch composition reduced
		2.1b	Stock assessments for target species	stock dynamics and size
		2.1c	Gear restrictions continued and expanded	risk of overfishing reduced
		2.1d	Size limits	juvenile mortality reduced
	2.2		Manage levels of active effort	
		2.2c	Species-based closures for short-term response	risk of stock collapse reduced
		2.2d	Implement minimum share holdings to determine access	active effort better known and controlled
		2.2e	Develop policy for bait collection by Commonwealth Tuna fishery	total catch understood, overfishing risk reduced
		2.2f	Develop policy for lift net use by line fishers	total catch understood, overfishing risk reduced
		2.2i	Develop an index of relative fishing power between boat-based and beach-based hauling	controls effort shift from beach to boat
	2.3		Manage levels of latent effort	
		2.3a	Establish minimum entry requirements at business level	catch sustainability improved
	2.5		Promote recovery of overfished species	
		2.5a	Implement recovery programs for overfished species where the OHF is major harvester	risk of stock collapse reduced
		2.5b	Contribute to recovery programs implemented by other fisheries where the fishery is a minor harvester	risk of stock collapse reduced
		2.5c	Implement precautionary actions during a recovery program	increased likelihood of species recovery
		2.5d	Consultation with other harvesters over silver trevally recovery program	likelihood of recovery increased
	2.5.1		Implement recovery program for garfish	
		2.5e	Remove garfish bullringing nets	fishing pressure reduced
		2.5f	Extend zoning scheme to all boat based haulers	localised fishing pressure reduced
		2.5g	Monitor the impact of zoning extension	effort reduction understood

Table E6 (cont.).

FMS Measures (Chapter 3)			Summary of purpose/ action	Likely outcomes from implementation of responses
Goals	**Objectives**	**Responses**		
		2.5h	Identify active effort and implement minimum share holding restrictions	active effort controlled/reduced
		2.5i	Remove 25 mm garfish net concession	reduced damage on catch; reduced juvenile mortality
		2.5j	Extend weekend hauling closure to all year for garfish hauling	reduced effort
	2.5.2		Improve stock assessment for sea garfish	
		2.5k	Research retention rate of various net sizes	bycatch reduced
		2.5l	Continue garfish research	improved stock knowledge
4			Appropriately share the resource	
	4.2		Share resource among commercial fisheries	
		4.2a	Monitor catch rates outside NSW jurisdiction	health of, and pressure on, total stock understood
		4.2b	Monitor catch rates within other fisheries	total effort understood
8			Improve knowledge of species	
	8.1		Promote scientific research	
	8.1.1		Continue mullet stock assessment monitoring	
	8.1.2		Continue bream stock assessment monitoring	
		8.1a	Monitor quantities of all species by each net	targeting practices understood
		8.1b	Sea mullet stock assessment continued	improved knowledge of stock
		8.1c	Yellowfin bream stock assessment continued	improved knowledge of stock
	8.2		Quality of catch and effort information	
		8.2d	Ensure catch and effort recordings accurately reflect circumstance	improved knowledge of stock
		8.2e	Report fish observed but not caught	improved knowledge of stock and escape rate

The proposed measures within the draft FMS pertaining to fully fished species focus primarily on improving the knowledge of stocks (Table E6). Sea mullet and yellowfin bream represent two of the most important species within the Ocean Hauling Fishery, and improvements in the stock assessments will be critical to the long-term sustainability of these species, both of which have suffered declines in recent catch history. Improved assessments will also be beneficial for management of stocks of yellowtail, because despite having been assessed to stage 3, the exploitable and spawning stock levels of this species remain unknown. The improved stock assessment will be assisted by the implementation of a scientific observer program, which will improve knowledge of active effort and help quantify the extent and composition of bycatch within the fishery. The implementation of share allocation, and in particular the use of minimum share holdings to determine access to the gear type may provide substantial benefits, particularly for the management of beach-based hauling teams. Estimates of effort for beach-based crews have been historically inaccurate due to the loose associations allowed under the current endorsement system and variations in how catch and effort are reported. The implementation of minimum share requirements for teams, and a pro-rata requirement for larger teams to hold an appropriate number of shares, will provide improved knowledge and management of active effort within the fishery. It will also assist in the management and ultimate removal of latent effort from within the fishery

While sea mullet are classified as fully fished, trends in both the total catch and catch per unit effort should be closely monitored. Recent sharp declines in the total commercial landings have

followed pronounced increases in the historical catch level largely due to the development of an export market for roe to Asia. The combination of increased effort due to changes in profitability, sharp increases in catch and the targeting of pre-spawning aggregations has the potential to place significant pressure on the long-term sustainability of the resource.

Targeting aggregations of fish is standard practice in many fisheries around the world, as it allows for the efficient harvest of large volumes of fish. Such aggregations are often associated with spawning. This has led to overfishing in some fisheries, such as the Californian and Sumatran mackerel fisheries and the eastern gemfish fishery. The issue of targeting of spawning aggregations is often raised by members of the public who associate the practice with overfishing. However, biologically the timing of capture relative to the spawning period is much less important than the proportion of the stock taken. This is particularly true of long-lived species such as bream and luderick. The fact that these species remain popular target species despite being subject to these sorts of practices for 100 years suggests that these practices are probably sustainable. Recent declines of some species in the fishery are of concern, however, the draft strategy proposes stock assessments, performance monitoring, species closures and net restrictions (ensuring the general purpose haul net is not used in offshore waters) in order to prevent the overfishing of species during spawning migrations along the coast.

Steadily increasing landings of yellowtail are of concern given its status as a fully fished species and the belief within sectors of the fishery that reported catch may not be a true reflection of the actual catch. Improved catch reporting, consideration of the bait usage by the Commonwealth tuna fishery and analysis of the age/maturity at capture proposed in the FMS will be vital to ensure that landings of this species do not continue to increase to the point where they become overfished.

Proposed measures within the draft FMS to regulate the harvesting of bait by lift nets and through the Commonwealth tuna fishery have the potential to substantially improve our knowledge of yellowtail and blue mackerel catches and stocks. The total catch of yellowtail and blue mackerel (as well as pilchards) is largely unknown, with fishers only required to report bait captured for own use since 1997. Additionally, the current recorded catch is believed to be well under actual levels, and there is still no reliable recording mechanism for the Commonwealth tuna fleet. Incorporating the use of lift nets within a restricted fishery is an essential component of furthering knowledge of bait species through stock assessments. No stock assessment of yellowtail or blue mackerel can be considered robust or reliable until the extent of catch taken for bait is more accurately quantified. The establishment of a trigger point and a timeframe for bait collection management is required to strengthen the draft FMS.

Both species would also benefit from the monitoring of catch levels and management structure in fisheries outside NSW jurisdiction. The Commonwealth Small Pelagic Fishery (SPF) makes no distinction between the five small pelagic species in its catch including jack mackerel, yellowtail and blue mackerel. At present, very little is known about the level or composition of catch from the SPF. The lack of differentiation between three species treated individually in the Ocean Hauling Fishery has the potential to cause difficulties when compiling robust stock assessments or estimates of total biomass. Improved knowledge of the size and composition of the catch of the Commonwealth SPF will benefit the management of stocks in the Ocean Hauling Fishery.

A future influence on the sustainability of blue mackerel stocks may come from the proposed processing operation planned for Eden. The operation of such a facility would add value to certain species, namely blue mackerel. It is envisaged that much of the demand would be met by the

Commonwealth SPF, which is likely to preferentially target blue mackerel schools to maximise supply to the Eden processing plant (D. Ferrell, NSW Fisheries, pers. comm.). The potential implications for the combined level of active effort across all sectors is of concern, especially given the level of uncertainty surrounding the status of the stock and the variability in historic commercial catch levels.

Overfished species

Within the Ocean Hauling Fishery, eastern sea garfish and silver trevally are classified as overfished and fully to overfished, respectively, according to the latest stock assessments. That eastern sea garfish are classified as overfished in the absence of a completed stock assessment (Table E1) suggests that the species is at risk of becoming depleted in the absence of suitable measures within the draft FMS. The risk assessment (Table E4) also identified that possibility and recommended the implementation of a recovery program for the species, as proposed in the draft FMS. The success of the recovery program will be crucial to return the stock, and thus fishery, to a more sustainable level.

For both of these species, the goals, objectives, management responses and associated trigger points of the Ocean Hauling draft FMS aim to reduce current exploitation rates in order to increase the likelihood of stock recovery, and prevent the stocks from becoming further depleted. A summary of the direct and indirect measures within the draft FMS that relate to overfished species are provided in Table E6.

As with most of the species within the Ocean Hauling Fishery, stock assessment information is limited and highly dependent on commercial catch data. As a result, management responses should be precautionary in nature to allow for changes in the assessment status of the stock. More robust stock assessments will afford greater confidence in management decisions and allow more targeted and proscriptive responses.

Chapter C (the draft FMS) lists the sustainability of eastern sea garfish as being one of the key management issues facing the Ocean Hauling Fishery. Accordingly, specific responses are provided for eastern sea garfish within the broader objective of promoting the recovery of overfished species. The other overfished species in this fishery, silver trevally, is caught in greatest numbers by the Ocean Fish Trawl Fishery, and as such, the recovery program for the species will be prepared under the FMS for that fishery. As the Ocean Hauling Fishery is not the primary harvester of silver trevally, responses under the broader objective are restricted to consultation with all silver trevally harvesters to develop the recovery program . Management responses within the draft FMS for the Ocean Hauling Fishery have a limited capacity to affect change in the overall sustainability of the stock, as the Ocean Hauling Fishery accounts for less than 2% of the reported catch. Combined with the more general initiatives to promote stock sustainability, the measures within the draft FMS would appear adequate in terms of this limited capacity.

Direct measures within the draft FMS designed to improve the sustainability and promote the recovery of eastern sea garfish include:

- removal of bullringing nets from the Ocean Hauling Fishery – subject to negotiation with industry and relevant MAC
- extension of the zoning scheme to incorporate boat-based haulers (limiting all fishers to single regions)
- enforcement of the existing weekend closures to include all garfish hauling, and to extend the closure to all year, not just weekends in summer

- identification of active effort for the garfish hauling net and implementation of minimum shareholdings
- removal of the concession for the use of 25 mm garfish nets and implementation of research to assess the suitability of larger mesh sizes if appropriate.

In addition, the draft FMS proposes specific research and monitoring programs aimed at quantifying the impact of the above measures and the impact of certain gear types on the resource. These programs include:

- monitoring the impact of zone-based hauling on stock harvest
- describing the retention and meshing rate of 28 mm and larger mesh sizes.

Combined with the more general management responses for overfished and fully fished species (Table E6), the initiatives contained in the draft FMS are an important step towards the recovery of eastern sea garfish. One of the main threats to the recovery of this species is the number of endorsed fishers (87) who may target it. The draft FMS proposes to limit the active effort within the fishery through an increase in minimum shareholdings. Structural adjustment through minimum share requirements provides a powerful mechanism for controlling active effort; however, the timeframe for the implementation of share management plans and the subsequent period required for share re-adjustment have the potential to be lengthy processes. The success or otherwise of long-term controls on active effort are dependent on the implementation of share management. The draft FMS proposes the timeframe of July 2003 for the allocation of shares and a similar two year time period from the commencement of the strategy for the establishment of minimum share holdings to reduce active effort. This differs from the fishery-wide response of minimum share holdings being established within two years of the allocation of shares. Given the current declines in the annual harvest and the uncertainty associated with alternative management measures (see below), the allocation and restriction of shares within the specified timeframe is of utmost importance to the sustainability of the fishery.

Four other management initiatives may have a more immediate impact on fishing effort for eastern sea garfish. As listed above, the removal of bullringing nets from the Ocean Hauling Fishery, the enforcement of existing weekend closure rules, the extension from summer to year round weekend closures, and the extension of the zoning scheme to include boat-based haulers are all designed to reduce overall effort on the stock. The impact of these responses is largely unknown, however, their potential to affect change is varied. Removing of bullringing nets is unlikely to have a significant impact on effort within the Ocean Hauling Fishery, as it is not a widely used method. There are currently 21 fishers holding bullringing endorsements within the fishery and of these, 17 have endorsements to use garfish hauling nets. The management initiative may change the method by which the fish are harvested, however, impact on overall effort would probably be minimal.

The remaining responses are likely to reduce effort within the fishery over the short-term. The enforcement and extension of weekend closures, in conjunction with the extension of zoning restrictions, should impact upon active effort. The extent of this impact is unknown, however, for it is unclear how many fishers regularly fish in multiple regions and how much effort is expended on weekends, thus it is difficult to quantify the impact of the management measures. This highlights the importance of monitoring the impact on effort, particularly with respect to the extension of zoning restrictions to all garfish hauling. Until the implementation of share management and the

establishment of associated effort controls through minimum share holdings, the monitoring of any changes in effort that may result from the planned management responses is essential.

The establishment of seasonal and area closures has been proposed in the draft FMS in the event that zoning does not have an immediate impact on landings of garfish. The draft FMS provides an estimate of the rate or level of an immediate impact, but does not provide information or justification for the use of that particular level. The justification for the level should be based on, and intrinsically linked to some aspect of the biology or stock assessment for the species. As stock assessments are proposed as part of the recovery program for the species, it is recommended that until they are completed, a more precautionary level should be adopted for determining the need for seasonal closures. As a minimum, it is recommended that this level be set at 50%.

Whilst considered an effective and stronger response to the problem than most others proposed in the draft FMS, it is recommended that the FMS present stronger measures in the event of setting off a trigger point, or failing to attain a reduction in landings for overfished species. These stronger measures should involve a combination of seasonal (as proposed) and gear closures. As boat-based hauling accounts for the majority of the catch for sea garfish, it may be necessary to implement closures to boat-based garfish hauling. The closures could entail a certain time of year and/or modifications to the nets beyond the proposal in the draft FMS to investigate retention and meshing rates of 28 mm mesh. Similar measures should be considered for any other species that is determined as overfished following the completion of the proposed stock assessments.

Unknown

Eight species within the Ocean Hauling Fishery (Australian salmon, pilchards, sweep, sprat, jack mackerel, dart, anchovy and bonito) are classified as unknown. For these species, there is little or no information from which to make an assessment of the stock. The goals and objectives of the draft FMS that specifically relate to "unknown species" are focused on improving our knowledge of these species (Table E7). Specifically, the development of stock assessments for all target species, implementation of the scientific observer program, and monitoring the accuracy of catch identification should significantly improve current knowledge of the target species.

The smaller baitfish species that are classified as unknown are most likely to benefit from the development of stock assessments and the proposed monitoring of the accuracy of catch identification through the scientific observer program. The catch data for sprat, anchovy and pilchard are believed to be unreliable due to confusion over the species identification and composition of some catches (K. Smith, NSW Fisheries, pers. comm.). Reliable stock assessments will not be possible until there is confidence in the accuracy of catches reported by fishers. The results from such a study may necessitate a process of standardisation for labelling catches if anomalies are shown to be present.

Pilchards will also benefit from the implementation of policies governing their capture by fisheries currently managed by the Commonwealth and other fisheries managed by NSW Fisheries. To adequately determine the stocks of pilchards, there must be inter-governmental liaison and agreement as to the best approach for the management of the different fisheries, and to maintain a consistent catch recording system. Catch data should also be stored and analysed in a central location, but also be readily available to other stakeholders. The inability to establish a holistic understanding of the stock of this species could lead to significant temporal closures to allow the stocks to recover from overfishing. For example, closures introduced following an outbreak of a virus in the species in 1995 and 1998 do not appear to have aided a recovery of the stock levels in NSW, and so any further closures with the same aim would necessarily have to be of greater duration, location or method-

specific. This species is an important prey species for numerous species of fish, including some within the Ocean Hauling Fishery, other fisheries and marine mammals and birds. The mismanagement of this species has the potential to have wide-ranging impacts, both ecological and economic.

Table E7. Direct measures within the FMS most relevant to unknown species.

FMS Measures (Chapter C)			Summary of purpose/action	Likely outcomes from implementation of responses
Goal	**Objective**	**Response**		
1			Conserve biological diversity	
	1.1		Minimise impact on non-retained fish	
		1.1a	Implement scientific observer program	bycatch quantified
		1.1b	Modify practices to reduce bycatch	bycatch reduced
		1.1c	Use best practice for handling bycatch	mortality reduced
		1.1d	Continue gear restrictions	risk of overfishing reduced
		1.1e	Continue prohibition of explosive devices	risk of overfishing reduced
	1.2		Minimise impact on habitats	
		1.2a	MAC contributes to habitat policy development	available habitat increased
		1.2b	Modify damaging practices	available habitat increased
		1.2c	Prohibit vegetation damage esp. hauling over seagrass beds	available habitat increased
	1.4		Prevent the introduction of marine pests and diseases	
		1.4a	Implement NSW marine pest or disease management plans within Ocean Hauling Fishery	habitat condition mortality and reduced competition
2			Maintain fish populations at sustainable levels	
	2.1		Avoid overfishing; control size, age, amount etc.	
		2.1a	Monitor length, age and sex composition of landings	risk of change in catch composition reduced
		2.1b	Stock assessments for target species	stock dynamics and size understood
		2.1c	Gear restrictions continued and expanded	risk of overfishing reduced
		2.1d	Size limits	juvenile mortality reduced
		2.1e	Promote research into robust stock assessments	increased knowledge of stock
	2.2		Manage levels of active effort	
		2.2d	Implement minimum share holdings to determine access	active effort better known and controlled
		2.2e	Develop policy for bait collection by Commonwealth Tuna fishery	total catch understood, overfishing risk reduced (pilchards)
		2.2f	Develop policy for lift net use by line fishers	total catch understood, overfishing risk reduced (pilchards)
	2.3		Manage levels of latent effort	
		2.3a	Establish minimum entry requirements at business level	catch sustainability improved
4			Appropriately share the resource	
	4.2		Share resource among fisheries	
		4.2a	Monitor catch rates outside NSW jurisdiction	health of, and pressure on, total stock understood (jack mackerel)
		4.2b	Monitor catch rates within other fisheries	total effort understood
8			Improve knowledge of species	
	8.1		Promote scientific research	
		8.1a	Monitor quantities of all species by each net	targeting practices understood
	8.2		Quality of catch and effort information	
		8.2d	Ensure catch and effort recordings accurately reflect circumstance	improved knowledge of stock

Reported landings of sweep have varied greatly over the past decade, but have displayed a sharp decline from approximately 143 tonnes in 1997/98 to 48 tonnes in 1999/2000. Preliminary data

from 2000/01 suggests that the decline is continuing, with unverified catches of 27 tonnes. Little is known about the biology and life history of sweep, although preliminary evidence suggests that the average age of sweep caught by recreational fishers is approximately 25 years and may reach a maximum age of 40 years (D. Ferrell, NSW Fisheries, unpubl. data). The longevity and slow growth of this species make it particularly susceptible to overfishing, and in the absence of a reliable stock assessment, recent landings suggest that this may be the case. The trigger levels proposed in the draft FMS should be an effective measure in the short term, while stock assessments are being developed and completed, to ensure the long term sustainability of the fishery for this species.

Adequacy of proposed stock recovery strategies, relevant threat abatement plans or recovery programs

Eastern sea garfish is the only species for which the draft FMS objectives provide a specific recovery program, and this is consistent with the risk assessment within this chapter (Table E4). The measures proposed within the draft FMS (Objective 2.5) should provide significant improvements in the likelihood of stock recovery. Limitations on traditional gear types, resource access and effort levels, primarily through share management and restricting fishers to zones, have the potential to markedly reduce the active effort on garfish. There is some doubt, however, in the ability of these management responses to improve garfish stocks in the short-term. This is due primarily to a lack of understanding about the biology and stock size of the species and how long recovery may take. It is also a consequence of the uncertain impact associated with net closures, zoning restrictions on active effort within the fishery, and the time taken to determine and implement share allocation and management. The extension of weekend closures to all year, not just summer, should also reduce fishing effort for the species.

The adequacy of proposed measures is largely dependent on the rigorous assessment of changes in landings by businesses that historically worked multiple regions and the extension of weekend closures to all boat-based haulers. The implementation of seasonal and/or gear closures should be considered if the associated change in fishing effort and landings for the species is insufficient, i.e. reduction of 40% as suggested by the draft FMS but 50% as recommended by this assessment. The longer-term use of minimum share requirements has a higher likelihood of success, however, this is subject to the acceptance of structural change within the fishery, and would need to be closely monitored.

There are no other recovery programs proposed for species within the draft FMS. The significant decline in catch levels of silver trevally warrant further attention, however, a recovery program will be developed within the Ocean Trawl Fishery.

Likelihood of recovery under proposed rules and known interactions with other fisheries

Until more biological information and stock assessments are complete, it is not possible to confidently determine the likelihood of recovery of eastern sea garfish under the draft FMS, however, it is considered highly probable that acceptance of the rules in the draft FMS will reduce landings of the species. In the absence of stock assessment data, a reduction in landings is seen as a necessary first step in the recovery of the species.

The recovery of eastern sea garfish stocks is dependent on two important aspects of the draft FMS: the implementation of share management; and the overall reduction in active effort resulting from changes to resource access in the Ocean Hauling Fishery. These aspects would also become part

of the recovery program for the species. Longer-term structural adjustment in the garfish fishery is likely to be carried out through increases in the minimum share requirements, which will undoubtedly provide an effective tool for limiting active effort and reducing the number of individuals who can access the species. The more immediate measures of zoning extensions and weekend closures, coupled with an associated monitoring program to measure the overall impact on effort, represents the most significant attempt to reduce current harvest levels. Without knowing the impact of the proposed zoning changes on effort, the likelihood of recovery must be considered uncertain. Longer-term changes to the management of the fishery through share allocation and minimum share requirements will significantly increase the likelihood of recovery over the first five years of the strategy.

The potential for the recovery of silver trevally stocks is largely unknown as the total catch within the Ocean Hauling Fishery comprises less than 2% of total commercial landings. In accordance with Response 2.5b, it is important for the ocean hauling sector to comply with any recovery program for the species. Such a plan will be developed by other sectors, namely the Ocean Trawl Fishery, as this sector takes the majority of the NSW commercial catch. Until this plan is implemented, the recovery of silver trevally stocks under the proposed rules of the draft FMS is unlikely.

Uncertainty in relation to the management of stocks

The major uncertainty associated with the management of target species is the knowledge of fish stocks and the accuracy of species assessments. Such uncertainty can only be addressed through the development of more robust and reliable stock assessments and through increased confidence in the accuracy of data collected, whether from within the fishery or from independent sources. The draft FMS details a number of measures to meet these requirements through improved stock assessments, verification of catch data and species-specific research. It must be accepted, however, that a level of uncertainty will remain until improvements in our knowledge of the stocks are cross-referenced against the predicted outcomes.

In terms of the management responses themselves, the greatest uncertainty surrounds the implementation of share management. The draft FMS relies heavily on share management as the primary means of managing active effort, preventing activation of latent effort and responding to potential species declines in the long term. The existing endorsement system has limited impact on active effort, and provides a poor representation of the actual effort involved in the fishery. The proposed move to share management will address many of the problems currently encountered with the endorsement system and will provide an improved framework for the long-term control of effort within the fishery. However, the draft FMS provides only limited information as to how share management will be implemented and how it will affect historical levels of fisher participation.

In a broader context, it should also be recognised that variability is inherent within systems and species themselves. Species abundance at any point in time at any location is highly dependent on a range of local and global factors. These may include rainfall, temperature, catchment influences, and historical fishing pressure or habitat availability. In the most part, the draft FMS accounts for potential variation, and in general it accounts for the level of uncertainty through precautionary management rules.

Compliance with the fishery management rules by all sectors (recreational, commercial, Indigenous and non-consumptive) is another uncertainty in the draft FMS. The consequences of non-compliance can negate the management initiatives introduced to ensure the sustainability of harvest.

Goal 6 addresses this issue in the draft FMS; the responses and performance monitoring associated with this goal are also detailed, and are the basis for constant review and improvement.

Confidence in achieving the planned outcomes of the draft FMS

Due to the paucity of information available for many of the species in the Ocean Hauling Fishery, it is difficult to accurately assess the level of confidence in relation to the responses that manage the fishery's impact and the associated risks. The historical presence of commercial fishing throughout inshore waters combined with the high proportion of species reaching sexual maturity at a relatively young age indicate that the species targeted are fairly resilient to exploitation. As a result, any adverse effects from excessive harvesting are likely to be relatively short term and reversible through future management initiatives. Whilst the overall impact of the Ocean Hauling Fishery is largely unknown, the draft FMS manages the uncertainty relating to both individual species and the wider environment through a series of appropriate, precautionary management responses.

The ultimate success of the draft FMS in achieving its stated goals and objectives is intrinsically linked to the acceptance/implementation of the proposed management rules. The greatest risk to the fishery would be represented by a failure to implement the proposed management responses, particularly the commencement of formal stock assessments for all target species, the implementation of share management or the undertaking of an appropriate review if a trigger point is breached. Despite the lack of quantitative data available, it would appear that the management responses and initiatives of the draft FMS allow improved confidence in the sustainability of the Ocean Hauling Fishery.

Overall acceptability of proposed measures in the draft FMS

Given our incomplete understanding of the status of particular stocks, their associated ecological interactions, and the wide range of external environmental influences (both anthropogenic and natural) affecting the fishery, it is impossible to predict the precise effect of the strategy's implementation on the resources of the Ocean Hauling Fishery. The draft FMS, however, contains a series of measures that aim to improve knowledge of stock status, limit active effort, improve participant management and reduce the likelihood of habitat damage.

Of these, the overall adequacy of the proposed measures in the FMS is largely dependent on improvements in the knowledge of stock status. The confidence in making predictions for most species is low (Table E1), and as a result improving our knowledge for each of the target species is the major challenge for the future management of the fishery. Despite specific concerns over certain aspects of the draft FMS, the implementation of the aforementioned initiatives and the continuation of current restrictions should increase the likelihood of long-term resource sustainability and the equitable distribution of resources.

ii) ESD assessment

Ecologically Sustainable Development (ESD) refers to the effective integration of economic, social and environmental considerations in society's decision making process. The five principles of ESD are outlined under Section 6 of the *Protection of the Environment Administration Act 1991* and can be summarised under the following subheadings. In each case an assessment of how the draft FMS addresses each principle is provided.

The precautionary principle

This principle states that if there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures aimed at preventing environmental degradation. For example, poor information should not be used as a reason to delay the implementation of more stringent management controls in relation to a fish species, if there is already reason to suspect that the species concerned may be over exploited.

This principle requires decision makers to carefully evaluate a given proposal to avoid, wherever practicable, serious or irreversible environmental damage. It also calls for an assessment of the risk-weighted consequences of all feasible options associated with a proposal.

Given the data-poor environment in which the Ocean Hauling Fishery operates, the draft FMS is substantially based on the precautionary principle. Our knowledge of the relevant ecosystems, habitats, threatened species and fish stocks, as well as the interactions between them, is currently limited. Goals 1, 2 and 3 of the draft FMS are therefore largely concerned with the application of the precautionary principle: specific management responses are, for the most part, designed to protect natural values on the basis of educated belief rather than scientific evidence. Under this approach, some specific strategies may ultimately prove (in light of further scientific understanding) to have been unnecessarily conservative. However, such an outcome would be far better than a situation under which serious or irreversible environmental damage occurred as a result of not taking action in the first place.

Despite a lack of scientific knowledge in many areas, the draft FMS provides a wide range of measures to address each of the main issues associated with the Ocean Hauling Fishery: protection of stocks, threatened and protected species, protection of key habitat, latent effort activation and major effort shift. Furthermore, Chapter D of the EIS provides an assessment of the feasible alternative management strategies for the Ocean Hauling Fishery.

The need for intra-generational equity

Intragenerational equity relates to distributing the costs and benefits of pursuing ESD strategies as evenly as practicable within each generation.

In the context of the Ocean Hauling Fishery, many of the species retained by the fishery are taken in other commercial fisheries or by other sector groups, such as the recreational fishery. As well as the question of allocation of fish stocks, there are issues relating to the allocation and management of often conflicting user activities (i.e. commercial fishing, charter boat/recreational fishing, boating, swimming, etc).

The proposed measures in the draft FMS include fishing closures, the code of conduct, the regional liaison process, zoning to share the resource between users and by specifying times or places when and where ocean hauling can occur. The draft FMS also proposals to assess the size of the non-commercial catch so that distribution of the resource is known, and performance measures to monitor and manage the distribution of catches of the retained species throughout time.

The need for inter-generational equity

Under this principle, the present generation needs to ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. For example, fish stocks need to be preserved so that fishing (whether commercial or recreational) remains viable in the future.

The preservation of inter-generational equity is fundamental to the goals of Chapter C, which focuses on maintaining or improving fish stocks, habitats and ecosystems for long-term benefit. The

main difficulty is our current lack of knowledge concerning these aspects. However, given this constraint, the draft FMS covers the important issues and adopts the precautionary principle (see above) where knowledge is lacking. Furthermore, the draft FMS contains a range of specific measures to ensure that our knowledge of the relevant fish stocks and their environment will continue to improve. In particular, it undertakes to "develop a stock assessment of target species and ensure the assessment is improved over the life of the FMS".

The need for the conservation of biological diversity and ecological integrity

This principle calls for the conservation of all aspects of biological diversity and ecological integrity, including species diversity, genetic variability and community interactions. This principle recognises that the conservation of these aspects should be a fundamental consideration. For example, under this principle the indirect effects of a fishing activity on non-target species need to be considered, even if the affected species are of no direct economic value.

This principle is also fundamental to the goals of the draft FMS, especially Goals 1 and 3. These goals relate to "biological diversity" and "threatened species, populations and ecological communities" respectively. The impacts of the Ocean Hauling Fishery on threatened species and biodiversity are thought to be minimal, however, as with many other aspects of the fishery, there are currently no quantitative data to support that belief. The Ocean Hauling Fishery targets large single-species schools of fish within an open high-energy oceanic environment. The fishery operates on oceanic beaches and open ocean waters where there is limited diversity in surrounding habitats (Romer, 1990; Robertson and Lenanton, 1984). As such, the fishery is unlikely to significantly impact upon biological diversity, nor are any effects likely to be long-term. It is important to note, however, that there are no quantitative data about the effects of the fishery upon the habitats in which it operates. Nevertheless, the draft FMS does cover a wide range of important issues relating to these aspects, and adopts the precautionary principle (see above) where knowledge is lacking. Furthermore, Chapter C contains a range of specific measures to ensure that our knowledge of biodiversity and threatened species, along with that of the associated interactions, will continue to improve. Examples of these measures include the scientific observer program and collaboration with other institutions to improve understanding of ecosystem functioning.

The need for improved valuation, pricing and incentive mechanisms

This principle recognises that environmental factors should be included in the valuation of assets and services. Essentially, this means that users should pay the full environmental costs of providing goods and services, including those relating to the use of natural resources and waste disposal. The implementation of cost-recovery measures in relation to fisheries management is an example of this principle being put into practice.

It would be difficult to have fishers and/or consumers pay the full environment costs associated with providing fresh seafood from inshore waters. However, it is intended that "operators need to be in a position after a five year period to afford to pay for the attributable costs of management from their fishing revenue": payment of such costs will go at least part of the way towards achieving full 'environmental cost recovery'. Proposing to use minimum shareholdings to improve the economic viability of the fishery and its participants should ensure that operators are better able to afford management costs and would provide them with a greater incentive to support the long-term decisions likely to be necessary. Furthermore, the draft FMS proposes moves towards 'environmental cost recovery' through the introduction of an industry funded scientific observer program.

2. Bycatch (non retained) Species

a) Method based assessment of potential impacts

i) Nature and quantity of bycatch

There are no data about the composition, quantity, spatial or temporal aspects of bycatch for the Ocean Hauling Fishery. This is largely because unlike many of the other fisheries in NSW, bycatch has not been considered a significant problem in the Ocean Hauling Fishery. The methods used in this fishery generally target large, single-species aggregations of adult fish, resulting in catches of low diversity and low numbers of juvenile fish. Anecdotal reports suggest that levels of bycatch using the methods in the Ocean Hauling Fishery are low, and international studies of comparable gear types for purse seining and ocean beach hauling generally support this belief. It is important to note, however, that during the interpretation of results of these studies, that bycatch is often reported by weight, and may not be an accurate reflection of the ecological significance of the bycatch.

Alverson *et al.* (1994), note that purse seine fisheries targeting mono-specific schools of fish have some of the lowest rates of bycatch in the world. This is supported by Arrhenius *et al.* (1998), who estimated total bycatch levels from the Swedish sprat and herring purse seine fishery to be only 2.3% (by weight) of the total catch. Similar investigations by Bailey *et al.* (1996), of the western Pacific purse seine tuna fishery used observations to estimate the level of bycatch at between 0.35% and 0.77% (by weight) of total catch.

Within the South African beach seine fishery (analogous to general purpose haul nets), non-retained species comprised 8.4% (numerically) of total landed catch, and accounted for 40 of the 66 species recorded (Lamberth *et al.,* 1994). In another study in South Africa using smaller mesh sizes than those used in the Ocean Hauling Fishery, spatially varying wave exposure was proposed as the cause of a gradient in species composition and abundance (Romer, 1990). Sheltered beaches supported more diverse and abundant assemblages than did exposed beaches. Of 63 species recorded, 59 were present in the sheltered beach and only 30 in the exposed beach, and all of the species from the exposed beach were recorded in the sheltered beach (Romer, 1990). In a study in Jervis Bay, NSW, sheltered beaches were also reported to support more diverse assemblages than exposed beaches, but these factors were not thought to be the only ones accounting for those differences (CSIRO, 1991). Given that beach hauling in the Ocean Hauling Fishery is largely conducted on the northern side of headlands and thus into the more sheltered beaches of the NSW coast, it is possible that beach hauling could be affecting more diverse and abundant assemblages than assemblages elsewhere on the beach.

The main fish and invertebrate species liable to be taken as bycatch, or that could be affected by the net but not captured, by the various methods used in the Ocean Hauling Fishery are listed in Tables E8 and E9. These are primarily sub-adult fish of economically important species, usually with minimum legal lengths (Table E8), and what is believed to be a diverse but small percentage of other, generally non-commercial species and invertebrates (Table E9). It is important to remember that there have been few studies of fish assemblages of NSW coastal beaches, and that Tables E8 and E9 are based on landings reported in the fishery, studies of similar methods elsewhere in Australia and overseas, and of the habitats in which the fishery operates. These tables do not provide any indication of the potential proportion of catch, are not exhaustive, and are purely indicative of species or families that could be caught or affected during ocean hauling operations. The fish and invertebrates in Table

E9 are primarily non-commercial and thus not recorded by fishers. They are often able to utilise both ocean beaches and rocky headlands, and as such could be caught/affected but not captured by both beach-based and boat-based methods.

Various other vertebrate classes (e.g. reptiles, birds and mammals) may occasionally interact with gear used in the Ocean Hauling Fishery. Most of these are classed as 'threatened' or 'protected' under state and/or commonwealth legislation: issues relating to these groups are discussed in Chapter F section 2.

Table E8. List of commercially important species of fish likely to be taken as juveniles in bycatch from the Ocean Hauling Fishery, with information on relevant habitats and methods.

Species	Types of area/habitat caught	Main capture (as bycatch)
Target species		
sea mullet	ocean beaches; rocky headlands	hauling nets
yellowfin bream	ocean beaches; rocky headlands	hauling nets
luderick	ocean beaches; rocky headlands	hauling nets
sand whiting	ocean beaches	hauling nets
Other retained species		
mulloway	ocean beaches; rocky headlands	hauling nets
kingfish	oceanic waters; rocky headlands	hauling nets
tarwhine	ocean beaches; rocky headlands	hauling nets
dusky flathead	ocean beaches	hauling nets
tailor	ocean beaches; rocky headlands	hauling nets; purse seine
snapper	rocky headlands	hauling nets
rock blackfish	rocky headlands	hauling nets
school shark	ocean beaches	hauling nets

Table E9. List of primarily non-commercial fish and invertebrate families that could be caught and discarded, or contacted but not captured, in the Ocean Hauling Fishery.

Family name	Common name	Family name	Common name
Aracanthidae	boxfishes	Loliginidae	calamari
Ariidae/Plotosidae	catfishes	Mullidae	red mullets and goatfishes
Atherinidae	hardyheads	Octopodidae	octopuses
Callionymidae	stinkfishes	Ostracidae	cowfishes and turretfishes
Caridae/Penaeidae	prawns	Percophidae	sandfishes
Clinidae	weedfishes	Portunidae	sand and swimmer crabs
Clupeidae	sprats and herrings	Scorpaenidae	fortescues and scorpionfishes
Creediidae	sand-divers	Scyphozoa	jellyfishes
Diodontidae	porcupinefish	Sepiidae	cuttlefishes
Gobiidae	gobies	Synodontidae	lizardfishes
Harpadontidae	sauries	Terapontidae	four- and six-lined trumpeters
Isonidae	surfsardines	Tetraodontidae	toadfishes
Latrididae	striped trumpeter	Torpedinidae	numbfishes
Leptoscopidae	pygmy stargazers	Tuethoidae	squid
(This list would also include numerous families of sharks and rays, and a variety of invertebrate epifauna and infauna such as marine worms, other crustaceans and molluscs, echinoderms, tunicates, ascidians and sponges)			

Hauling

Direct capture

'Hauling' refers to several methods within the Ocean Hauling Fishery, including general purpose hauling nets, PAB (pilchard, anchovy and bait) nets, garfish hauling nets and garfish bullringing nets. A description of the dimensions, mesh sizes and operation of these nets under the existing management is provided in Chapter B and changes proposed in the draft FMS are provided in Appendix C1.

Like all gear types in the Ocean Hauling Fishery, anecdotal reports suggest that hauling nets capture very few non-target organisms. The most likely bycatch is of fish of target species that are less than the legal length requirement. Four target species (sea mullet, yellowfin bream, luderick, and sand whiting) have minimum legal lengths that all retained fish must exceed, but it is possible that following completion of stock assessments, other target species could also be subject to minimum lengths. The majority of fish captured by hauling nets are generally targeted schools of adult fish, and as a consequence, sub-adult fish are thought to rarely comprise a significant proportion of the catch. Garfish hauling and bullringing nets do not contact the substratum, and as a result incidental captures of sub-adult retained species and non-commercial demersal species are thought to be very low.

There is also some bycatch relating to sub-adults of retained species that are classified as either conditional target or by-product species. These species all have a minimum legal length, and include dusky flathead, mulloway and tailor (Table E8). Conditional target species may be specifically 'shot' by fishers using general purpose hauling nets, but not by any other method within the Ocean Hauling Fishery. These catches can exceed the usual 20% per shot bycatch rule, however, the total catch of all non-target species for a reporting period (i.e. one year) must not exceed 5%. At times, individuals of conditional target or by-product species will be captured below the minimum legal length and discarded. Within the Ocean Hauling Fishery, there are no data quantifying the level of these discards or the rates of mortality associated with capture and release.

Physical contact without capture

All hauling methods can result in certain size fish and invertebrates being 'squeezed' through net meshes, swept over by the movement of the net, amassed in front of the net, or deprived access to prey or habitat by the presence of the net. Whilst no data are available for the NSW Ocean Hauling Fishery, information from other fisheries suggests it is possible that such fish would suffer fin damage, scale loss and/or skin damage, and some degree of subsequent mortality. Based on experiments by Broadhurst *et al.* (1997, 1999) in which juvenile fish were forced through trawl equipment (grids and square meshes), mortality would be extremely variable within and among species. The number of fish affected will vary according to the mesh of the net used and the sizes of fish present. Seasonal patterns are also likely, with vulnerable size classes being prevalent at certain times of the year, depending on the life cycles of the species concerned. The survival of invertebrates would also be highly variable, with harder bodied animals more likely to survive than softer bodied animals. Any attached animals, such as sponges, are also unlikely to survive should they be dislodged from the substratum or suffer sufficient damage. Nets sweeping over the top of mobile invertebrates, such as echinoderms, may make them susceptible to predators or drag them from preferred habitat.

Lost gear (ghost fishing)

Ghost fishing (the on-going capture of fish after gear has been lost or abandoned) does not normally apply to hauling. The different types of hauling are all 'active' methods, whereby the net is continually attended until its retrieval, preventing the loss, damage or discarding of gear.

Purse seining

Direct capture

Purse seine nets are exclusively used from boats, and a description of the dimensions, mesh sizes and operation of these nets is provided in Chapter B of the EIS. Purse seine nets are used primarily within the Ocean Hauling Fishery to capture yellowtail, blue mackerel and pilchards, and do not contact the substratum. The species targeted with purse seine nets form large, single-species aggregations, which usually results in low species diversity within each shot. Furthermore, it is thought that the majority of species caught during purse seining are retained. Whilst no data exists for the level of direct capture by purse seine nets within the Ocean Hauling Fishery, international studies of other purse seine fisheries report low levels of bycatch. For example, Bailey *et al.* (1996) estimated the percentage of bycatch (by weight) in the western Pacific tuna fisheries was between 3% and 7.3%, while a similar study by Arrhenius *et al.* (1998), estimated levels of bycatch (by weight) from the Swedish sprat and herring purse seine fisheries to be 2.3%.

Physical contact without capture

As with hauling methods used within the Ocean Hauling Fishery, there are no specific data documenting the rate of injury or mortality from physical contact with purse seine nets. Broadhurst *et al.* (1997, 1999) suggested mortality rates for some species squeezed through trawl mesh may be low, however, species targeted in the purse seine fishery differ from those used in the aforementioned experiments and the methods are also markedly different. This makes comparisons between the gears difficult, but could suggest that purse seining is likely to have a lower mortality rate of escaped fish and invertebrates than trawling. Purse seines do not contact the substratum, so are unlikely to disturb or affect many of the species that could be affected by some of the other hauling nets used in the Ocean Hauling Fishery.

Lost gear (ghost fishing)

Ghost fishing (the on-going capture of fish after gear has been lost or abandoned) does not normally apply to purse seining. Purse seining is an 'active' method, whereby the net is continually attended until its retrieval.

Lift nets

Direct capture

The level of bycatch from lift nets used to source bait for the Commonwealth Tuna Fleet and the Ocean Trap and Line Fishery is unknown. However, as with all gear types within the Ocean Hauling Fishery, it is believed to be very low.

Physical contact without capture

Very few individuals are thought to come into contact with lift nets without being captured. For those that do, contact is believed to be incidental and the possibility of injury or harm remote.

Lost gear (ghost fishing)

Ghost fishing does not apply to lift nets.

ii) Likely mortality/injury rates from methods in the Ocean Hauling Fishery

Hauling

The various hauling methods may result in limited mortality amongst discards (juveniles of retained species and unwanted species). The mechanisms contributing to this mortality may include:

- stranding
- being crushed in the cod end
- temperature and oxygen stress due to being crowded into shallow water
- damage from contact with the net material
- general poor handling, particularly in relation to scale loss
- predation (e.g. by birds) on weakened/ disorientated fish in shallows.

Some species, such as bream, are thought to survive these rigours better than others, although no quantitative information is available in relation to the above mechanisms. Fish have been observed with large notches in the tops of their heads, suggesting previous capture by nets, although there is no data to suggest the proportion of those that survived the initial capture. Even if a fish is able to swim away following contact with a haul net, it may have been seriously stressed, as well as be injured in some way, possibly making it more susceptible to subsequent disease (Broadhurst *et al*., 1999).

Nonetheless, evidence is available that suggests that some fish, at least, survive in the long term. West (1993) tagged and released species including yellowfin bream, luderick and sand whiting that had been captured in haul nets to determine their movement patterns. Many of these fish were recaptured, sometimes years later, however, it should be noted that the initial method of capture did not involve the fish being hauled through the surf or landed on the beach as would be the normal practice in this fishery. Whilst this research does not provide any direct evidence to suggest that many fish survive beach hauling capture and release, it does demonstrate the ability of certain species to survive some degree of handling and stress. Gray *et al.* (2001) noted that, among the beach haul catches they sampled, "several small fish were observed to have notches on their heads where they had previously been meshed in a net (either gill or seine), indicating that they had previously been captured in a net-based fishery". Comparisons between tag return rates from beach hauling and from trawling suggest that long-term survival rates were higher for the hauled fish (West, 1993).

Purse seine and lift nets

There is no available information on the injury and mortality of non-retained species from purse seines and lift nets within the NSW Ocean Hauling Fishery. As previously mentioned, the total number of non-retained individuals caught is not believed to be significant.

iii) Likely mortality/injury rates from other commercial and recreational fisheries

Given the paucity of data available for bycatch within the NSW Ocean Hauling Fishery, it is not possible to make direct comparisons between rates of mortality or injury of bycatch within this fishery and those of other commercial and recreational fisheries. However, levels of bycatch in other fisheries such as the Estuary General Fishery and Estuary Prawn Trawl Fishery have been more thoroughly documented. Anecdotal reports suggest that levels of mortality and injury within these fisheries exceed those for the Ocean Hauling Fishery in relation to species that are taken as bycatch in both.

Amongst the target species of the Ocean Hauling Fishery, those with a minimum legal length (sea mullet, yellowfin bream, luderick and sand whiting) are likely to be taken as bycatch in the Estuary General Fishery and Estuary Prawn Trawl Fishery, primarily through direct capture (Table E10). Many other species taken as bycatch within the Ocean Hauling Fishery are also likely to be taken as bycatch in the Ocean Trap and Line and Ocean Trawl Fisheries (Table E10).

Within other fisheries, the bycatch of species also taken in the Ocean Hauling Fishery is not limited to those classified as 'target species' in that fishery. Conditional target species such as mulloway and retained by-product species such as tailor and dusky flathead are taken as bycatch in large quantities by other commercial fisheries (Table E10). Comparisons between the catch rate of these species in the Ocean Hauling Fishery and other commercial fisheries are not available; however, anecdotal reports suggest that levels within the Ocean Hauling Fishery are relatively low. Individuals of non-retained species captured in the Ocean Hauling Fishery are also captured in other commercial fisheries and the recreational sector.

Many of the species retained by the Ocean Hauling Fishery are discarded by the recreational sector as they are often primarily individuals under the minimum legal length for the species. Other non-retained species such as jellyfish, which are taken as bycatch in the Ocean Hauling Fishery, may also be taken in the recreational sector by methods such as prawning (Table E10). Comparisons of the level and composition of catch between sectors are not available.

iv) Possible indicator groups of bycatch species to be monitored

The draft FMS proposes to monitor bycatch by developing a scientific observer program to document the rate and species composition of bycatch, and by modifying the catch and effort returns to collect and monitor information on sightings or captures of threatened species. Given the paucity of information that currently exists for bycatch within the Ocean Hauling Fishery, it would be difficult at present to identify indicator groups or species that could be used to monitor levels of bycatch. However, those species amongst the target species for which there is a minimum legal length may be appropriate. Given the nature of the fishing, whereby schools are first spotted and then specifically targeted, levels of bycatch are likely to be of greatest concern for under-size individuals of retained species as opposed to non-retained species. The use of these species (sea mullet, yellowfin bream, luderick and sand whiting) as an indicator group may be considered once more information of bycatch levels is available.

Further species or groups of species that do not form part of the commercial catch may also be included as indicator groups when improved estimates of bycatch are developed. As a consequence of the significant travelling biomass (e.g. sea mullet) targeted in the Ocean Hauling Fishery, estimates of bycatch by weight of total catch have the potential to be misleading. Most Australian studies on ocean

beaches have concentrated on the invertebrate fauna (Dexter, 1983 and 1984; James and Fairweather, 1996). However the resident fish community of beach habitats has been studied by Romer (1990) and Robertson and Lenanton (1984) who showed the fish community can vary greatly as a result of many factors, including wave energy and the presence of detached macrophytes, respectively. As a result, the potential exists for small percentages of bycatch in terms of the total landed catch (by weight), to represent a significant proportion of the non-migratory biomass in a given area. For this reason, consideration needs to be given to planning the assessment of bycatch levels to ensure the impacts on non-commercial species are assessed.

Table E10. Information relating to other commercial fisheries/fishing sectors for species expected to be taken as bycatch or affected but not captured in the Ocean Hauling Fishery.

Species/group	Other fisheries/sectors where taken as bycatch*	Relative amount taken/affected	Relative susceptibility to injury**	Possible mortality/injury rate
Retained species				
sea mullet	Rec; EG	high	medium	med-high
yellowfin bream	Rec: EG; EPT; OTL; OT	high	medium	med-high
luderick	Rec; EG; EPT	high	medium	medium
sand whiting	Rec; EG; OT	high	medium	med-high
mulloway	Rec; EG; EPT	medium	medium	med-high
dusky flathead	Rec: EG;	high	medium	med-high
snapper	Rec; EG; EPT; OTL; OT	medium	medium	med-high
tailor	Rec; EG; EPT	high	high	high
Non-retained species				
rays & sharks	Rec; EG; EPT; OTL; OT	medium	medium	med-high
non-commercial fish	Rec; EG; EPT; OT	medium	medium	med-high
jellyfish, squid, prawns, crabs	Rec (prawning); EG; EPT; OT	high	high	high
other invertebrates	Rec; EPT; OT	high	high	high

* Fisheries/sectors abbreviated as follows: Rec = recreation; EG = Estuary General; EPT = Estuary Prawn Trawl; OTL = Ocean Trap and Line; OT = Ocean Trawl.

** Relative susceptibility to injury rated "high" for fish that shed scales easily and for invertebrates that have unprotected soft bodies or that normally live attached to the substratum; susceptibility rated "low" for species that have a protective shell or exoskeleton, and "medium" for all other species.

b) Method based assessment of bycatch reduction strategies

There are currently no specific measures to reduce levels of bycatch for any gear type within the Ocean Hauling Fishery. This has been a consequence of the historical acceptance that the rate and composition of bycatch within the fishery is not considered to be a significant issue. However, there are examples of bycatch reduction strategies for similar gear types to those used in the Ocean Hauling Fishery. For example, Bjordal (1999) documents the development of sorting grids to improve size selectivity within the Norwegian purse seine fishery, while Gray *et al.* (2000b), noted increased escapement of flat-tail mullet and silver biddies with the insertion of transparent panels in the bunts of haul nets in the Estuary General Fishery.

Specific initiatives within the draft FMS are designed to quantify the level and composition of bycatch within the fishery and measures are in place to implement bycatch reduction measures once the extent of the issue has been quantified.

c) Assessment of bycatch management measures in the draft FMS

i) Adequacy of proposed strategies

Given the paucity of information on bycatch in the NSW Ocean Hauling Fishery, proposed strategies within the draft FMS must first address the issue of describing the non-retained catch. The poor reporting mechanisms for non-retained catch is a common problem within many fisheries (Bailey *et al*., 1996), and is unlikely to be resolved over the long term for the Ocean Hauling Fishery. In the short term, the draft FMS proposes to meet this requirement through the industry-funded scientific observer program, and this measure is seen as an effective tool for documenting bycatch of the fishery. The inability of the fishery to sustain observer programs in the long term or to implement effective recording mechanisms for fishers, however, would mean that any changes in the distribution and abundance of species of bycatch may not be detected. Such data will add confidence to this assessment, and provide information that is currently lacking about the subtidal fauna of NSW beaches. The observer program will also provide some information about the initial mortality associated with the methods of the fishery, although it is not proposed to investigate longer term survival following the release of those fish that survive initial netting.

While the need to quantify levels of bycatch cannot be doubted, also of concern is the accuracy of data gathered from the scientific observer program. There is a degree of uncertainty surrounding the ability of observers to detect any changes in skipper behaviour during the period of observation. Whilst for some fishing techniques, individual deviation from the behaviour of the fleet may indicate altered behaviour, most of the methods used within the Ocean Hauling Fishery do not allow for such comparisons. This issue is of greatest concern for boat-based fishers, as the presence of the observer will be known to the skipper. However, beach–based skippers may not always be aware of the presence of the observer, thus the potential for altered skipper or crew behaviour is reduced. As a consequence, data gathered from the observer program relies on the observed behaviour being an accurate representation of typical fishing practice. Management decisions based on information from the scientific observer program should be mindful of this potential bias.

ii) Summary of the uncertainty associated with the management of bycatch

Overall, the draft FMS has been assessed to adequately address one of the most significant knowledge gaps in the fishery, that of bycatch. The principal tool proposed to quantify the level of bycatch is the observer program, and mindful of the potential bias in its implementation, is seen as the most effective way of accurately documenting bycatch of the fishery. An understanding of the composition, abundance and distribution of bycatch associated with the various methods is required before effective management measures can be introduced. Whilst there will be some uncertainty related to future management of bycatch, measures currently proposed within the draft FMS are likely to minimise that uncertainty once bycatch has been documented. In particular, modifying fishing methods, the use of best-practice techniques for incidentally captured organisms, and the use of

closures or gear restrictions to minimise bycatch are likely to lead to improved management of bycatch.

iii) Current or proposed precautionary management measures and associated levels of confidence

The observer program and subsequent measures to be implemented should bycatch be found to be higher than currently thought are considered highly likely to both improve our knowledge of bycatch and minimise it where it does occur. Using the design phase of the observer program to target areas, times and methods where bycatch is thought to be a problem is considered a more efficient use of resources than trying to cover too many areas with few resources. This is likely to produce more realistic, useful data than sporadic information from all along the coast.

Given the levels of uncertainty that exist in bycatch management in all fisheries, particularly the lack of information about survival rates of discards from the methods in this fishery, it is difficult to measure the levels of confidence associated with the precautionary management measures. As a minimum, however, the measures proposed will increase the existing levels of confidence, which must be considered low owing to the lack of quantitative data. Only improved understanding of the extent of the problem will allow an assessment of the confidence in achieving specific outcomes.

iv) Level of confidence in achieving predicted outcomes and resilience of environment to change

As discussed above, it is difficult to measure the level of confidence in achieving predicted outcomes due to the level of uncertainty involved in bycatch management. One of the main commitments of the draft FMS, however, is to quantify the extent and composition of bycatch in the Ocean Hauling Fishery and it has a strong likelihood of success. The implementation of the scientific observer program will provide the first quantitative data on bycatch within the Ocean Hauling Fishery and provide important information for formulating future management decisions. It will also improve our knowledge of the biodiversity of ocean beaches, although it is neither intended nor likely to provide information about all aspects of biodiversity. It will also provide some data about the initial survival rates of non-retained species, and the periodic repeats of the survey will provide some indication of the effect of the fishery on the fish fauna of ocean beaches. Its periodic nature and the type of information that will be gathered, however, is unlikely to make it possible to adequately determine the composition and distribution of assemblages of ocean beaches, and thus impossible to determine the resilience of the ocean beach environment to change. Furthermore, the observer survey is unlikely to provide the necessary information to determine whether or not the fishery is having an impact on that environment, so it is not possible to determine if the proposed management measures are likely to lead to the mitigation of any potential impacts.

3. Bait Resources

Species and volume of bait

Bait is not commonly used within the Ocean Hauling Fishery. Purse seine fishers are the only regular users of bait, and this is limited to burley retained from their own catch (mainly pilchards, yellowtail and blue mackerel). No quantitative data are available on the overall use of bait within the Ocean Hauling Fishery, but anecdotal reports suggest that levels are minimal.

Of greater importance is the taking of fish for use as bait in other fisheries. Bait species are caught for use within NSW (primarily in the Ocean Trap and Line Fishery) and for use by the Commonwealth tuna fleet. These species are captured by lift nets and purse seines. The lift net is not currently part of a restricted fishery, although fishers have been required since July 1997 to report "bait for own use" through either the Ocean Hauling or Ocean Trap and Line return forms. It is widely believed that the level of catch is under-reported due to "bait for own use" not being a historical part of catch returns. Bait taken for the Commonwealth tuna fleet is collected primarily by purse seines that are not currently licensed through the NSW Ocean Hauling Fishery. The impact of these catches, the necessity for policy development and the associated impact on the accuracy of stock assessments and total landed catch are discussed in Section E1b, "Assessment of the retained species management measures in the draft FMS".

All bait used within the Ocean Hauling Fishery is sourced from within the fishery itself, in the form of retained catch for use as burley. Anecdotal reports suggest that purse seine fishers and garfish haulers may also use bread or bran to concentrate fish prior to a shot. No bait is sourced from elsewhere, and as such, the risk of introducing disease or pest species is considered minimal.

Alternatives to reduce impacts

The impact of bait use within the Ocean Hauling Fishery is not considered to be significant. As such, no alternative management measures have been considered.

4. Data, Monitoring and Research Adequacy

One of the obvious requirements of the draft FMS is to identify the future information needs for the fishery. Within the Ocean Hauling Fishery, there are two main information requirements: the acquisition of data and information on the species and their interactions with the environment, and a measure of the effectiveness of the FMS to achieve its stated goals and objectives through the implementation of management responses. Given the differing nature of these two information needs, they are addressed separately.

a) Data and research

Information used to address impacts on fish resources was obtained from catch statistics for 1940-1992 (Pease and Grinberg, 1995), 1998/99 (Tanner and Liggins, 2000) and 1999/2000 (Tanner and Liggins, 2001), peer reviewed scientific papers by fishery scientists and NSW Fisheries internal reports. These are listed in Chapter J. The reliability of the information for the stock assessments is given in Table E1. The classification of stock status for all target species should be regarded as preliminary. The uncertainties associated with the data and assessments are due to the knowledge gaps for target and conditional target species.

i) Knowledge gaps

The draft FMS has revealed substantial knowledge gaps that affect the management of the Ocean Hauling Fishery. The three main areas identified by the draft FMS are stock assessment, quantification and reduction of bycatch and the interaction between the fishery and habitat. Each of these gaps are discussed below in terms of their role in improving the management of the Ocean Hauling Fishery.

Stock assessments

All of the target species in the Ocean Hauling Fishery require proper stock assessments. As outlined in Table E1 of this chapter, the overall confidence level for making predictions for the majority of species in the Ocean Hauling Fishery is low. Given the importance of robust stock assessments for the future management of the fishery, this appears as the greatest challenge for the future management of the fishery.

Some of the target species such as yellowfin bream, sand whiting, luderick and sea mullet have preliminary estimates on the status of their stocks in selected locations (Gray *et al*., 2000a), although further work is required to provide more robust and comprehensive information. Gray *et al.* (2000a) and Scandol and Forrest (2001) outline the specific data that is needed and the role of that data in providing stock assessments for all retained species (Table E11). Broadly, the information is necessary to determine the current health of the stocks, recruitment variability and to design scientifically sound long-term monitoring and assessment procedures, all of which will improve the future management of the fishery.

Estimates of harvest rates (e.g. annual landings) are essential to the stock assessment process. Hilborn and Walters (1992, p. 160) state “it is almost impossible to perform stock assessment without knowing the history of the catch”. The primary source of harvest estimates for the commercial sector comes from monthly catch return reports provided by fishers. Stock assessments should ideally include catch estimates from all sectors and the first estimates of statewide recreational harvest will be

available with the publication of the National Recreational and Indigenous Fishing Survey in early 2002.

Current research projects being undertaken by NSW Fisheries aim to improve the knowledge of some commercially important species such as sea mullet, yellowfin bream and eastern sea garfish. Whilst it is appreciated there are shortcomings in relying on fishery-dependent data to develop robust stock assessments, the development of extensive fishery-independent sampling is resource and funding dependent. As proposed in the draft FMS, significant improvements in the data available can be made through changes to the catch return records, as estimates of effort have historically been unreliable due to confusion over reporting structures, species identification and monthly reporting time frames. The development of daily logbooks detailing individual shots and the initiation of 'spotters' diaries will significant enhance the accuracy of stock estimates, especially for sea mullet. The recently commenced study into the fishery and biology of eastern sea garfish will assist in filling a large gap in the knowledge of the biology of this species.

Table E11. Summary of biological data required and their role in providing robust stock assessments for retained species in the Ocean Hauling Fishery.

From Gray *et al.,* (2000a).

	Purpose			
Biological information required	**Stock assessments**	**Designing long-term strategies for monitoring and assessing stocks of fish in coastal waters**	**Managing fish stocks**	**Forecasting future catch levels**
Landing/harvest estimate	Y	Y	Y	Y
Size and age composition of catches	Y			
Spatial and temporal variation in recruitment and growth of juvenile species	Y	Y		
Spatial and temporal changes in abundance of different year classes	Y	Y	Y	Y
Changes in abundance of pre-recruits to the fishery				Y

Quantification and reduction of non-target species (bycatch)

The quantity and composition of bycatch within the Ocean Hauling Fishery has not yet been documented. Overseas studies (Alverson *et al.* 1994; Lamberth *et al.* 1994 and Bailey *et al.* 1996), along with anecdotal reports for the fishery, suggest that fishing methods that target schools of predominantly adult fish of a single species produce little bycatch. These studies and assumptions need to be formally addressed for the fishery, and the proposed observer program is seen as an effective way of quantifying the level of bycatch. Improvements in bycatch data will allow the commencement of initiatives to reduce the size of the non-retained catch if appropriate. The establishment of a scientific observer program aimed at quantifying non-retained species is an integral part of the fishery's future management.

Interaction between fishery and habitat

A further historical and anecdotal assumption is that the Ocean Hauling Fishery has minimal impact on oceanic habitats. No quantitative data exist to describe any such impact or to assess the need for mitigating measures. The draft FMS proposes the use of a scientific observer program to identify interactions between the fishery and habitat. The operation of the fishery in high energy open

oceanic waters suggests that direct interactions between fishing gear and habitats would be relatively minor and temporary. However, there are a number of indirect influences on terrestrial environments (such as sand dunes) that require quantification. The overall impact of the Ocean Hauling Fishery needs to be more thoroughly described in order to manage the associated effects on surrounding habitats.

ii) Research assessment

The Ocean Hauling draft FMS identifies research initiatives to address the three main knowledge gaps that exist within the fishery. These initiatives and their associated management goals and responses are listed below (Table E12). Research has been targeted towards areas of greatest uncertainty within the fishery. As for most fish stocks harvested within the NSW commercial sector, a thorough understanding of biomass, exploitation status and long term viability is lacking. The management responses proposed within the draft FMS to address this lack of understanding include responses 1.1, 2.1b and e; 2.5.1, 2.5.2, 8.1b, c and e; and 8.2c, d and e.

The draft FMS proposes no specific fishery-independent surveys to enhance current stock assessment programs, but rather relies on improvements to the catch return systems to provide more robust estimates of stock abundance and improved measures of fishing effort. Whilst fishery-independent data would undoubtedly benefit the future management of the fishery, the ephemeral nature of many of the target species on ocean beaches reduces the likelihood of success in such studies. Fishery-independent research proposed for the Estuary General Fishery, where many of the species in the Ocean Hauling Fishery are more predictable residents, has the potential to provide important information for improved knowledge and management within this fishery. However, the implementation of aerial surveys to ground truth spotters logs and improve estimates of biomass may be an approach that might be considered to improve the stock assessments for certain species.

Fishery-independent data is of greater importance for species that are permanent residents of habitats fished as part of the Ocean Hauling Fishery. Stock assessments based on catch return information for species such as yellowtail and blue mackerel could be construed as unreliable due to the influence of market forces on effort. Without a reliable index of catch-per-unit-effort, the development of acoustic surveys for the smaller pelagic species in the fishery would provide valuable information for biomass estimates. In a broader context, there are two important aspects to be considered in relation to fishery-independent surveys and their inclusion in a research strategy for the Ocean Hauling Fishery; the cost of the research and the value of the fishery. Whilst each of the research programs proposed within the draft FMS will be assessed in terms of its scientific adequacy, the research strategy for the fishery would benefit from an overall review. The review should assess the minimum research needs of the fishery to determine whether current research programs and priorities are effectively meeting the fishery's needs.

The other major area of uncertainty relates to the impact of the fishery on both bycatch and surrounding habitats. The general view that the fishery has traditionally left a minor ecological footprint needs to be properly verified. It is no longer acceptable to base decisions on anecdotal beliefs that are not supported by data or targeted research. Like all sectors, the NSW Ocean Hauling Fishery has a responsibility to operate in a sustainable manner. Issues that might affect this sustainability need to be described and quantified to ensure the long-term viability of the fishery.

The assessment of the interaction between the fishery and habitat resulting from the observer program needs to be carefully monitored. As it is currently proposed in the draft FMS, the scientific

observers will have a limited capacity to accurately assess the impacts of the fishery on subtidal habitats. A review of the outputs of the observer program in relation to the assessment of fishery/habitat interactions would be beneficial for prioritising future research needs of the fishery.

Table E12. Summary of knowledge gaps and proposed/current research to address these gaps along with relevant objectives and responses of the draft FMS.

Knowledge gaps	Proposed/Current research	Objective	Management response
Stock assessments	Fishery and biology of sea garfish	2.5.1	1
	Stock assessment of sea mullet	8.1	b and e
	Stock asessment of yellowfin bream	8.1	c
	Stock assessments for all target species	2.1	b and e
	Estimate catch return accuracy (scientific observer program)	1.1	a
	Document accuracy of species identification (scientific observer program) and catch reporting	8.2	c and d
	Catch returns to include observed but not caught fish (spotters' logs)	8.2	e
Bycatch	Document rate and composition of bycatch (scientific observer program)	1.1	a
	Describe retention and meshing with 28 mm and larger garfish nets	2.5.2	k
Habitat interaction	Document impact of fishery on habitat (scientific observer program)	1.1	a

b) Performance and monitoring

i) Performance indicators and trigger points

Performance indicators are used to gauge whether the goals of the strategy are being met. Trigger points for each indicator set the level at which a review into a particular aspect of the management goals is instigated. For each target species within the Ocean Hauling Fishery, trigger points for annual catch returns have been established. An explanation of how the trigger points were determined is provided in Chapter C section 5 of the EIS. In general, the indicators are appropriate for the goal they are associated with, however, their adequacy to address progress in some of the key areas of uncertainty is of concern.

As discussed under Chapter E section 4(a) – Data and Research, two of the key knowledge gaps within the Ocean Hauling Fishery relate to the level and composition of non-retained species and the impact of the fishery on surrounding habitats. Neither of these issues appears to have been appropriately addressed by the trigger points in the draft FMS, although it is accepted that at this stage there is no information upon which to establish a trigger point for habitats. The most pressing requirement in relation to bycatch is undoubtedly the need to describe and quantify the number of non-retained species. While the draft FMS proposes to address this issue through the establishment of a scientific observer program, the performance indicators for Goal 1 fail to identify the outputs of this program as being an essential component of the FMS. The observer program's operation is nominated as a performance indicator for Goal 8, however, there is no target or associated trigger for what the observer program can realistically achieve. A nominated time period for the establishment of an indicative level and composition of bycatch would seem appropriate.

The above criticisms are applicable to further aspects of the scientific observer program. The draft FMS relies heavily on the outputs of the proposed program to quantify many of the unknowns within the fishery. However, there is little reference within the trigger points of the draft FMS to suggest that the outputs of the program will be routinely reviewed, nor have targets been established to ensure the observer program is delivering the data that it was established to provide. In Table C2 of Chapter C, the performance indicator relating to the quantification of non-target species has an associated trigger of "...non-target species exceeds 5% of total harvest for any method in any region per year". The indicator does not seem appropriate under the goal of conserving biological diversity. The trigger point is designed to ensure there is no major effort shift towards non-target species, and as a consequence, is more relevant to the goal of maintaining harvest sustainability.

Given the uncertainty that surrounds much of the data for the Ocean Hauling Fishery, a review of the effectiveness of trigger points as a whole may be appropriate within a prescribed timeframe. Although the appropriateness of each trigger point will undergo a predetermined review within two and a half years of the commencement of the strategy, the effectiveness of the process as a whole may also warrant consideration. A trigger point being breached will result in a review of the associated circumstances by the MAC, however, given the levels of uncertainty that surround the data on which the trigger points were established, the option is available for no measures to be implemented in the event of such a breach. An assessment of the trigger point reviews (which are published on the NSW Fisheries website following a trigger point being breached), to determine whether they are influencing management decisions would be beneficial.

ii) Monitoring and review

There is monitoring for each performance indicator in the draft FMS against the relevant trigger point (see Table C11 in Chapter C). The proposed monitoring involves observer-based programs, analysis of catch returns on a regular basis and/or other specific reviews of regulations and their outcomes. Given that the monitoring programs are the information gathering process for the trigger points, the adequacy of certain performance indicators and trigger points (as discussed above) needs to be addressed. For those performance indicators that are appropriate, the proposed monitoring programs adequately cover the indicators listed in Tables C2 to C9 in Chapter C.

c) Relationship between research, performance indicators and review

An important aspect of assessing the research and monitoring strands of the draft FMS is whether the link between research, performance indicators and review is clear. Figure E2 shows a possible pathway by which the results of research and reviews feed back into each other to produce better management responses. For example, as research provides improved stock assessments for target species, tighter or even different performance indicators and trigger points can be set. Similarly, as trigger points are breached the review process may discover knowledge gaps that have not previously been identified and that require research. The dual feedback system of these links between research and review is crucial to the future development and better management of the fishery.

One important element that has not been clearly addressed in the draft FMS is the measurement of whether relevant results of research have been adopted into the FMS. Chapter C section 5 outlines circumstances that will trigger a review of the FMS. It includes contingencies for unpredictable events, one of which are the results of research programs. However, this is presented in

terms of unpredictable circumstances. Therefore, research results can only trigger a review of the FMS under contingency circumstances determined by either the Minister for Fisheries or the Ocean Hauling MAC. Under these circumstances, there is a danger that significant recommendations of research to improve the FMS could be overlooked simply because they were not deemed to require contingency measures. A more useful approach to incorporating research outcomes is to include in the draft FMS either an annual or bi-annual review by the MAC of the recommendations of research programs relevant to the Ocean Hauling Fishery. Furthermore, justification should be given as to why recommendations of research programs were not adopted. The proportion of research program outcomes reviewed (out of the total number produced within a review period) would be one appropriate measure to monitor the incorporation of research results. In addition, a list of the research outcomes reviewed, adopted or not adopted and their justification would be another useful measure.

Whilst the draft FMS does suggest links between the research and review components of the document, they are not made explicitly clear. A useful flow diagram, as illustrated in Figure E2, would clarify these or similar relationships intended in the draft FMS.

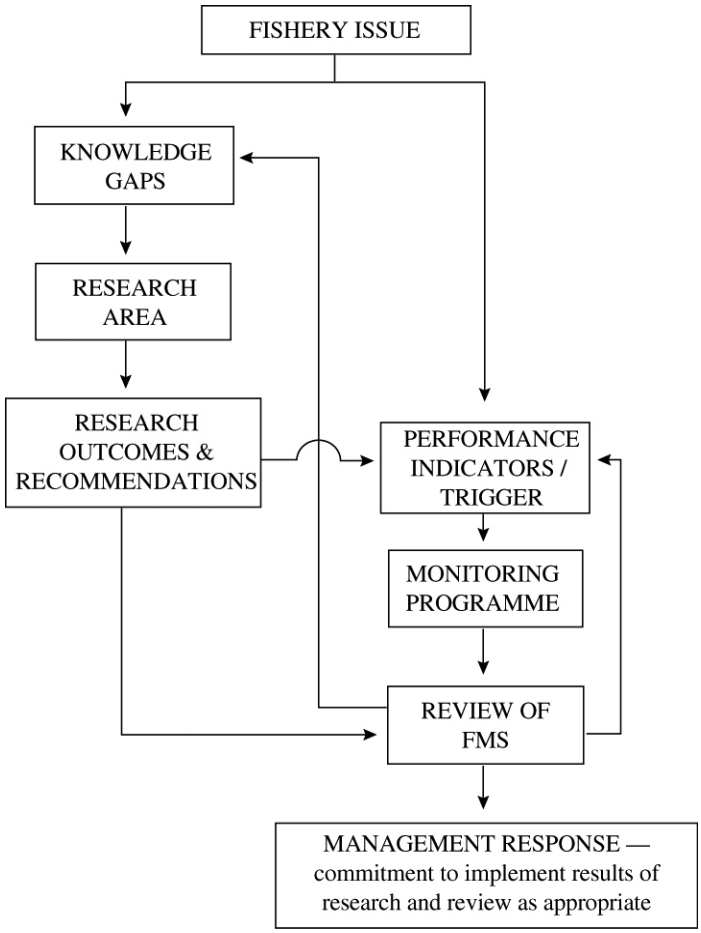

Figure E2. Flow diagram showing links between research, performance indicators and review.

CHAPTER F. IMPACT ON THE BIOPHYSICAL ENVIRONMENT

The purpose of this chapter is to focus on aspects of the general environment of ocean beaches and nearshore coastal waters, beyond those fish and invertebrates that are caught as a result of the Ocean Hauling Fishery. It broadly describes the major types and extent of habitats commonly found along the NSW coast and describes how each of these, and the fauna that depend on them, are potentially affected by the fishery. It assesses the effectiveness of mitigation measures outlined in the draft FMS to minimise these potential impacts, and the effectiveness of the monitoring and research programs proposed in the draft FMS to provide the information required to adequately assess the potential impacts of the fishery. Physical aspects, such as water and air quality, are also discussed both in terms of the impact that fishing has on them, and how they affect the fishery.

1. Biodiversity and Habitat Issues

The NSW coastline is in excess of 1,700 km long, and consists of approximately 920 km of sandy beaches and 800 km of rocky shores (NSW Fisheries mapping in progress). Hauling from beaches is the focus of activity within the fishery, targeting species such as sea mullet and Australian salmon during winter spawning runs. Boat-based hauling and purse seining are also practiced adjacent to headlands, rocky shores, offshore islands and inshore waters, particularly for baitfish and other pelagic species.

Currently, less than 4.5% (~ 40 km) of sandy beach is permanently closed to the fishery, although there is a weekend and public holiday closure for all beaches between 1st November and the last day in February, which is a condition of fishers' licences. There is a further 26 km closed between 1st October and the last day in February (Table F1). Due to the limited potential for conflict with other stakeholders, there is less than 10 km of rocky shore or offshore reefs that are closed to the fishery. Overall, the fishery currently has effectively unlimited access to approximately 95% of the NSW coast, except at weekends and public holidays during spring and summer. It would appear that the fishery, in its existing form, has the potential to cause widespread impacts on the biodiversity and habitats of the NSW coast.

These habitats are described below, as are the potential impacts on them due to the fishery, along with measures within the draft FMS to mitigate those impacts. Potential impacts are broadly discussed, as there have not been any studies done to determine the type, extent or magnitude of actual physical, biological or chemical impacts due to the fishery. Where applicable, impacts associated with gear similar to that used in the fishery are discussed to provide some indication of the potential impacts, and examined in terms of effort within each region. Marine protected areas and similar such habitats are also discussed in this section as they form part of the ecosystem and habitat management section of the draft FMS.

a) Coastal habitats used in the fishery

i) Sandy beaches

Brief description

Approximately 720 beaches are recognised in NSW and are intersected by rocky headlands, rocky intertidal platforms, subtidal rocky reefs and/or estuaries. Sandy beaches are formed by waves and currents depositing sediments in the nearshore zone and on beachfaces. There are broadly two types of beach recognised in NSW, reflective and intermediate, however, both share some general characteristics. They consist of a rippled nearshore zone (up to 20 m deep) where waves shoal and steepen; a dynamic surf zone where waves break and transform into whitewater, swash and currents; and a beachface where the waves expend the last of their energy as swash on the beach (Jones and Short, 1995).

Reflective beaches are comprised of coarse sands and gravels, have steep faces, and waves usually less than 0.5 m high. They do not have a surf zone, rather waves surge up the beachface. This produces a short but strong swash, which coupled with coarse sediments, makes these beaches least suitable for organisms. They tend to have few species and small abundances. Reflective beaches are more common on the south coast and at the more protected ends of long beaches and in sheltered, deeply embayed beaches.

Intermediate beaches account for 70% of all beaches in NSW. They develop where waves are 0.5 to 2 m high and the sediment is fine to medium. They have a surf zone up to 100 m wide and contain alternating bars and rip channels. These beaches support more diverse and abundant populations than reflective beaches, largely because the finer sediments are able to retain moisture and detritus.

Summary of the importance of sandy beaches

Sandy beaches are not generally considered to be highly productive environments, as they do not support macrophytes, and most of the organic matter is allochthonous in origin, i.e. it comes from elsewhere, namely the land and the sea. Insects, plant litter and nutrients come from the land, and detritus, dissolved organic matter, carrion and stranded macrophytes come from the sea (Jones and Short, 1995). Beaches are also immediately responsive to changes in weather and physico-chemical conditions, particularly storms and rainfall (McLachlan and Hesp, 1984).

Physical processes rapidly shift material between adjacent estuaries, beaches and offshore waters, which allows beaches to shift between a role as importers and exporters of organic matter. As such, the trophic links and purported importance of sandy beaches are relatively weak and low, respectively, and sandy beaches are often thought of as ecological deserts because most of the organisms that occupy sandy beaches are small and live beneath the sand, not above it. Furthermore, there is no suitable substratum for macrophytes (algae or seagrasses) and no vertebrate animals are thought to be permanent inhabitants of exposed, coastal sandy beaches. They do, however, provide important habitat for a variety of flora and fauna, if only on an intermittent basis.

Beach flora consists of benthic micro-algae and phytoplankton, as well as some microscopic bacteria and fungi. Some open ocean embayments, such as Jervis Bay and Twofold Bay, whilst generally considered estuaries, can also be fished by the methods in the Ocean Hauling Fishery.

Seagrasses, particularly strapweed (*Posidonia australis*) are recorded within these bays and are currently exposed to hauling.

Autochthonous energy and carbon flow within most sandy beach ecosystems that have been studied is dominated by high rates of diatom production (Cappo *et al.,* 1998). In other beaches, however, the major input of primary production is macrophyte detritus, which is swept in during storms (Robertson and Lenanton, 1984). Different drivers of primary production also support different communities of fishes and invertebrates, although the fish fauna of most sandy beaches, whilst sometimes very diverse, is usually dominated by only a few species. Some studies report that surf zones are dominated by a high proportion of resident species (Ayvazian and Hyndes, 1995), and yet others report that the majority of species are represented by immature individuals (Robertson and Lenanton, 1984). Surf zones reliant on phytoplankton are generally dominated by planktivores, whereas benthic feeders generally dominate beaches that are supported by macrophyte detritus and the invertebrates that feed upon it (Romer and McLachlan, 1986; Robertson and Lenanton, 1984). Another correlative study of beaches whose communities of fishes are structured by macrophytes, reported a positive relationship between the abundance of surf zone fishes and the volume of macrophytes. It was also reported that for at least one commercially important species, the result was the same during night-time sampling, suggesting that the primary role of macrophytes for that species was in the provision of food, not shelter (Lenanton and Caputi, 1989).

Inter-related factors structuring communities of fish and invertebrates of sandy beaches are likely to be the pattern of water movement, geomorphology of the beach, and the associated stability of the sediment (Robertson and Lenanton, 1984; Lincoln Smith and Jones, 1995). For example, Romer (1990) and CSIRO (1991) reported that sheltered beaches supported more diverse and abundant assemblages than exposed beaches, but the study by CSIRO (1991) was confounded by the presence of adjacent habitats. Ayvazian and Hyndes (1995) reported the importance of adjacent habitats and water movement in structuring communities of fishes in their study in southwestern Western Australia. They concluded that the more diverse assemblages of the west coast were due to the presence of seagrass beds and limestone patch reef adjacent to the west coast, which provided more microhabitat for fish and created more sheltered and temporally stable surf zones. Water movement, specifically the reduced influence of the Leeuwin Current, was also thought to have contributed to the south coast supporting fewer species. Most of the studies discussed above examining the processes and mechanisms that structure communities of fishes of sandy beaches have been correlative studies of natural conditions, and not manipulative field studies. As such, the influence of those processes has not been clearly identified (Lincoln Smith and Jones, 1995). Furthermore, none of them were done on beaches of the NSW coast in which the Ocean Hauling Fishery operates.

Beach infauna consists of a variety of invertebrates, comprising groups of animals based on their relative size. Microfauna are generally less than 0.5 mm, and consist of very few species. Macrofauna are dominated by crustaceans, polychaetes and molluscs, and include familiar animals like ghost crabs, beachworms and pipis (Jones and Short, 1995). Despite comprising approximately 65% of the NSW coast, published work on sandy beach macrofauna in Australia is limited (James and Fairweather, 1996). At least 85 species are recorded from sandy beaches of NSW, although many others remain undescribed (Dexter, 1983). Assemblages vary significantly across and along beaches, with the lower shore and less exposed beaches generally supporting more diverse and abundant assemblages, but species are likely to be different both within and among beaches.

In addition to natural variability, different sampling techniques used in different studies are also likely to obtain different results. A limited number of isopod species often dominate the high tide zone (Dexter, 1984; James and Fairweather, 1996). Dexter (1984) reported that amphipods were most abundant in the mid-zone, whereas James and Fairweather (1996) reported that glycerid polychaetes were dominant in this zone. The lowest tidal levels are characterised by a diverse fauna. Dexter (1984) reported that polychaetes of the family Spionidae were abundant but dominated by peracarid crustaceans, whereas James and Fairweather (1996) reported that the swash zone was dominated by amphipods, glycerids, bivalves and cumaceans.

Birds are the most common, readily observed fauna on sandy beaches, and include numerous species protected under State legislation and international treaties (discussed below). Gulls and terns are the most readily identifiable and numerous birds, but there are also a variety of waders and shorebirds, as well as birds of prey such as sea-eagles and kites.

Potential effects of the fishery on sandy beaches

General purpose hauling, pilchard anchovy bait (PAB) hauling and garfish hauling are the only methods likely to be used on sandy beaches, and the only methods that could have an impact on the substratum. Purse seine, lift nets and pelagic garfish nets are hauled into boats and do not contact the substratum, and garfish hauling is also increasing in popularity with boat haulers. Beach-based methods in the fishery are done in response to observing travelling schools of fish, usually pre-spawning aggregations, and utilise a netting site. They are thus seasonal and active in their nature, as opposed to passive methods that involve setting nets and allowing them to fish unmanned for extended periods. This restricts the potential extent and duration of impacts, but may increase their local intensity during the periods of fish migration, which are primarily the winter months for most species in the fishery.

There are very few studies on the effects of beach hauling on habitats of coastal beaches. Only one of these was in NSW and it looked at eelgrass (*Zostera capricorni*) in estuaries (Otway and Macbeth, 1999). Most inferences of the effects of hauling are based on studies of trawling, which uses much heavier and larger gear, covers greater areas, and is practised in waters of the inner and outer continental shelf, and not in the comparatively depauperate shallows of sandy beaches. Nevertheless, some of the potential impacts that could occur as a result of hauling nets across the seabed include:

- mechanical damage to sedentary organisms (Lamberth *et al.,* 1995; Reimann and Hoffmann, 1991)
- entrapment, transport and removal of organisms, including micro- and macroalgae (Reimann and Hoffmann, 1991; Lenanton *et al.,* 1982)
- delaying the re-establishment of biofilm in areas of moderate current or wave action, and repeated hauling in such areas could therefore permanently reduce populations of benthic grazers (Hall, 1999; Kaiser and de Groot, 2000)
- resuspension of sediments and contaminants (Dayton *et al.,* 1995; Reimann and Hoffmann, 1991)
- a shift in the composition of benthic communities through direct contact and overturning sediment (Dayton *et al.,* 1995), or to fish or bird communities through the removal of predators, discards or disturbance (Sainsbury *et al.,* 1997; Paton *et al.,* 2000)
- alteration of sediment type and stability (Churchill *et al.,* 1994)

- modifications to microbial activity (Meyer *et al.,* 1981)
- altering the growth of seagrass, including a reduction in leaf length of eelgrass (*Zostera capricorni*), and increases in shoot and leaf densities (Otway and Macbeth, 1999).

The degree to which these effects occur during the use of haul nets on sandy beaches of NSW is unknown. The impacts associated with hauling are unlikely to be more pronounced than those associated with natural variability given the high-energy environment that exists on coastal beaches.

Beach-based hauling accounts for more than two-thirds of the effort in the fishery and can occur on more than 95% of the sandy shores of the coast, although effort is thought to be decreasing due to a recent increase in the popularity of hauling to boats. Beach hauling is generally done on broad, unvegetated shorelines, however, extensive seagrass beds can be found on ocean beaches within Jervis Bay, Twofold Bay and Disaster Bay. There are also areas of seagrass around Broughton Island adjacent to beaches that may be used for hauling. The frequency, intensity and effects of hauling over those seagrass beds are unknown. A study of the effects of hauling in eelgrass beds in estuaries reported altered growth (Otway and Macbeth, 1999), but that study was of a different species and in a different environment to those beds (*Posidonia australis*) that could be affected by the Ocean Hauling Fishery. It is probable that any of the hauling methods that contact seagrass could have some as yet unknown impact, including similar impacts to those recorded by Otway and Macbeth (1999). The presence of *Posidonia* beds in these open ocean embayments may represent somewhat unique habitats of the open coast, supporting different assemblages of fish and invertebrates compared to *Posidonia* beds within estuaries (e.g. Ferrell *et al*., 1993). Any impacts associated with hauling in those beds are thus unlikely to be compensated for by the protection of seagrass beds elsewhere.

Most hauling effort is focussed on the beaches in Regions 3 (from about Brooms Head to Diamond Head) and 4 (Diamond Head to Hawkesbury River). This area contains some of the State's largest and most productive estuaries, including Hunter River, Port Stephens and Wallis Lake. These estuaries all have extensive stretches of sandy beach where they meet the sea. They also have a relatively small amount of rocky shore, and a limited number of beaches permanently or seasonally closed to hauling.

Assessment of management responses proposed in the draft FMS for sandy beaches

To minimise any potential impacts on the biodiversity and habitats of sandy beaches, and/or to investigate such impacts, the draft FMS proposes to:

- use scientific observers to document the likelihood of impact on fish habitats from ocean hauling methods and to use that data to modify methods where necessary
- document rate and species composition of bycatch
- modify fishing practices to reduce the impacts on habitats, communities and non-retained fauna
- use best practice methods for handling incidentally caught organisms
- continue to prohibit damage of marine vegetation, specifically

    a) identify all areas where ocean hauling takes place over the seagrass *Posidonia australis* (strapweed)

b) identify the ocean hauling methods that occur in those areas and prohibit the use of the general purpose hauling net in those areas

- participate in the selection and management of marine protected areas
- involve the Ocean Hauling MAC in the development and review of habitat management policies and activities
- use fishing closures to control the time and area fished
- annually review the code of conduct for fishers
- define and declare Recognised Fishing Grounds (RFG) through the regional liaison process
- annually review access restrictions imposed by external bodies, e.g. NPWS and local councils
- manage the fishery in a manner consistent with other jurisdictional or natural resource management requirements.

Table F1. Summary of changes proposed in the draft FMS through the regional liaison process, showing the extent of beaches that can be hauled in each region.

The regional negotiation process is incomplete in Regions 5 and 6. All distances are in kilometres, and the approximate total distance of sandy beach within each region is provided below the region number. E = existing and P = proposed distances. See text for definitions.

	OCEAN HAULING FISHING REGIONS											
	1		2		3		4		5	6	7	
	127.64 km		51.78 km		220.94 km		197.99 km		29.96 km	125.67 km	160.04 km	
CLOSURES	E	P	E	P	E	P	E	P	E	E	E	P
Traditional Hauling Grounds		100.87		4.5		32.08		21.17				14.31
Closed Beaches		12.07	9.61	8.28		56.29	9.28	51.46		11.26	10.27	15.27
Shared Beaches		14.7		39		132.57		125.36				130.46
No Closures	14.7		40.87		194.49		188.71		16.44	114.41	149.77	
1 Nov - 28 Feb									13.52			
1 Nov - 28 Feb (weekends & public holidays)	127.64	127.64	51.78	51.78	220.94	220.94	197.99	197.99	29.96	125.67	160.04	154.54
Easter	112.94	127.64										
31 Oct - 1 Feb		30.54										
1 Dec - 31 Jan			1.3	2.5	1			3.18				15.61
1 Oct - 28 Feb					25.45	17.92						
1 Aug - 31 Jan								75.47				

Most of these measures are likely to minimise impacts on the biodiversity and habitats of ocean beaches. This is particularly true for the implementation of the recommendations within the regional liaison process, which include a variety of closures, declaration of RFG and a code of conduct. Central to the process was the establishment of Traditional Hauling Grounds, Closed Beaches and Shared Beaches (Table F1). Traditional hauling grounds are likely to be those beaches or parts of beaches that become, or are more readily identified, as RFG. Traditional hauling grounds are the major fishing beaches in each region and fishing can occur at day or night. These areas are nearly all located at the southern ends of beaches, and it is proposed to return the 'priority of shot' to haulers at these beaches. For the purposes of this assessment, closed beaches are those that are closed for the entire year, and other partial closures have been distinguished by season or period. Beaches not

categorised as either traditional or closed are considered to be shared beaches. Priority of shot at these beaches is determined by whomsoever was fishing first, and hauling can only be done during the day.

This process has the potential to significantly increase the area permanently closed to beach hauling from currently less than 4.5% to approximately 17%. Traditional hauling grounds could represent 19% (173 km) of beaches, but more than half of those are in Region 1 (100 km), which could consist of more than 80% of traditional hauling grounds. In most other regions, traditional hauling grounds account for approximately 10% of beaches. Almost half (74 km) of Region 4 could be permanently closed for six months of the year, in addition to the weekend and public holiday closure during spring and summer. The draft FMS also proposes to extend that closure to year-round for garfishers to reduce the effort on that species.

In addition to limiting the area and time fished, the liaison process also restricts access to the beaches to specified points, which have been agreed upon through the regional negotiation process, which included fishers, councils, NPWS and numerous other stakeholders. External expertise and local knowledge should limit the potential for impacts generally unforseen by fishers and fishery managers, particularly as it pertains to fauna and habitats beyond those targeted or utilised in the fishery.

Of concern, however, is the current failure of stakeholders to agree upon traditional hauling grounds in Regions 5 and 6. This may not be so vital in Region 5, the beaches of which are in the heavily urbanised area between Barrenjoey Headland and Bulli Point. It may be more significant in Region 6, however, which stretches from Wollongong to Ulladulla. Region 6 incorporates Jervis Bay, the mouth of the Shoalhaven/Crookhaven Rivers and other areas likely to be important for a variety of fauna and habitats, particularly birds and marine mammals. Current changes proposed for Jervis Bay Marine Park could restrict beach-based hauling to only a few beaches and prohibit purse seining throughout the bay. Whilst it is agreed that it would be prudent to delay negotiations for traditional hauling grounds until zones within the park are determined, the draft FMS should consider the region as a priority for the observer study if the zonings are not finalised by the time the FMS is finalised. In the absence of the regional negotiation process for the region, it is recommended that the observer program be strengthened to include recording access points, regular fishing areas, and the potential for disturbance of marine mammals and birds. The latter should also be added to the program for all regions. The annual review of the observer program should be used to determine the need or otherwise for additional closures in Region 6 in particular, but also in other regions wherever there are large numbers of shorebirds that utilise beaches or places that are regularly used by marine mammals or turtles.

At this stage, the draft FMS does not propose any research programs to examine the effects of fishing methods on habitats. The proposed observer survey may well be adequate for recording the numbers of directly or indirectly affected fauna such as fish and birds, but will offer little information to prioritise areas of habitat that are damaged. Subjective observation should not be the basis for determining which habitats are damaged, or which methods warrant modification, as proposed in the draft FMS. Given that the various beach hauling methods are thought to be the only methods that consistently affect the substratum, a sampling program should be established that could more adequately determine the degree of any impact on habitats and fauna. This program should include comparisons with areas that are closed to beach hauling. Such impacts would be most likely in the traditional hauling grounds or other beaches that are frequently fished.

The trigger point associated with total discarded catch requires refinement. Whilst it is agreed that a quantitative measure cannot be determined until data are gathered through the scientific observer/sampling program, the trigger should also consider the possibility that the proposals will fail to decrease discards. Several management responses in the draft FMS discuss gear modifications and bycatch reduction, but only set triggers against increasing levels. If gear modifications and other management responses are successful, then there should be a corresponding decrease in the discards, and as such there should be a trigger point to address that potential outcome. Such an approach would provide feedback on two levels: it would improve our understanding of the impact on biodiversity; and would provide a measure of the success or otherwise of any gear modifications or closures.

ii) Rocky headlands, rocky reefs and offshore islands

Brief description

Rocky headlands usually form the extremities of ocean beaches, and include near vertical cliffs with or without intertidal rock platforms at their base. Some intertidal platforms exist as stand alone features along stretches of sandy beaches, and may be completely submerged at high tide. These areas provide a variety of habitats, including the platform itself, rock pools and boulder fields, as well as subtidal rocky habitats. Beach-based haulers often lay nets immediately adjacent to headlands and rocky outcrops to catch fish as they move north. Purse seiners and boat-based garfish haulers can utilise the water column above subtidal rocky reefs, targeting the smaller schooling species such as pilchards and yellowtail. Most of the purse seining effort occurs between Botany Bay and Tuross Heads, an area which has extensive areas of rocky shoreline.

There are numerous subtidal rocky reefs within the 3 nm limit of the fishery. Subtidal rocky reefs often exist amongst great expanses of sand, providing complex habitat where there would otherwise be very little. The peaks of some rocky reefs are sometimes sufficiently close to the surface to allow waves to break on them, appearing as bomboras during periods of high wave energy. Generally, the distributions of various habitat types on subtidal reefs are related to depth, wave exposure and biological processes, and their distributions vary in space and time and may not necessarily apply to all reefs (Underwood *et al.,* 1991). Some of the habitats recognised on reefs of the NSW coast include Fringe, Pyura, Phyllospora, Barrens, Turf, Ecklonia and Deep Reef (Underwood *et al.,* 1991). Habitats are defined by their physical properties and the relative dominance of sessile invertebrates and algae. This habitat complexity and variety allows rocky reefs to support one of the most diverse fish communities, with 680 species recorded from rocky reefs of southern Australia (Lincoln Smith and Jones, 1995).

There are also numerous offshore islands within the fishery, including Cook Island, Julian Rocks, Solitary Islands, Broughton Island, Cabbage Tree Island, Brush Island, Montague Island and Belowla Island. Many offshore islands are protected under various pieces of legislation and restrict the use of most of the methods used in the fishery.

Summary of importance of reefs and islands

Rocky reefs enhance habitat complexity by providing a suitable habitat for settlement and recruitment, particularly by diverse assemblages of brown, red and green macroalgae, along with sponges, ascidians and other sessile invertebrates (e.g. Jones and Andrew, 1990; Lincoln Smith and Jones, 1995). The large macroalgae (such as kelp) that partially cover most rocky reefs enhance

overall species diversity by providing patches of shaded habitat favoured by distinct assemblages of organisms (Kennelly, 1995).

Rocky reefs and other such habitats:

- provide extensive refuge and feeding opportunities for a variety of fish and invertebrates, particularly soft corals, bryozoans, ascidians and sponges (e.g. Butler, 1995; Jones and Andrew, 1990; Lincoln Smith *et al.,* 1992; Lincoln Smith and Jones, 1995)
- may be utilised on a seasonal basis by juveniles of tropical fish that are swept southward by the East Australian Current each summer and autumn (Kailola *et al.,* 1993; Kuiter, 1993). Such fish do not usually survive the winter, or if they do, they fail to establish breeding populations (Lincoln Smith and Jones, 1995)
- provide areas of breeding and foraging habitat isolated from the majority of anthropogenic impacts
- could be utilised by many of the protected species of fish in NSW during at least part of their lifecycle. Species relevant to this fishery include grey nurse shark, black cod, estuary cod and blue groper.

Potential effects of the fishery on reefs and islands

The methods used in the fishery are unlikely to affect the habitats of rocky reefs, as those that can be used in such areas do not contact the reef itself. Most of the impacts associated with reefs are potential flow-on effects and/or the effects of disturbance, with the latter likely to be restricted to marine mammals, marine reptiles and birds. Some potential trophic effects that could occur on reefs within the fishery include:

- a local decline in the abundance of an apex predator (e.g. mulloway, turtles or seabirds) caused by the selective removal of baitfish during garfish hauling and purse seining
- an increase in the survival (and therefore abundance) of a prey species caused by the selective removal of one or more predator species
- the favouring of mobile opportunists, such as sharks and dolphins, that are better able to follow food supplies created by hauling operations, at the expense of less mobile or less aggressive species
- changes to benthic communities arising from the removal of species that feed on microalgae, detritus and/or grazing species
- short-term increases in the abundance of scavenger or predator species (fish, crabs or birds) as a result of large numbers of dead or injured fish being made available as food during or after a haul or seine
- the dispersal of bait fish schools as a result of purse seining or hauling may cause predators to move elsewhere or to have difficulty in finding sufficient food.

Trophic effects are poorly understood and the degree to which they could occur as result of the fishery is unknown. Many of the reefs that could be indirectly targeted in the fishery, for example by purse seining in the waters above them, are likely to provide complex habitat where there would otherwise be very little such habitat. These reefs could therefore be considered unique or discrete habitats. Even in such habitats, it is not clear what the effects of fishing could be, or how long they

would be sustained. Studies suggest that the complexity of such environments does not lend itself to basic predator-prey relationships, and that the removal or increase of a species does not necessarily equate to detectable changes in ecological processes (Jennings and Kaiser, 1998). At this stage, the proportion of habitat used by the fishery is unknown, so it is not readily possible to assess the impacts of the fishery on the fauna of rocky reefs, beyond those potential effects described above. Given that hauling to boats is thought to be on the increase within the fishery, the number and area of reefs and islands fished, and the species taken from each, requires further investigation.

Assessment of management responses proposed in the draft FMS for reefs and islands

There are no responses in the draft FMS that relate directly to rocky reefs, as the general issues of habitat protection are similar to those for ocean beaches. Furthermore, the methods in the fishery are not designed to contact reefs and rocky outcrops, so the perceived limited interaction with those habitats is unlikely to require extensive management. Beyond the general habitat protection measures discussed for ocean beaches, other applicable responses include developing a policy for the use of lift nets, and identifying the level of active effort for the garfish hauling net. These measures should remove some of the uncertainty associated with the distribution and intensity of these methods, and in conjunction with the observer program, may also provide some indication of the potential for trophic effects due to these methods. As there is thought to be very limited direct contact with the reef itself associated with purse seining or garfish hauling, the observer program should record interactions with marine mammals, turtles, seasnakes, birds, and fish observed but not retained by the fishery.

The potential to encounter threatened or protected fish on rocky reefs should primarily be accommodated by the observer program, the existing prohibition on the capture or sale of threatened or protected fish, and the continued prohibition on the use of explosive devices to take fish. These measures should be adequate to minimise potential impacts on the habitats and fauna of rocky reefs.

iii) Marine protected areas

Marine protected areas are coastal, estuarine or oceanic areas that are managed to conserve marine biodiversity. They range from small, highly protected areas that focus on species or community protection to large multiple-use areas that include complex linkages of ecosystems and habitats. Marine protected areas may include reefs, seagrass beds, rocky platforms, mangroves, estuarine waters, mudflats, saltmarshes, shipwrecks, archaeological sites, and coastal and offshore areas of airspace, seabed and water. Internationally, marine protected areas are considered an important tool for achieving conservation objectives in the marine environment. In NSW, marine protected areas consist of Marine Parks, Aquatic Reserves, Intertidal Protected Areas (not affected by the fishery), and marine or estuarine components of National Parks or Nature Reserves. Coastal parks and reserves often incorporate the beds of adjoining lakes and estuaries, and may include areas to the high water mark of ocean beaches.

Other important habitats that are protected, although not referred to as marine protected areas because they are protected under international treaties, include intertidal areas used by migratory waders, coastal plant communities and adjacent beaches. These areas are generally referred to as JAMBA (Japan-Australia Agreement for the Protection of Migratory Birds, Birds in Danger of Extinction and their Environment) or CAMBA (Agreement between Australia and the People's Republic of China for the Protection of Migratory Birds and their Environment) habitat.

Marine parks and aquatic reserves

There are currently two marine parks, Solitary Islands Marine Park (71000 ha) and Jervis Bay Marine Park (21450 ha), within the area of the fishery. At the time of writing this report, a third marine park between Brunswick Heads and Lennox Head was proposed and open to public consultation. All of the methods used in the fishery can be used within these parks, although the zones within Solitary Island and Jervis Bay Marine Park were under review at the time of writing this report. If proposed zoning plans are approved, they would significantly reduce the area available to purse seining and beach hauling methods within the parks.

There are four aquatic reserves on the coast and thus within the area of the fishery. These include Cook Island (12 ha), Julian Rocks (80 ha), Long Reef (60 ha) and Bushrangers Bay (3 ha). Zoning within Cook Island Aquatic Reserve is still under review. The methods used in the fishery can not be used within Bushrangers Bay, 500 m of Julian Rocks, or 100 m of Long Reef.

Future marine protected areas will be selected on the basis of the National Representative System of Marine Protected Areas (NRSMPA), a strategy that has been endorsed by the States and Territories for the conservation of Australia's marine resources. The Interim Marine and Coastal Regionalisation for Australia report (ANZECC, 1998) provides the general planning framework for developing the NRSMPA. That report identified six discrete regions in NSW, made up of five coastal bioregions and one marine province: the Tweed-Moreton Shelf, Manning Shelf, Hawkesbury Shelf, Batemans Shelf, Twofold Shelf bioregions; and the Lord Howe province. A Marine Park will be established within each bioregion, as well as numerous Aquatic Reserves covering estuarine areas and rocky shores of the open coast.

Marine components of national parks or nature reserves

There are approximately 35 National Parks or Nature Reserves that contain marine protected areas and/or occur on the coast. Several, such as Myall Lakes NP and Ben Boyd NP, cover extensive areas of shoreline that could be used for any of the beach hauling methods and could thus be affected by the fishery. The marine component of Bouddi National Park is the only offshore area in NSW reserved as national park. NSW Fisheries and the Waterways Authority jointly manage the waters of the marine component of the park.

JAMBA and CAMBA bird habitat

There are no listed sites for JAMBA or CAMBA birds because of the periodic preference for certain areas by such birds. For the purposes of this assessment, those areas identified in Environment Protection Authority (EPA - formerly the State Pollution Control Commission) coastal resource atlases were used to provide some estimate of the occurrence of these birds by fishing region within the fishery (Table F2). Most of the birds protected under these agreements are migratory waders and seabirds, which are far more common in estuaries but also utilise offshore islands, coastal beaches and nearshore waters and could thus be affected by the fishery. Some of these birds are jointly protected by the NSW *Threatened Species Conservation Act 1995* (TSC Act) as either endangered or vulnerable species.

Many of the islands adjacent to the coast are particularly important to numerous species for breeding and/or roosting. The most important islands are Cook, Solitary Islands, Little Muttonbird, Muttonbird, Korffs, Sawtell, Green, Delicate Nobby, Broughton, Cabbage Tree, Moon, Bird, Lion, Five Islands, Comerong, Bowen, Brush, Belowla, Grasshopper, Wasp, Tollgates, and Montague.

Table F2. JAMBA and CAMBA birds that could be affected by the Ocean Hauling Fishery and their status under the TSC Act.

Where E = endangered and V = vulnerable (Source: Simpson and Day 1996; Pizzey and Doyle 1984; NPWS Atlas of Wildlife database).

				DISTRIBUTION		
FAMILY	**COMMON NAME**	**SCIENTIFIC NAME**	**STATUS**	**region**	**timing**	**breeding**
Procellariidae	Streaked Shearwater	*Calonectris leucomelas*	J,C	All	Su	no
	Wedge-tailed Shearwater	*Puffinus pacificus*	J	All	Sp & Su	all
	Fleshy-footed Shearwater	*Puffinus carneipes*	J,V	All	Su & Au	no
	Sooty Shearwater	*Puffinus griseus*	J,C	All	Sp, Su & Au	islands of 4-7
	Short-tailed Shearwater	*Puffinus tenuirostris*	J	All	Sp, Su & Au	islands of 4-7
Phaethontidae	White-tailed Tropic-bird	*Phaethon lepturus*	J,C	1-4	Su & Au	no
Sulidae	Brown Booby	*Sula leucogaster*	J,C	1-2	All	no
	Masked Booby	*Sula dactylatra*	J,C	1-4	All	no
Fregatidae	Greater Frigate-bird	*Fregata minor*	J,C	1-3	All	no
	Lesser Frigate-bird	*Fregata ariel*	J,C	1-3	Su & Au	no
Ardeidae	Eastern Reef Egret	*Egretta sacra*	C	All	All	no
Scolopacidae	Turnstone	*Arenaria interpres*	J,C	All	Sp & Su	no
	Eastern Curlew	*Numenius madagascariensis*	J	All	Sp, Su & Au	no
	Whimbrel	*Numenius phaeopus*	J,C	All	Sp & Su	no
	Little Whimbrel	*Numenius minutus*	J,C	1-4	Sp & Su	no
	Little Greenshank	*Tringa stagnatilis*	J,C	All	Winter	no
	Greenshank	*Tringa nebularia*	J,C	All	Sp & Su	no
	Grey-tailed Tattler	*Tringa brevipes*	J,C	All	Sp & Su	no
	Wandering Tattler	*Tringa incana*	J,C	1-5	Sp & Su	no
	Common Sandpiper	*Tringa hypoleucos*	J,C	All	Sp, Su & Au	no
	Terek Sandpiper	*Xenus cinereus*	J,C,V	All	Sp & Su	no
	Japanese Snipe	*Gallinago hardwickii*	J,C	All	Sp & Su	no
	Black-tailed Godwit	*Limosa limosa*	J,C,V	All	Sp & Su	no
	Bar-tailed Godwit	*Limosa lapponica*	J,C	All	Sp & Su	no
	Red-necked Stint	*Calidris ruficollis*	J,C	All	Aug-May	no
	Long-toed Stint	*Calidris minutilla*	J,C	All	Sp & Su	no
	Sharp-tailed Sandpiper	*Calidris acuminata*	J,C	All	Aug-Apr	no
	Curlew Sandpiper	*Calidris ferruginea*	J,C	All	Sp & Su	no
	Knot	*Calidris canutus*	J,C	All	Aug-Apr	no
	Great Knot	*Calidris tenuirostris*	J,C,V	All	Sp & Su	no
	Sanderling	*Crocethia alba*	J,C,V	All	Sp & Su	no
	Broad-billed Sandpiper	*Limicola falcinellus*	J,C,V	All	Sp & Su	no
	Ruff	*Philomachus pugnax*	J,C	1-4	Sp & Su	no
Charadriidae	Mongolian Sand-Plover	*Charadrius mongolus*	J,C,V	All	Sp & Su	no
	Large Sand-Plover	*Charadrius leschenaultii*	J,C,V	All	Aug-May	no
	Eastern Golden Plover	*Pluvialis dominica*	J,C	All	Aug-Apr	no
	Grey Plover	*Pluvialis squatarola*	J,C	All	Aug-Apr	no
Stercorariidae	Pomarine Skua	*Stercorarius pomarinus*	J,C	All	Sp & Su	no
	Arctic Skua	*Stercorarius parasiticus*	J	All	Sp & Su	no
Laridae	White-winged Black-tern	*Chlidonias leucoptera*	J,C	All	Sp & Su	no
	Crested Tern	*Sterna bergii*	J	All	All	all
	Asiatic Common Tern	*Sterna hirundo*	J,C	All	Sp & Su	no
	Little Tern	*Sterna albifrons*	J,C,E	All	Sp & Su	Scattered*
	Caspian Tern	*Sterna caspia*	C	All	All	4-7
	Common Noddy	*Anous stolidus*	J,C	1-5	All	no
Accipitridae	White-bellied Sea-Eagle	*Haliaeetus leucogaster*	C	All	All	all

* denotes that little terns have historically bred in or near the mouth of approximately 70 estuaries, but the number of successful sites is diminishing. The most successful coastal sites at the time of this report were Harrington and Farquhar Inlet and those beaches are closed to the Ocean Hauling Fishery.

Some of the more important beaches include Ten Mile Beach, Woody Bay, those between Smoky Cape and Hat Head, those between Crowdy Head and Old Bar, those adjacent to Myall Lakes

National Park, those between The Entrance and Box Head, Bhewerre, Cudmirrah and those between Lake Conjola and Lake Tabourie.

There are approximately 90 species of birds covered under these agreements, but only about 46 of those are likely to occur on ocean beaches or in nearshore waters of NSW (Table F2). The most numerous are from the families Scolopacidae (curlews, sandpipers and godwits), represented by approximately 22 species, and Laridae (terns) with six species. Most wader birds migrate to the NSW coast during spring and summer and return to the Northern Hemisphere in autumn and winter to breed. Most shearwaters breed on islands, particularly Lord Howe and those south of Broughton Island and skuas return to the Arctic Circle to breed. Wedge-tailed shearwaters and little terns arrive in spring to breed and may remain on our coast all year. Other nomadic and resident species (i.e. occur all year and breed in Australia) include white-breasted sea-eagles, caspian terns, crested terns and white egrets.

Potential effects of the fishery on marine protected areas

In its current form, the fishery could affect the beach and reef areas of the marine parks, but not the four aquatic reserves as the methods used in the fishery are not permitted within the reserves. Beach hauling methods are currently permitted on approximately 94% of the beaches within Solitary Islands Marine Park (approximately 70 km long), and on all but Grenfields Beach within Jervis Bay Marine Park. Purse seining and other boat-based methods can be done in 97% of the waters of the Solitary Islands Marine Park and all of Jervis Bay Marine Park. With the potential for the trophic effects described above to occur within areas supposedly reserved to conserve unique marine environments, it would appear that current zoning is inadequate to protect the fauna and flora of the parks from the activities of the various user groups. Acknowledging this inadequacy, the Marine Parks Authority (MPA) is currently proposing to change the zoning within both parks, and most likely in future parks, in a way likely to impact on ocean hauling methods.

Proposed changes to Solitary Islands Marine Park could reduce the beaches available to beach-based hauling to the six traditional hauling beaches agreed to during the regional liaison process, and an extra hauling ground at Woolgoolga Beach. Purse seining would not be permitted within the park. Similar proposals for Jervis Bay Marine Park could also see purse seining prohibited within Jervis Bay west of a line drawn between Bowen Island and Point Perpendicular, within 300 m of the foreshore between Little Beecroft Head and the Drum and Drumsticks, and between Brocks Rock and a headland approximately 400 m south of Kitty's Point. Beach-based hauling could also be restricted to Callala Beach and Long Beach within the bay, and Bherwerre Beach, Currarong Beach and Warrain Beach on the open coast.

Beach hauling methods are also permitted on the foreshores of those National Parks and Nature Reserves that have ocean beaches, which also include most JAMBA or CAMBA bird habitat. As with the other habitats, there is no information about how frequently or intensely these habitats are used, nor of the actual effects that the fishery may have had on them. Disturbance is the most likely effect due to the fishery, and some studies have suggested buffer zones of up to 200 m around the most important sites for these species (Paton *et al.,* 2000). With the majority of beach hauling effort occurring in late autumn and winter, this should restrict the potential for disturbance of the majority of these birds. Furthermore, most of the more important beaches listed above are either permanently closed to the fishery or are shared beaches, with the exception of Woody Bay, which is a traditional hauling ground.

Assessment of management responses proposed in the draft FMS for marine protected areas

There are a limited number of responses in the draft FMS that relate to minimising effects of the fishery on marine protected areas, and this probably reflects the limited knowledge about the fishery's interaction with such habitats. All of the responses relating to sandy beaches and rocky reefs are also applicable to marine protected areas. Some of the more specific responses include:

- continuing to use fishing closures to control the time and area fished to protect key fish habitat and minimise interactions with threatened species
- further developing and annually reviewing a code of conduct for the fishery with respect to operating on beaches to minimise environmental impacts in those areas
- defining and declaring recognised fishing grounds through the regional liaison process
- participating in the selection and ongoing management of marine protected areas in ocean waters.

Most of these measures are likely to minimise impacts on the biodiversity and habitats of marine protected areas, particularly when considered in conjunction with the probable closure of vast areas to the fishery following the establishment of more marine parks along the coast. The potential declaration of RFG, or at least traditional hauling grounds, and a code of conduct for operating within those beaches should further restrict the area available to fishers and thus the potential for impact.

There are no responses that relate directly to JAMBA or CAMBA birds, again probably reflecting the perceived lack of interaction with such species. They may, however, be identified in the preliminary phase of the observer survey, during which time species or areas of greatest risk will be determined in consultation with the threatened species units of NSW Fisheries and NPWS. Additional measures include the code of conduct, declaration of traditional hauling grounds and access points formulated during the regional liaison process, which included staff of the NPWS, the agency responsible for the management of birds and all animals other than fish. The regional liaison process included the establishment of access points and speed limits for four-wheel drive vehicles on beaches, thereby minimising potential harm to the environment and adjacent residents. With the peak of activity for the fishery in winter, establishment of traditional hauling grounds, and the ongoing selection of marine parks, there should be no need for seasonal closures, and the measures proposed in the draft FMS should be adequate to minimise potential impacts on JAMBA and CAMBA birds. Beyond those measures, however, the draft FMS should include reference to those species in the response to minimise interactions with threatened species.

b) Knowledge gaps

In the absence of data, this assessment compared the area, methods and timing of the fishery with the fauna and habitats that could be affected and found that there was limited scope for habitat damage due to the fishery. Nor did there appear to be any significant effects on fauna beyond those species targeted in the fishery. The potential effects of the various gear types were based on extrapolations from studies of much larger, more intensive equipment, often from overseas and in offshore environments. The few studies of similar gears and habitats were inconclusive or not readily correlated. As such, there is a fair degree of uncertainty associated with the assessment of impacts of the methods on the biodiversity and habitats of the coastal environment in which the fishery operates.

The proposed observer program may provide information on some of those aspects, but alone is unlikely to be adequate to provide all the answers.

There is an obvious need for the collection of targeted, quantitative data, and for this data to be fed back into the FMS during future reviews and/or during the annual review of the code of conduct. Some of that data should be collected independent of the fishery, such as NPWS recording the distribution and abundance of fauna to determine key sites for species that may require increased management measures by the fishery in the future. Other studies could more accurately determine the biodiversity of ocean beaches, particularly of nearshore waters. Such studies could be done either dependent upon or independent of the fishery. Most of the existing information is of the fish fauna caught using commercial nets, but provides little information about the fish and invertebrates that are too small or escape capture, and nothing of the invertebrate fauna of the subtidal area of beaches. Other data, for example determining the effect of hauling on the environment of ocean beaches, would necessitate fishery-dependent surveys. At this stage, however, the draft FMS does not propose any such research programs examining the effects of methods on habitats and/or biodiversity. Furthermore, it is considered a very low priority. The proposed observer survey may well be adequate for recording the numbers of directly or indirectly affected megafauna such as birds, whales and fish, but will offer little information to prioritise areas of habitat that are damaged. Subjective observation should not be the basis for determining which habitats and methods warrant modification as proposed in the draft FMS. It is recommended that during the establishment of traditional hauling grounds, impact (fished) and control (non-fished and/or where fishing is proposed to be stopped) sites be selected for a research program into the effects of the fishery on habitats and biodiversity.

c) Conclusion

This assessment has adopted a precautionary approach in the absence of reliable data about the effects of the fishery on habitats and biodiversity of ocean beaches. Most of the impacts are inferred and relate to beach hauling methods, based on what are thought to be much more intensive and destructive methods. Assuming hauling on ocean beaches is less destructive than those methods for which a lot of research has been done, and pending the results of observer surveys, it is probable that any impacts due to past activities of the fishery are not long term or permanent. They are thought to be negligible both in terms of habitat damage and subsequent effects on fauna. Furthermore, many areas of the fishery are also affected by recreational and residential activity, thereby restricting the capacity of the fishery to manage all potential impacts upon ocean beach environments and fauna. The involvement of the Ocean Hauling MAC in the development of policies by other agencies, however, should be able to ensure that such policies do not conflict with measures proposed in the draft FMS. Overall, the draft FMS is considered to represent the optimal strategy for mitigating potential impacts due to the fishery.

The numerous area and seasonal closures that are already in place, and those proposed in the draft FMS to strengthen existing closures, although designed to minimise conflict among beach user groups, have inadvertently provided significant protection to habitats and fauna of the fishery, particularly birds protected under international treaties. The proposed observer program, although requiring some strengthening in the features it would record, should also provide some data about other fauna that could be affected by the fishery. The ongoing involvement of NPWS and NSW Fisheries Office of Conservation staff in the regional liaison process and review of the code of conduct should highlight the need for any alternate mitigation measures, such as more area or seasonal closures

to minimise disturbance or habitat damage. At this stage, it does not appear necessary to implement more closures on an area or seasonal basis.

The draft FMS proposes to significantly increase the amount of beaches permanently closed to hauling to approximately 17%, with other less permanent closures applying to all beaches. Such measures would minimise the total area susceptible to any potential impacts. The draft FMS has some shortcomings, however, in relation to biodiversity and habitats, in particular the failure to propose research programs to determine the effect of the fishery on habitats and fauna of sandy beaches. Whilst it is agreed that beaches are thought to support fewer organisms than other coastal habitats, and that changes in such high energy environments may be difficult to detect, this does not remove the onus from the fishery to implement research to more accurately define potential impacts. The establishment of traditional hauling grounds and the closure of some beaches provides an opportunity to investigate those potential impacts and should therefore be included among the proposed research programs.

2. Threatened and Protected Species

a) Threatened species that could be affected by the fishery

For the purposes of this assessment, threatened species refers to any species, populations or ecological communities and their habitats as defined and listed under Schedules 4 or 5 of the *Fisheries Management Act 1994* (FM Act), Schedules 1 or 2 of the *Threatened Species Conservation Act 1995* (TSC Act), or Subdivisions C or D of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This assessment also includes any species of fish listed as protected under Sections 19 (totally protected - not to be taken) or 20 (not to be taken by commercial fishers) of the FM Act. The species considered below have been selected from within their respective schedules because their distribution and some aspect of their lifecycle suggests that the species could be affected by the Ocean Hauling Fishery. Potential impacts could include direct impacts such as capture or habitat disturbance and/or damage, and indirect impacts such as targeting the preferred food source of the species.

The species considered in the following general assessment under the FM Act, and the TSC Act and EPBC Act, are summarised in Tables F3 and F4, respectively. Detailed species profiles are provided in Appendix F1, and the complete eight-part test referred to below is in Appendix F2.

Table F3. List of species protected under the *Fisheries Management Act 1994* that could be directly or indirectly affected by the Ocean Hauling Fishery.

* denotes species also considered vulnerable under the EPBC Act.

PAB = Pilchard anchovy bait hauling

Species	Types of habitats where most likely to be affected	Types of methods with potential to cause direct or indirect impacts
Endangered Species		
Green sawfish*	Beaches of far north coast	General purpose hauling
Grey nurse shark*	Sand gutters, rocky reef	All
Vulnerable Species		
Black cod	Rocky reef	Garfish hauling, PAB, Purse seine
Great white shark*	Beaches, reef	General purpose hauling, Purse seine
Protected Species (Section 19)		
Estuary cod	Rocky reef	Garfish hauling, PAB, Purse seine
Queensland groper	Rocky reef, particularly in north of state	Garfish hauling, PAB, Purse seine
Weedy seadragon	Sand gutters, rocky reef	All
Protected Species (Section 20)		
Blue groper	Rocky reef	Garfish hauling, PAB, Purse seine

Table F4. List of species protected under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* that could be affected by the Ocean Hauling Fishery.

J and C denotes species that are protected under JAMBA or CAMBA treaties, respectively.

Species/group	Types of habitat where most likely to be affected	Most likely effects	Protective treaties or legislation
Endangered Species			
Birds			
Beach stone-curlew	North of Nambucca River; open beaches, sandflats and mudflats	disturbance - feeding	TSC
Gould's petrel	Cabbage Tree and Boondelbah Islands	disturbance - nesting	TSC, EPBC
Hooded plover	South of Jervis Bay on long sandy beaches backed by vegetated dunes	disturbance - feeding	TSC
Little tern	Sand-spits and beaches, open water	disturbance - feeding, nesting	TSC, EPBC, J and C
Wandering albatross	North to central coast, during winter	disturbance - feeding	TSC; EPBC - vulnerable
Marine Mammals			
Blue whale	Coastal waters	disturbance	TSC, EPBC
Endangered Populations			
Little penguins	North Harbour Aquatic Reserve, entrance to Port Jackson and waters within about 15 km radius	disturbance - feeding, nesting, capture	TSC
Vulnerable Species			
Reptiles			
Green turtle	Coastal waters, particularly on north coast	disturbance - feeding capture	TSC and EPBC
Leatherback turtle	Coastal waters, particularly on north coast	disturbance - feeding, nesting, capture	TSC and EPBC
Loggerhead turtles	Coastal waters, particularly on north coast	disturbance - feeding, nesting, capture	TSC; EPBC - endangered
Birds			
Black-browed albatross	Coastal waters	disturbance - feeding	TSC
Black-tailed godwit	Sandflats and beaches, esp. near estuaries	disturbance - feeding	TSC, J and C
Black-winged petrel	Islands along entire coast	disturbance - feeding, nesting	TSC
Broad-billed sandpiper	Hunter to Shoalhaven Rivers, sand and mudflats	disturbance - feeding	TSC, J and C
Fleshy-footed shearwater	Coastal waters of northern half of the State	disturbance	TSC, J and C
Great knot	Far South Coast on sandflats and mudflats	disturbance - feeding	TSC, J and C

Table F4 (cont.).

Species/group	Types of habitat where most likely to be affected	Most likely effects	Protective treaties or legislation
Vulnerable Species (cont)			
Birds (cont)			
Greater sand plover	Sandflats and beaches, esp. near estuaries	disturbance - feeding	TSC, J and C
Grey ternlet	Coastal waters of northern NSW, particularly December to March	disturbance - feeding	TSC
Kermadec petrel	Coastal waters - rarely recorded	disturbance - feeding	TSC, EPBC, J and C
Lesser sand plover	Sandflats and beaches, esp. near estuaries	disturbance - feeding	TSC, J and C
Little shearwater	Coastal waters	disturbance - feeding	TSC, J and C
Osprey	Areas of extensive open water	disturbance	TSC
Pied oystercatcher	Sandflats, mudflats, beaches	disturbance - feeding, nesting	TSC
Providence petrel	Coastal waters of northern half of the State	disturbance	TSC
Sanderling	Sandflats and beaches, esp. near estuaries	disturbance - feeding	TSC, J and C
Shy albatross	Coastal waters of southern NSW, particularly July to November	disturbance - feeding	TSC and EPBC
Sooty oystercatcher	Rocky shores, beaches	disturbance - feeding, nesting	TSC, J and C
Sooty tern	Coastal waters, particularly of northern NSW	disturbance - feeding	TSC
Terek sandpiper	Sandflats and beaches, esp. near estuaries	disturbance - feeding	TSC, J and C
White tern	Coastal waters, particularly of northern NSW	disturbance - feeding	TSC
Marine Mammals			
Humpback whale	Coastal waters	disturbance	TSC and EPBC
Indo-Pacific humpbacked dolphin	Coastal waters, particularly of northern NSW	disturbance	TSC - vulnerable; EPBC - insufficiently known
Long-snouted spinner dolphin	Coastal waters, particularly of northern NSW	disturbance	TSC - vulnerable; EPBC - insufficiently known
Sei whale	Coastal waters	disturbance	TSC and EPBC
Southern right whale	Coastal waters	disturbance	TSC; EPBC endangered

Based on the various legislatures to protect threatened species and an analysis of their distribution and ecology, it would appear that the proposal has the potential to impact about 43 species. The following sections will aim to more precisely define this level of impact, to isolate measures from within the draft FMS designed to mitigate the potential impacts and determine the effectiveness of those measures.

b) Potential impact due to direct capture or disturbance

As discussed in previous sections, the Ocean Hauling Fishery uses a limited number of methods in a few habitats, primarily ocean beaches, waters above rocky reefs and adjacent to headlands, and open water out to 3 nm. This section will focus on how the methods are thought to

impact on threatened species through either capture or disturbance, or by altering their habitat. For brevity, generalised statements will be used for species that utilise similar habitats, except where it is apparent that a technique or its timing may adversely impact a particular species.

i) Capture rates and mortality

There are no data about the capture of threatened species attributable to the Ocean Hauling Fishery. Historically, information about capture rates and/or mortality due to fishing has not been recorded for threatened species as part of the monthly catch returns for fishers. Except for some of the protected fish and the little penguin, other threatened species are unlikely to be captured by the methods used in the fishery. Turtles and seasnakes could also be caught by most of the methods used in the fishery, but are unlikely to die as a result of capture as they are not towed through the water at a speed or in a manner which could drown them, and can be released alive.

Assessment of management responses proposed in the draft FMS

To minimise any potential impacts on threatened species, and/or to collect data to better understand any interactions between the fishery and threatened species, the draft FMS proposes to:

- use scientific observers to document the likelihood of impact of ocean hauling methods on threatened species and to use that data to modify methods where necessary
- document rate and species composition of bycatch and use best-practice methods for the handling of incidentally captured organisms
- modify fishing practices to reduce the impacts on non-retained fauna
- modify the catch and effort returns to collect and monitor information on sightings or captures of threatened species
- develop a code of conduct for purse seiners with respect to appropriate handling methods for incidental catches of marine birds or mammals
- implement provisions of recovery programs or threat abatement plans
- continue the prohibition on taking protected fish (s19 of FM Act) and fish protected from commercial fishing (s20)
- continue the prohibition of taking any species protected under other jurisdictional arrangements
- continue to use fishing closures to control the time and area fished to minimise direct interactions with threatened species, populations or communities.

The content of each of the responses and the monitoring programs designed to test their effectiveness should be able to adequately address the issues as they pertain to threatened species. The underlying assumption is that in the absence of data to the contrary, the fishery in its existing form is thought to be having minimal impact on threatened species. The draft FMS will both elucidate those effects by monitoring capture rates and modifying fishing practices to prevent them from occurring. Initially targeting the observer survey based on the risk to particular species or populations, as determined by recovery teams and threatened species units, is likely to be more effective than trying to set trigger points based on capture rates or catch returns. This allows more observer surveys to be done in regions or areas where numerous species, or a species or population at highest risk, are

thought to occur. This should prevent duplication of research into threatened species and ensures the most efficient use of available resources.

ii) Habitat disturbance or loss

As discussed previously in section 1 of this chapter, there is no quantitative or qualitative data on the direct effects of the methods used in the fishery on aquatic habitats, although the potential is thought to be minimal. The methods are highly unlikely to have caused the loss of habitat of any threatened species. The fishery has existed for over a hundred years, and it is probable that any changes that might have occurred due to fishing would have taken place early on and any subsequent changes would probably be less visible or dramatic. Furthermore, any such changes may no longer be readily identifiable due to the variety and extent of other factors affecting habitats, such as urbanisation and pollution.

Analysis of the methods used in the Ocean Hauling Fishery suggests that any potential impacts are likely to be restricted to sandy beaches, as the methods used adjacent to reefs do not contact the substratum. This should restrict any potential impacts on threatened fish to very few species, as most inhabit rocky reefs. Those that utilise sandy beaches include green sawfish, and to a lesser extent, weedy seadragons. In the absence of data about the effects of habitat and faunal changes resulting from hauling on beaches, it is only possible to speculate about the extent of impacts on those species. Hypothetically, if beach hauling was causing changes in benthic and fish communities such that they were unable to support diverse and abundant assemblages, this would remove a primary food source of green sawfish. Beach-based hauling methods could also remove detached algae from nearshore waters, which could be used on an intermittent basis by weedy seadragons. Until research is done, particularly during the formulation of management and recovery plans for such species, the extent of this type of impact will remain unclear.

Habitat disturbance, in its various forms, is amongst the processes threatening the survival or viability of many species or communities, particularly threatened birds and turtles. For example, haulers working adjacent to some islands off the coast of Wollongong were reputedly responsible for preventing adult little penguins (not part of the threatened population at Manly) from returning to their nests (NPWS, 2000a). Physical obstruction, noise, light and general activity could all have contributed to preventing access. During the breeding season, this would restrict the ability of adults to feed their young. Whilst not intentional, it provides some indication of the sensitivity of certain animals to disturbance and provides some insight as to what may occur elsewhere, or in relation to other species or populations.

The endangered population of little penguins in North Harbour Aquatic Reserve would not be directly affected by the methods in the Ocean Hauling Fishery. The capture of bait species in nearshore coastal waters, however, could provide direct competition for food resources, particularly during breeding when they are thought to have shorter foraging ranges. Dayton *et al.* (1995) highlighted the problem of catching aggregated prey, particularly baitfish, and were concerned that it could be a significant, but unstudied problem in Australia. A study in Port Phillip Bay, Victoria, suggested that adult little penguins had died from starvation because fishing had depleted stocks of anchovies and pilchards (Harrigan, 1992). A later study reported that weather patterns, particularly related to the El Nino – Southern Oscillation phenomenon, caused dramatic shifts in baitfish recruitment, schooling behaviour, abundances and distributions, such that penguins were probably unable to catch sufficient food, irrespective of fishing practices (Hoedt *et al*., 1995). There is potential that during periods of low abundance, fishers may take a significant proportion of the available fish,

limiting the resources available to the penguins. Monitoring fluctuating catch levels, as detailed in the recovery plan for the endangered population of little penguins at Manly, may not necessarily provide any information about the impact of fishing unless there is some indication of the stock levels of baitfish and the feeding requirements of the penguins. Chapter E suggests that adequate stock assessments are not yet available, which is likely to weaken this management action within the recovery plan. The NPWS is currently researching the feeding requirements and feeding ranges of the little penguin population. The combination of such research may provide some indication of the effects of fishing on the little penguin population at Manly, and may be indicative of similar problems elsewhere.

Beach-based hauling has the potential to affect the nesting capabilities of turtles, although the likelihood of fishers or their activities affecting turtles or their nests is thought to be very low (L. Tarvey, NPWS, pers. comm.). Turtles generally bury their eggs on or behind the foredunes of beaches, usually coming ashore at night. After hatching, the young generally access the sea by following moonlight, so any lighting adjacent to nests could attract the young. Given that any fishers working at night would probably be on the lower shore, any lights they may be using are unlikely to attract hatchlings away from the sea. Anecdotal reports suggest that one or two loggerheads have probably nested every year for the last ten years, although there is yet no database on the number, success, or location of nests (L. Tarvey, NPWS, pers. comm.). There are also infrequent reports of green turtles nesting south to about Coffs Harbour, but no quantitative data of their occurrence. In 1993 and 1995, leatherback turtles nested at Lennox Head and Forster, respectively. Those nests were unsuccessful, probably due to nesting too far south of their preferred breeding areas. It will be important that when nesting sites are identified by NPWS, they are considered during the establishment of traditional hauling grounds and/or recognised fishing grounds.

Paton *et al.,* (2000) examined the effects of disturbance on migratory waders, some of which are threatened, and found the disturbance distances were extremely variable both within and among species. They recommended that key areas used by birds in the Coorong-Murray Mouth estuary should be identified and buffer zones of 150 - 200 m established around them. They did, however, acknowledge that some compromise with respect to the sizes of the buffer zones may be required in areas where current human activity is high, particularly if those activities could not be shifted to other areas of less importance to the birds. The study by Paton *et al.,* (2000) was in wetlands that are likely to receive far less visitation, both recreational and commercial, than beaches of coastal NSW, thereby complicating the implementation of buffer zones on NSW beaches. The NSW NPWS is currently considering such temporary zones for the key breeding sites of little terns, and when more information is available for other species, it may also be possible to implement permanent or temporary closures on all beach users, not just fishers.

Assessment of management responses proposed in the draft FMS

In addition to the responses listed above to minimise and/or understand potential impacts due to capture, other responses applicable to habitat disturbance include:

- participate in the selection and management of marine protected areas in ocean waters
- annually review the code of conduct for beach haulers with respect to operating on beaches
- monitor and assess access restrictions from other jurisdictions (e.g. NPWS).

These and the other applicable responses should be adequate to provide information about the potential for the fishery to affect the habitats of threatened species. It will be important that any

information gathered about the abundance and distribution of such species is widely circulated so that it can be incorporated into sightings databases and used to implement actions in recovery and threat abatement plans. The involvement of the NPWS in the RLC process and code of conduct review will be important for ensuring that activity on, and access to beaches, does not affect threatened species under their jurisdiction.

iii) Indirect impacts

Whilst not readily quantifiable, other indirect impacts such as collisions with vessels or behavioural modifications could affect some threatened species, although as with most other aspects related to threatened species, there are no data to indicate the extent or frequency of such occurrences. There are over 180,000 vessels registered by the Waterways Authority in NSW, of which commercial fishing vessels used in the fishery account for less than 0.5%. Recreational vessels comprise approximately 96% and other commercial vessels 3.5%. Acknowledging that a percentage of recreational boats would be unlikely to operate in ocean waters, such vessels are still likely to comprise a significant proportion of offshore boats at any given time, particularly on weekends. Studies by NSW Fisheries of offshore recreational and charter boat fishing have reported significantly greater effort in those fisheries than in the Ocean Hauling Fishery. In 1993/94, in excess of 217,500 trailer boat trips and in excess of 24,500 cruiser and game-boat trips were made to the marine waters of NSW, and similar numbers of trips were also made in the following year (Steffe *et al.,* 1996a; Steffe *et al.,* 1999). This compares to the total effort for all methods within the fishery during 1993/94 and 1994/95 of 20,375 and 20,941 days, respectively (NSW Fisheries Database). Unverified data for 1999/2000 suggests that less than 10,000 days were spent fishing in the Ocean Hauling Fishery.

Beach haulers are restricted to certain areas and therefore any indirect effects would be limited to a small number of species. During setting and retrieval of nets, fishers usually use a second, smaller motor and operate it at low speed, and many (28%) row their boats out from the shore. Such practices are likely to further minimise potential effects due to boat strike, even at night when other boating activity would be minimal. Boat-based garfish haulers and purse seiners work in open waters and adjacent to reefs and headlands, and probably have a greater chance of encountering species that could be struck by vessels, particularly whales, turtles and dolphins. The use of lights and burley could also attract sharks, turtles, dolphins and birds, and operations at night are unlikely to be aware of the presence of fauna beyond the target school of fish.

It is apparent that the behaviour of numerous species, including some threatened species, have become adapted to some fishing activities, particularly to the larger trawling and longline operations conducted in oceanic waters. It is not uncommon for many species of dolphins, sharks and birds to aggregate behind such vessels and scavenge for either discards or bait (e.g. Wassenburg and Hill, 1990; Broadhurst, 1998; Blaber *et al.,* 1995; NPWS species profiles). Of the threatened species considered in this assessment, it is unlikely that the behaviour of many of these is affected by the methods of the fishery, and the extent to which the fishery is responsible for such modifications is unknown. The few possible exceptions could include the dolphins and sharks, and some of the birds, such as albatross and petrels.

Assessment of management responses proposed in the draft FMS

There are no management responses that apply directly to the potential for boat strike or behaviour modification. The observer survey, biodiversity monitoring programs and selection and management of marine protected areas, assuming they are chosen to protect threatened species, should

all prove effective in increasing our understanding of these aspects. Behaviour modification of albatross, in particular the scavenging of baits from longline vessels, was thought to be one of the processes threatening the survival of that species. Data collection and the proposed modification of the gear used in that fishery are included in the threat abatement plan to reduce the number of fatalities due to longline fishing in the Southern Ocean (Environment Australia, undated). That is the same process that is proposed in the draft FMS, and is seen as the most effective way of determining the degree of interaction between the Ocean Hauling Fishery and threatened species. At a more advanced stage, information gathered during the preparation of recovery plans, and the observer survey, may facilitate the use of closures on a time and/or area basis to further minimise the potential for encounters between fishers and threatened species.

iv) Summary of the eight-part test of significance

This assessment has considered the eight factors under the relevant sections of the FM Act, the TSC Act and the EP&A Act in deciding whether there is likely to be a significant effect on threatened species, populations, ecological communities or their habitats (Appendix F2). The assessment was based on a review of biological information derived from the various agencies responsible for those species, from published literature and from personal communications. The assessment has found that the draft FMS will not have a significant effect on any threatened species, populations, ecological communities or their habitats, and as such, a Species Impact Statement is not required for the draft FMS.

v) Assessment of impact on threatened species

Whilst hardly definitive or based on an abundance of scientific data, the factors listed above suggest that the Ocean Hauling Fishery in its current form is not having a direct and/or adverse impact on any threatened species, populations, ecological communities or their habitats. There is, however, a high degree of uncertainty associated with this assessment due to the paucity of quantitative data and reliance upon anecdotal or speculative information. The draft FMS proposes numerous management responses to remove this uncertainty and to better estimate what impacts, if any, the fishery is having on threatened species. Concurrent with the data collection and mitigation measures proposed in the draft FMS, data will also be collected for analysis and development of species recovery plans and threat abatement plans. At this stage, there are no recovery plans for any marine or estuarine species under the FM Act considered in this assessment. The NSW NPWS has finalised a recovery plan for the little penguin colony at Manly, and drafted recovery plans for the little tern and Gould's petrel. Environment Australia has drafted a recovery plan for marine turtles, great white sharks, grey nurse sharks and an action plan for cetaceans. The applicability to, and consistency with, the draft FMS of these recovery plans is discussed below.

The little penguin population is located within North Harbour Aquatic Reserve, which is administered by NSW Fisheries. Despite being listed in the recovery plan as a threatening process for the little penguin population, some commercial fishing is allowed in the reserve (NPWS, 2000a). The potential impact on the population was assessed under the Estuary General Fishery EIS, but is also considered in the ocean hauling assessment as there is potential for boat-based fishers to indirectly affect the population by competing for bait resources and disturbing penguins during feeding. Part of the overall monitoring program of the population is a threat abatement program, which includes the establishment of a mortality register by NPWS and for NSW Fisheries to monitor fishing effort and catches of baitfish, and to record any incidental catches of little penguins. Since the establishment of

the register, there have not been any deaths associated with commercial fishing. At this stage, and until more information is available from the NPWS research, it would appear that the Ocean Hauling Fishery is not having an adverse impact upon the little penguin population and that the draft FMS will assist and/or improve the recovery plan.

The draft recovery plan for little terns does not specifically mention commercial fishing, although such an activity would be included as a form of human disturbance, for which management actions are listed in the plan (NPWS, 2000b). Four breeding sites, Harrington, Farquhar Inlet, Botany Bay and Lake Wollumboola, were identified as requiring intensive management during the breeding season because they have supported more than 20 breeding pairs for the last few years. Lake Wollumboola and the island used by terns in Botany Bay are not parts of this fishery. The sites at Harrington and Farquhar Inlet are permanently closed to the fishery, effectively preventing direct or indirect disturbance of the species at these primary sites. The annual review of the code of conduct, and involvement by the NPWS in the regional liaison process, should also minimise any potential impact due to direct or indirect disturbance at other less important sites.

The draft recovery plan for Gould's petrel does not specifically mention commercial fishing as a real or potential threat, but it could be included as a potential form of human disturbance. Given the extensive research and successful recovery actions that have been implemented for the species by the NPWS, however, this seems highly unlikely. This is largely because the species does not feed in coastal waters within which the fishery operates (NPWS, 2000c).

The recovery plan for marine turtles in Australia did not include any commercial fishery of NSW, nor any of the methods used in the Ocean Hauling Fishery, in its list of Australian fisheries known or thought to have a potential impact on marine turtles (Environment Australia, 1998). The plan identified fisheries from Queensland, Northern Territory, Western Australia and Tasmania, and detailed programs to resolve uncertainties about bycatch and mortality of marine turtles in those fisheries. Most of these related to prawn trawling and longline operations. Consistent with the recovery plan, the draft FMS proposes to monitor sightings and/or captures of marine reptiles.

The draft recovery plan for grey nurse sharks in Australia did not include any of the methods used in the Ocean Hauling Fishery in its list of fisheries known or thought to have a potential impact on grey nurse sharks (Environment Australia, 2000a). The plan identified demersal gillnetting, setlining, droplining and fish and prawn trawling as probably being responsible for the incidental catch of grey nurse sharks, but noted that the degree of this impact was unknown. Some of the measures recommended in the plan were consistent with those proposed in the draft FMS and included:

- assessing commercial data to determine current levels of grey nurse bycatch
- modifying fisheries logbooks to record grey nurse catch and biological data
- ensuring that existing fishery observer programs record interactions with grey nurse sharks
- developing appropriate mechanisms to protect key sites.

The draft recovery plan for great white sharks in Australia did not include any commercial fishery of NSW, nor any of the methods used in the Ocean Hauling Fishery, in its list of Australian fisheries known or thought to have a potential impact on white sharks (Environment Australia, 2000b). The plan identified the southern shark fishery, the snapper fisheries in Victoria, the Gulf of St Vincent and the Spencer Gulf, the tuna farming industry and the WA shark fishery as taking or killing significant numbers of sharks as bycatch. The plan detailed programs to resolve uncertainties about bycatch and mortality of white sharks in those fisheries.

Overall, the draft FMS is consistent with the limited number of recovery plans that have been implemented or drafted to date. This should minimise any potential impacts on the threatened species or populations and provide data that can be fed into the recovery plans. Assuming recovery plans are effective and numbers of threatened species increase, there will be an associated increased likelihood of occurrence and interaction within the fishery. It will be important that observer surveys are scheduled every few years to make provision for this, and not just as a one-off when the likelihood of occurrence or interaction is relatively low.

c) Summary

The proposal has the potential to affect numerous threatened species listed under the FM Act, TSC Act and the EPBC Act. At this stage, however, there appears to be no data implicating the fishery in having an adverse impact on any of those species, their habitats, or accentuating other circumstances that may be having an adverse impact upon them. It will be important for the observer programs discussed within the draft FMS to obtain information about effects due to disturbance, not just direct capture, as this appears to be the most likely form of impact on the majority of threatened species and species of international significance. It will also be important for some of this data to be collected by organisations independent of the fishery. The draft FMS includes numerous measures to mitigate any impacts, including complementarity with departmental initiatives to expand the range of marine protected areas, closures and research programs. These strategies have been considered adequate to mitigate any future potential impacts due to the fishery and should remove a large degree of the uncertainty associated with threatened species.

3. Trophic Structure

There is no information about trophic interactions in relation to the habitats fished in the Ocean Hauling Fishery, although there has been some overseas studies that have inferred trophic changes due to intense fishing pressure (see Dayton *et al.*, 1995). Most of the Australian research on trophic effects due to fishing has focussed on the effects of prawn trawling on benthic and fish communities of the continental shelf (e.g. Sainsbury *et al.,* 1997). After several years of trawling, changes in the abundances of large fish with high economic value (emperors and snappers) were replaced by smaller species with little or no value (lizardfish and butterfly bream). The major mechanisms suggested to explain these shifts were:

- an intraspecific mechanism, under which the observed changes are regarded as independent, single-species responses
- an interspecific mechanism in which there is a negative influence of the larger species on the population growth rate of the smaller species so that the latter experience a competitive release as the abundance of snapper and emperors is reduced by fishing
- an interspecific mechanism in which there is a negative influence of lizardfish and butterfly bream on the growth rate of snappers and emperors such that they are inhibited as the abundance of lizardfish and butterfly bream increases for other reasons
- habitat determination of the carrying capacity of each genus, so that trawl-induced modification of the abundance of the habitat types alters the carrying capacity of the different genera.

The degree to which these types of changes and mechanisms could occur on the sandy beaches commonly used by the Ocean Hauling Fishery is unknown. Given the limited scope for habitat alteration of sandy beaches, there would appear to be minimal likelihood of such pronounced and permanent changes. The fishery also catches a variety of species that utilise numerous habitats beyond those of ocean beaches and which are extremely mobile, making change specific to an area both unlikely and very difficult to discern, even if it were occurring. Furthermore, some studies suggest that the complexity of marine environments does not lend itself to basic predator-prey relationships, and that the removal or increase of a species does not necessarily equate to detectable changes in ecological processes (Jennings and Kaiser, 1998). The complexity and scope of trophic effects due to fishing have proven extremely difficult to conclusively demonstrate in the past (Hall, 1999), and discussing them at length purpose in the absence of appropriate data would serve little in the assessment of the draft FMS. Some of the other potential trophic and productivity changes that could occur due to the fishery were discussed in section 1 of this chapter.

a) Species likely to be affected by the Ocean Hauling Fishery

The NSW coastline plays host to a large number of birds, fish, marine mammals, turtles and invertebrates, all of which could be affected by trophic interactions arising from fishing activities. Little is understood of the effect of fishing on trophic interactions, and much of the information available are summaries of other studies (e.g. Dayton *et al*., 1995) or inferences based on observations. Where the effects have been studied in detail, the studies have been limited to effects on a small number of economically important or physically obvious species. Such studies are unlikely to provide an indication of the effects through entire food chains. Those studies have not been done in similar environments to the Ocean Hauling Fishery, nor examined similar species or methods, so any

extrapolations to the fishery are likely to be of little value. Without reliable, quantitative information, it is not possible to definitively isolate those species that could be affected by trophic changes.

The fishery targets species such as sea mullet, Australian salmon, yellowfin bream, sea garfish and luderick, all of which spend considerable portions of their lifecycle within estuaries and some of these species also utilise rocky reefs. Therefore any trophic effects could also be experienced within estuaries and adjacent offshore rocky reef environments. The other species primarily targeted in the fishery are those broadly described as baitfish, which form schooling aggregations and include fish such as pilchards, yellowtail, whitebait and blue mackerel. These are important prey sources for a variety of dolphins and seabirds, as well as larger species of fish such as salmon, tunas and billfish. The dispersal or the wholesale removal of aggregations by fishing could cause predators to move elsewhere or to have difficulty in finding sufficient food, with further potential flow-on effects (Cappo *et al.,* 1998). Chapter E suggests that those bait species range from moderately to overfished, and that some are unknown because of a lack of information and/or limited understanding of the status of the stocks. Even in the absence of data about trophic effects, the overfishing of bait species could have serious implications for predators such as Australian salmon, tailor, mulloway, seabirds, turtles, dolphins and sharks.

Other than potential trophic effects due to the removal or dispersal of species targeted in the fishery, there are those non-target organisms that may be directly or indirectly affected by the fishery. Those fish that are retained are listed in the draft FMS, but there are also those species that are not retained as part of the fishery, i.e. bycatch. Other species that could be affected by fishing operations, but not caught and thus not recorded, are those generally too small to be retained by the nets. This is far more likely to occur during beach-based hauling, as boat-based methods do not contact the substratum and are thought to be even more target-specific. At this stage, there are no data relating to levels of bycatch within the fishery, although it is thought to be minimal. Despite this absence of data, it is probable that numerous species of fish and invertebrates common to ocean beaches are affected by the fishery, and that they represent a variety of trophic groups. Furthermore, these species, although probably not accounting for significant abundance or biomass, are likely to represent resident species as opposed to itinerant species that are targeted in the fishery. As a guide, affected fauna could include, but is not limited to, members of the following families of fishes and invertebrates: Aracanthidae (boxfishes), Atherinidae (hardyheads), Callionymidae (stinkfishes), Caridae (prawns), Clinidae (weedfishes), Clupeidae (sprats and herrings), Creediidae (sand-divers), Diodontidae (porcupinefish), Gobiidae (gobies), Harpadontidae (sauries), Isonidae (surfsardines), Latrididae (striped trumpeter), Leptoscopidae (pygmy stargazers), Loliginidae (calamari), Octopodidae (octopuses), Ostracidae (cowfishes and turretfishes), Penaeidae (prawns), Percophidae (sandfishes), Portunidae (sand and swimmer crabs), Scorpaenidae (fortescues and scorpionfishes), Scyphozoa (jellyfishes), Sepidae (cuttlefishes), Synodontidae (lizardfishes), Terapontidae (four- and sixlined trumpeters), Tetraodontidae (toadfishes), Torpedinidae (numbfishes) and Tuethoidae (squids). Indirectly affected species would include all of those fauna which prey on those fish and invertebrates, such as birds, other fish, marine mammals and reptiles.

In addition to those higher level trophic groups, there are also a variety of invertebrates associated with the substratum and detached (usually macroalgae) and attached macrophytes (seagrass). The movement of nets across bare substratum could damage or remove fauna, or expose them to predators. Invertebrates associated with macrophytes could also be stranded on the shoreline and become targets for scavenging birds, crabs and invertebrates. Accumulations of macrophyte debris on beaches, known as wrack, create important habitats for all fauna of ocean beaches, primarily

through the provision of food and/or refuge (Colombini *et al*., 2000; Kirkman and Hendrick, 1997). Wrack is also important for a variety of shorebirds (Kirkman and Hendrick, 1997), and the breakdown of wrack releases nutrients that can be used by beach infauna and fauna of adjacent waters.

b) Fate of discards

At this stage, there is no indication of the volumes or species that are regularly discarded, of the methods that are responsible for most discards or of the habitats or areas in which most discards are caught in the Ocean Hauling Fishery. The selectivity of the methods used in the fishery, primarily by targeting large schools of a primarily single species of fish, is likely to severely restrict the potential for discards. Purse seining, garfish hauling and lift netting are primarily done in open water, further limiting the potential for bycatch that could otherwise be caught if the net were swept across or just above the substratum. Pilchard nets can be hauled from the beach, and although they are increasingly being used from boats, the small mesh could retain species of no economic value such as those listed above. They could include fish such as gobies or sandfish, or juveniles of economic species, which cannot be retained under the regulation for that type of net. The general purpose haul net could also catch a variety of species that are likely to be discarded, consisting of undersized individuals of target species and species of no economic value.

The effects of discard provisioning would depend on whether the discards floated or sank upon return to the water (Harris and Poiner, 1990; Wassenberg and Hill, 1990). Floating discards would be readily available to birds such as shearwaters, gannets, boobies, gulls and terns, and species of fish that feed on the surface, such as tailor and Australian salmon. Any fish that are subsequently washed ashore could also be collected by most of the aforementioned birds, as well as by ospreys, kites and sea-eagles, and ravens or other carrion eaters from adjacent forested areas. Sinking animals could be taken in mid-water or on the bottom by a variety of fish and invertebrates, as well as by diving birds such as penguins, petrels and skuas. The degree to which benthic organisms such as worms, bivalves and echinoderms (sea urchins and starfish) are able to capitalise on sunken discards will depend on how much damage these organisms sustain during the hauling of the net and on the volumes of discards. Some studies have reported oxygen depletion in areas receiving high volumes of discards (Dayton *et al.,* 1995), but this is unlikely in this fishery given the perceived low volume of discards and the high-energy environment of coastal beaches.

Dolphins, sharks and turtles could exploit both floating and sinking discards, and dolphins in particular are known to remove fish from the codend of trawl nets and to prey on fish, such as whiting, that are able to pass through the wings and codend of trawl nets (Broadhurst, 1998). Dolphins, sharks and a variety of seabirds have been reported to modify their behaviour in order to capitalise on discards from trawlers (Broadhurst, 1998). As mentioned above, the degree to which any faunal group, community or species benefits from discards of the Ocean Hauling Fishery is unknown, but based on the perceived limited bycatch associated with the fishery, is likely to be minimal.

c) Assessment of management responses proposed in the draft FMS

There is a great deal of uncertainty in relation to trophic impacts associated with fishing, and most of the studies that have attempted to examine these impacts have been done in vastly different environments and of different methods to those of the Ocean Hauling Fishery (Cappo *et al.,* 1998; Jennings and Kaiser, 1998; Hall, 1999). In the absence of quantitative data about the bycatch

associated with the fishery, although it is believed to be insignificant, there is some risk that the fishery could affect the trophic structure of sandy beaches or rocky reef ecosystems, and to a limited number of strapweed (*Posidonia australis*) beds. Consideration of the methods used in the fishery and the fact that fishers target schooling species, however, would suggest that there is likely to be minimal habitat damage, little or no discards, and thus limited potential for alteration of the trophic structure of beach, reef or seagrass ecosystems. Unfortunately, as with the trophic effects themselves, there is a fair degree of uncertainty as there is no data upon which to base such an assessment.

Acknowledging the need to understand more about both discards and potential trophic effects, the draft FMS proposes to:

- use scientific observers to document the likelihood of impact of ocean hauling methods on fish habitats and to use that data to modify methods where necessary
- prohibit general purpose haul netting over beds of *Posidonia australis*
- use scientific observers to document the rate and species composition of bycatch
- modify fishing practices to reduce the impacts on non-retained fauna
- improve understanding of ecosystem functioning and fishing impacts
- collaborate with other institutions to understand the concepts of ecosystem function
- develop a policy to manage the harvest of bait for the Commonwealth tuna fishery in NSW waters and the use of lift nets for collection of bait by NSW line fishers.

Overall, these measures are likely to be useful for assessing fluctuations in the composition of catches, but are unlikely to significantly aid our limited understanding of trophic interactions. Such studies would necessarily be far more complex, extensive and expensive than the draft FMS is likely to be able to accommodate.

Some factors that could be strengthened are not beyond the scope of the draft FMS. It is important that some of the data from the observer program are collected by organisations independent of the fishery. This will improve transparency of the program and aid stakeholder confidence. The results, both data and reports, should also be made widely available for independent scrutiny. The program should also record interactions with fish other than those targeted in the fishery, as well as all fauna, not just those of conservation significance. It would be difficult to ascertain potential discard effects if observers were only recording the presence of threatened species, which by their nature may be rarely recorded. It may be more important, for example, to document that silver gulls are consistently removing fish from purse seines and consuming the majority of discards and/or escaped fish at beach hauling operations. The benefits derived by that species are likely to have serious repercussions for other species of birds, and observations of this nature may provide some insight as to which aspects should be considered by successive studies.

4. Translocation of Organisms and Stock Enhancement

Translocation of an aquatic organism is defined as "the movement of live aquatic material (including any stages of the organisms' lifecycle and any derived, viable genetic material) beyond its accepted distribution, or to areas that contain genetically distinct populations, or to areas with superior disease or parasite status" (MCFFA, 1999).

The introduction of exotic species into new environments can pose a major threat to the integrity of natural communities, the existence of rare and endangered species, the viability of industries based on living resources and pose risks to human health. Marine pests can be as damaging as pollution events but their effects are likely to be much more persistent (CRIMP, 2000a).

The risks associated with the translocation of any organism include the potential for the establishment of feral populations, environmental impacts and genetic shifts in wild populations. There is a wide range of species that have been introduced into Australia (Pollard and Hutchings, 1990a&b). Some of the more notable marine translocations that have occurred in Australia include northern Pacific seastars (*Asterias* sp.) and the Japanese seaweed (*Undaria* sp.).

Translocated species, if introduced to a new water body under the right conditions, may grow or breed prolifically and adversely affect other species or habitats; for example an introduced marine snail may compete with local snails, whilst a macroalgae (such as *Caulerpa taxifolia*) may smother seagrasses.

a) Possible mechanisms of translocation

Live aquatic organisms may be transported either deliberately through the trade in live product or the use of live bait, or inadvertently, through the movement of water or through the movement of vessels (hull fouling, ballast water and/or internal waters) and gear. Some invertebrates and macroalgae readily survive transport if lodged amongst damp equipment, and in some cases only a small fragment of macroalgae is necessary for propagation.

i) Deliberate translocation

Currently there is no trade in live organisms derived from this fishery, however, the draft FMS proposes to investigate the potential for purse seiners to retain bait in holding pens. At this stage, the proposal has not been formalised, but it is likely to involve holding a small volume of live baitfish, such as yellowtail, in collapsible pens either alongside fishers' boats or within estuaries. Recreational and commercial fishers would then be able to purchase live bait, improving the knowledge of supply and demand for the species and improving the management of the species. Such a proposal would be subject to a separate approval process, including an assessment of the potential for the transport of diseases.

ii) Inadvertent translocation

Movement of water

Should live product trade or live bait practices be introduced as proposed, the fate of the transport medium is of some concern as undesirable organisms may be transported with it. This is of particular concern if the stock is being sourced from an area where pests, red tides, algal blooms or

disease outbreaks are current and/or common, and there is a possibility of subsequent release into environments without those problems.

The risk may be minimised through appropriate treatment and disposal of transport medium, including the appropriate treatment (e.g. cleaning and storage) of equipment. The risk can be further minimised through obtaining target species from areas where there have been no associated pest species or disease outbreaks.

Movement of fishing vessels

As the vessels used in this fishery are predominantly trailer boats, there is little risk of transmission of organisms through the fouling of hulls or their internal water supply systems. Most vessels are removed from the water when fishing has been completed and stored out of the water until the next fishing operation. The restriction to zones for all hauling methods also minimises the distances over which vessels can travel. Boats that are not removed from the water are likely to undergo regular maintenance, including hull anti-fouling, and to regularly release water from their boats via the bilge. Hauling nets onto boats would provide a continual source of water, and it would need to be immediately removed to ensure boat performance and safety. As such, water is unlikely to be transported far from its point of origin.

Movement of fishing equipment

Beach-based haulers are restricted to regions within the fishery, which would minimise the potential transport of equipment between different areas of the state. Purse seine fishers, however, are not restricted to those zones but are limited in their movements by the capacity of their boats. The movement of haul nets between fishing grounds is a significant vector for the movement of some hardy species, particularly if the nets are not thoroughly cleaned after each fishing operation, and it is rolled or bundled so that it remains damp until the next operation. A number of species, of algae and molluscs for example, can remain alive in damp conditions for several days and could be routinely and inadvertently translocated by this means.

b) Species likely to be translocated by fishing equipment

For an organism to be successfully translocated as a result of fishing activities it will need to survive collection, transportation and release. Species that are most likely to be translocated by fishing equipment are those that are vulnerable to capture by, or attachment to, the gears used and not susceptible to mortality as a consequence of the collection, transport or release. Such organisms would include species that are found on the fishing grounds and in association with target species or their habitat, are hardy, and can survive out of water for reasonable periods.

Organisms that may be subject to translocation can include species native to NSW that are moved between existing populations; native species that are moved to new locations (range extensions); or exotic species which having been established in one location (in NSW or neighbouring states) could be spread further by their movement by fishing equipment or vessels.

While some organisms that are translocated do not establish feral populations, they could still pose a risk of introducing disease and or parasites from their original environment by direct impact, such as predation or competition with species in their new environment. The primary threat of translocation, however, comes from those species that are able to adapt and survive and form viable populations in their new environment.

The species most likely to be translocated successfully through operations of the Ocean Hauling Fishery include any number of native or exotic species of aquatic plants and animals, but those more likely are molluscs, echinoderms and algae. Further, because many beach haulers are also endorsed to work within estuaries, there is potential for widespread movement within and among estuaries and nearshore environments.

In addition, there is an increasing number of introduced species which are in NSW or neighbouring states, or could become established in NSW waters, which may be subject to translocation by fishing activities in the future. These include species that have been listed as 'trigger' species for national emergency response procedures, and are briefly described below.

***Caulerpa taxifolia* (Vahl.) C. Agardh (1822)**

An invasive strain of this macroalgae has become established in numerous estuaries of NSW and, of these, only Botany Bay can be accessed by this fishery. The species is known to compete with seagrass populations and colonise a wide range of habitats, reducing biodiversity and possibly fisheries productivity. It is very difficult to eradicate and can be spread readily through fishing gear, anchor chains and boating activities (CRIMP, 2000b; Grey, 2001). Fishing gear has been identified as a possible vector for the movement of the species.

Mytilopsis sallei

This species (known as the black striped mussel) is similar to the zebra mussel which has invaded the Great Lakes in North America and resulted in annual control costs of over US$30 million. It forms massive monocultures of up to 24,000/m^2, out-competing native species and threatening maritime industries through fouling. Although it was eradicated following a $2 million emergency response program, the introduction of the species into Darwin Harbour in 1999 threatened the pearl culture industry and could have spread to northern Australian coastal waters between Sydney and Perth (CRIMP, 2001a).

***Undaria pinnatifida* (Harvey) Suringer**

This Japanese seaweed is extensively cultivated as a food plant in Japan, and was probably introduced to New Zealand and Australia as a result of hull fouling or ballast water. The species is highly invasive, grows rapidly and has the potential to overgrow and exclude native marine vegetation. It also has the potential capacity to create major fouling problems for marine farmers (CRIMP, 2000c). It is present in Tasmania and Victoria.

***Maoricolpus roseus* (Quoy and Gaimard, 1834)**

Although a native to the South Island of New Zealand, the NZ screw shell has been reported from waters of NSW since having spread from populations established as the result of translocation into Victoria and Tasmania. The species is known to establish extremely dense populations and compete with native mollusc species. Its extremely high abundance on some fishing grounds is likely to result in economic losses and the high possibility of further translocation. It is present in NSW waters.

***Asterias amurensis* (Lutken, 1871)**

The northern Pacific seastar is arguably the most significant marine pest established in Australian waters. In 1998 some 50 juveniles were found in Port Phillip Bay (www.brs.gov.au, 2000) and in June 2001 that population had grown to an estimated 130 million (Rod Gowans, pers. comm.).

The species is a significant predator and a threat to native marine communities and commercial shellfish farming operations. Although its translocation is most likely in the larval form in ballast water, an individual has been found in the water intakes of a coastal vessel, and movement of adults in fishing gear is possible (CRIMP, 2000d). It is present in Tasmania and Victoria.

***Codium fragile tomentosoides* (Sur.) Hariot subsp.(Van Goor) Silva**

This species is regarded as a pest because of its invasive capabilities and reported impacts on shellfish farms in the United States of America. It is also reported to settle on native algae and to foul commercial fishing nets. Its habitats include intertidal and subtidal estuaries and ocean sites on hard substrata (CRIMP, 2001b). It is present in NSW waters.

c) Risks and implications of translocations

The translocation of aquatic organisms raises many issues relating to the maintenance of local biodiversity including genetic shift in wild populations; establishment of feral populations; environmental impacts from the release of the species, and translocation of associated species (MCFFA, 1999). The social and economic impacts of established feral populations resulting from translocations can be very significant, as evidenced by the financial and amenity costs associated with management of the introduced zebra mussel in the Great Lakes of North America.

The introduction of parasites and diseases as a consequence of translocations can also have implications for both biodiversity and social and economic values.

i) Genetic shift in wild populations

Genetic diversity is recognised as one of the three levels of biodiversity that should be preserved to ensure the conservation of biological diversity. Genetic shift is a change in the composition of a population that results in a loss of biodiversity. Translocated individuals may interbreed with distinct resident populations of the same species, and this may result in the genetic shift in the local population through the introduction of foreign genetic material.

There is evidence that translocations have resulted in genetic shifts in native populations (Sheridan, 1995), however, there are little data available on the genetic composition of populations of aquatic organisms in NSW and hence no evidence of any such changes in NSW to date.

ii) Establishment of feral populations

Feral populations are defined as populations that successfully establish as a result of the escape or release of organisms. Translocated organisms may establish feral populations and these can have a range of negative environmental effects including competition, predation and environmental modification.

There are a number of feral populations of marine organisms already established in coastal waters of NSW, including fish, sea squirts, bryozoans, gastropod and bivalve molluscs, isopods, crabs, barnacles and annelids (Furlani, 1996).

iii) Environmental impacts from escaped organisms

Regardless of their ability to establish self sustaining populations in receiving waters, if translocated organisms are able to survive long enough they may have other impacts including competition, displacement, predation and habitat alteration.

Translocated organisms may compete with and displace local species, potentially causing permanent changes to community structure. Additionally, translocated organisms may eat endemic species. In many cases, endemic species will generally be at greater risk to the translocated predator than to local predators because there would not have been a similar predator-prey evolution. This may be particularly devastating if the local species are not normally eaten, and consequently have not developed defence mechanisms or appropriate defensive behaviours.

Translocated organisms may also alter habitats, as is believed to have occurred with the marine alga *Caulerpa taxifolia.* This species has become established in numerous estuaries of NSW, often out-competing and replacing seagrasses. A species shift in itself may not always be significant, but *Caulerpa* is thought not to provide a suitable environment for epiphytic organisms, which are important in the food chain of estuaries and adjacent environments.

iv) Implications for aquaculture

Some introduced species such as the northern Pacific seastar, could prey on aquaculture species such as mussels and oysters. Other species such as marine algae could overgrow equipment and sites causing economic losses, and control measures such as obligatory cleaning of mussel ropes and the washing or sterilisation of gear could impose additional operational and financial burdens on farmers.

As a result of the establishment of *Caulerpa taxifolia* in Lake Conjola, the oyster farmer in the area has been obliged (under the conditions of his permit) to ensure that his dinghy and gear is clean, and inspected before he moves to other sites. Further, the depuration water from Lake Conjola oysters must not be released into waterways.

v) Implications for other water users

Introduced species can have a direct impact not only on aquatic biodiversity and fisheries production, but also on other water users. Feral populations of fouling organisms such as mussels and algae could result in loss of amenity and additional costs to all water users, tourism and the community in general. The introduction of the invasive zebra mussel into the Great Lakes has resulted in fouling of fishing vessels, pleasure craft, stormwater outlets, marinas and moorings, boat ramps and beach amenities.

vi) Implications for the environment

The establishment of introduced species breaks down the isolation of communities of co-evolving species of plants and animals. Such isolation is essential for the evolution and maintenance of biodiversity. Disturbance of this isolation by alien species can interfere with the dynamics of natural systems and cause shifts in predator-prey relationships, and ultimately, premature extinction of species (www.iucn.org 1995, see Sheridan, 1995).

vii) Diseases and parasites

As a consequence of translocation, there is the risk of introduction of an exotic disease or parasite (bacteria, virus, protozoan or other organisms e.g. polychaetes, nematodes) and subsequent infection of fish stocks or aquatic vegetation. The translocation of endemic diseases and parasites to new areas is also a major concern.

Parasites and disease are an integral part of any natural system, however, the introduction of disease or parasites (not necessarily exotic) could change the existing parasite and disease status of the waters. This introduction may perpetuate or aggravate existing diseases by increasing their incidence, virulence, potency and frequency. This impact may apply to parasites such as ecto-parasites on fish, fungal flora and stomach parasites.

d) Assessment of management responses proposed in the draft FMS

As translocation requires the movement of an organism from one water body to another where it is not normally found, the more mobile the fishery and the greater degree of flexibility of operators to move around the State, the greater is the risk of translocation regardless of the means.

In the case of the Ocean Hauling Fishery, the draft FMS proposes to restrict purse seiners to those regions that beach-based haulers already operate within, and to establish and implement a code of conduct for all boat-based haulers. The RLC process would also significantly reduce the area available to beach-based haulers, and hence the potential for translocation. Some of these regions, such as 1 and 2, are relatively small coastal stretches and with few estuaries, limiting the potential for translocation along the coast or into estuaries. Other regions, including the busiest in terms of the Ocean Hauling Fishery, Regions 3 and 4, are both lengthy and have multiple estuaries within each region, including some of the most important in terms of the Estuary General Fishery. Translocation along those stretches of coast or among estuaries could have serious repercussions for both fisheries.

Other responses within the draft FMS that relate to translocation include:

- contributing to relevant biodiversity monitoring programs
- continuing the prohibition on taking or selling declared noxious fish
- implementing measures required in accordance with any NSW Marine Pest or Disease Management Plans
- developing a policy to manage the harvest of bait for the Commonwealth Tuna Fishery in NSW waters
- determining the means by which purse seiners could keep small quantities of their catch alive in holding pens for short periods, while meeting the legislative requirements of the Department and other stakeholder groups or agencies
- cooperating with SafeFood Production NSW in the development and implementation of food safety programs relevant to the fishery.

These measures appear to be effective to the extent that is possible for the draft FMS to monitor or control the translocation of organisms. The National Taskforce on the Prevention and Management of Marine Pest Incursions was established to monitor the movement or introduction of pest organisms, and it will be primarily their responsibility to notify fishers, through the Ocean Hauling MAC, of changes or requirements as they pertain to fishers. Despite this, the observer program should be used initially to monitor boat and gear maintenance and to record the presence of any readily identifiable introduced pest or fouling organisms. Any records could then be fed back into the taskforce database.

i) Management of marine pests in NSW

There are currently no formal processes in place for the management of introduced marine pests in NSW, although the State is committed to the development of such processes in the short term. The NSW Government has endorsed the recommendations of the National Taskforce on the Prevention and Management of Marine Pest Incursions. These recommendations included the requirement for all States and Territories to provide resources for the interim and/or long term for:

- effective and timely implementation of interim arrangements for managing marine pest incursions pending the development of a National System for the Prevention and Management of Marine Pests
- the development and implementation of a NSW Emergency Marine Pest Management Plan (EMPMP)
- data collection and dissemination on pests and response processes
- a review of legislative powers to act in the event of an emergency
- communication and information programs
- the development of the National System for the Prevention and Management of Introduced Marine Pests
- plans for the mitigation of impacts of established marine pests
- the inclusion of marine pests provisions in port environment management plans
- investigating the issue of liabilities for persons involved in dealing with emergency responses
- agreement to contribute to interim national cost sharing arrangements for emergency responses comprising a 50:50 share between the States and the Commonwealth, with the States' contribution calculated on a per capita basis
- agreement to contribute to a national funding base for the support of the National System in the long term including port baseline surveys, community preparedness, education and training, research and development and monitoring (AFFA, 2000).

The NSW EMPMP will include details of the mitigation methods proposed and these will be in accordance with the guidelines laid down in the Taskforce Report (AFFA, 2000). These will include general protocols for the transport and handling of equipment being moved between estuaries and coastal waters in the event of an outbreak of marine pests in any region.

e) Contingency plan for pest species management in NSW

In the event of an outbreak of marine pests in the intervening period, NSW will adopt the draft Australian Emergency Marine Pest Plan as detailed in the report of the Taskforce on the Prevention and Management of Marine Pest Incursions.

Education programs are required to make boat operators and owners aware of the potential for their vessels to transport exotic fouling organisms and the steps they should take to minimise the risk of this occurring.

Codes of practice are required to ensure that fishing operations do not facilitate the spread of exotic organisms through the movement of equipment between areas. This will involve industry

awareness programs and the development of treatment ('sterilisation') protocols for gear and equipment. In Victoria, for example, research has commenced to develop ways of treating mussel grow-out lines to kill exotic species before lines are moved between coastal waters (CRIMP, 2000a). Similar protocols are imposed in NSW for the management of *Caulerpa taxifolia*.

i) Current situation: *Caulerpa taxifolia*

Following the identification of invasive populations of the marine algae *Caulerpa taxifolia* in NSW, the Minister for Fisheries announced a series of restrictions, including prohibition on the removal of equipment from already affected estuaries, area-specific fishing nets and boats, and the closure of certain waterways to netting activities. At this stage *Caulerpa* is restricted to estuaries. These actions complement an intensive public education and awareness campaign on the nature and impact of the species, and the declaration of the species as noxious marine vegetation.

ii) Small ports project

NSW Fisheries is working in association with the Victorian Department of Natural Resources and Environment, local port managers, the Centre for Research on Introduced Marine Pests and other agencies to develop practical ways to assist fishers, vessel operators and port managers to reduce the risk of spreading marine pests. The key focus is on ways to reduce the spread of marine pests through gear and hull fouling and will take the form of a series of guidelines (DNRE, 2000).

iii) Diseases and parasites

The *Fisheries Management Act 1994* contains provisions for response to disease of fish or marine vegetation. These include the powers to declare a disease, establish quarantine areas, prohibit the sale or movement of diseased fish or marine vegetation and control the release or transmission of the disease. In addition, plant diseases can also be declared and subsequently managed in a similar manner under the provisions of the NSW *Plant Diseases Act 1924*.

Following its endorsement by the Commonwealth Ministerial Council on Forestry Fisheries and Aquaculture, NSW (along with all States and Territories) is committed to the management of aquatic animal health through AQUAPLAN. This plan is a broad, comprehensive strategy that outlines objectives and projects to develop a national approach to emergency preparedness and response to the overall management of aquatic animal health in Australia (AFFA, 1999). Within AQUAPLAN there are a series of programs, including quarantine, surveillance, monitoring and reporting, preparedness and response, and awareness, that will address aquatic disease management issues.

In a manner similar to that for marine pests, it will be important to ensure that fishing operations do not facilitate the spread of disease through the movement of equipment between areas. Depending on the nature of the disease this may include industry awareness programs and/or the development of treatment protocols for gear and equipment. Alternatively, the closure of areas to fishing can be ordered by the Minister under the provisions of Section 8 of the FM Act. These aspects are addressed in the draft FMS.

f) Stock enhancement

There are currently no proposals for the artificial enhancement of species that are the target for this fishery and none are anticipated in the immediate future. Current research into the aquaculture of

marine species is focussed on snapper (*Pagrus auratus*) and mulloway (*Argyrosomus japonicus*), both of which are targeted in the Ocean Trap and Line Fishery and have previously been stocked into estuarine waters. The environmental impact of past stockings, on either the estuaries to which they were released or reefs that they may have recruited to, is unknown and has not been assessed. All such future proposals of stock enhancement would be subject to separate environmental impact assessment processes in accordance with the provisions of the EP&A Act 1979.

5. Fish Health and Disease

a) Impacts of gear types and fishing methods

There is no information available on the levels of stress, injury or susceptibility to disease that might be imposed as a consequence of the activities of the fishery, however, it is unlikely to have a significant impact on the quality or health of target and non-target fish, respectively. It is highly probable that individuals will be physically injured or stressed by the direct effect of fishing gear. Injury and stress are factors known to cause diseases in fish or to make them more susceptible to disease in aquaculture environments, which although designed to mimic optimal growth conditions, do not mimic natural environments. The methods' ability to target particular species of fish in a high energy environment severely restricts the potential for discards and thus the potential for the release of stressed or diseased fish, assuming some became stressed or diseased.

As stated previously, the draft FMS proposes to investigate the ability of purse seiners to hold catches alive in pens for short periods. This temporary impoundment could act as a miniature aquaculture facility, with the associated potential for spreading disease through overcrowding or by stressing fish and making them more susceptible to disease. The potential for such diseases and the viability of the proposal will be assessed under a separate approval process.

b) Use of bait

Imported seafood products are regularly used in Australia as bait for commercial and recreational fishers, and have been associated with a number of fish disease incidents in recent years. There is some concern that the use of imported bait, particularly pilchards and raw prawns, presents a significant disease risk (Fletcher *et al.,* 1997; Gaughan *et al.,* 2000; and Whittington *et al.,* 1997).

Purse seining and lift netting are the only methods in the Ocean Hauling Fishery that use bait. Purse seiners routinely collect their own bait to use as burley to target another species from the immediate vicinity of the area in which they are fishing (Stewart *et al.,* 1998). This negates having to purchase bait, local or imported, prior to fishing trips. It is unlikely that there is any additional risk of transmission of diseases using bait under these circumstances.

c) Stock enhancement

The deliberate translocation of any target species resulting from stock enhancement would present a risk of disease and parasites, although this can be mitigated by the use of fingerlings/fry that have been raised in accordance with appropriate health protocols. As previously noted, however, there are no proposals for the artificial enhancement of populations of species that are targeted in this fishery and none are anticipated in the immediate future. All such proposals would be subject to separate environmental impact assessments.

6. Water Quality Issues

a) Potential sources of pollutants

There is likely to be a limited capacity for the fishery to cause water pollution on either an individual basis or cumulatively. The majority of boats used in the fishery are small trailer boats that are not designed or operated in lengthy trips out at sea. Under such conditions, there would be little potential for continual transfer of human and other organic wastes into the water. The NSW Waterways Authority recently proposed some changes relating to vessels and the need and means to prohibit the release of pollutants from vessels into waterways. One of the proposals for discussion was the compulsory use of holding tanks on all vessels that had sleeping quarters and/or were a certain type of commercial vessel. It is now compulsory for commercial vessels less than ten years old to have holding tanks fitted. Such regulations are likely to be the most effective technique for reducing direct inputs of organic wastes into estuarine and marine waters.

Most of the effort within the Ocean Hauling Fishery is focussed on beach hauling, which would usually entail putting a boat into the water very close to the hauling site and then retrieved once the haul was complete. Under those circumstances, there would be almost no pollution other than the release of chemicals and paints from the hull or frame of the boats. Purse seiners and garfish haulers can spend small periods at sea, and those boats without effluent holding tanks would release treated and/or digested waste. Other sources of waste would include engine emissions from outboard motors, fish waste and ice slurry, although on-board processing of fish is not practiced within the fishery. Most of the fish waste would be generated during the sorting and icing of fish. Those and other potential sources of pollution are discussed below and summarised in Table F5.

i) Antifouling agents

Antifouling agents are painted onto boat hulls to reduce marine growth and the consequent loss of performance. In recent years, much concern has been raised about the environmental affects of tributyl-tin compounds. Those products are now banned on all vessels less than 25 metres in length, and as such are no longer used on boats in the fishery. They are now treated with other chemicals that are thought to be less damaging to the environment and are less susceptible to degradation. Boats used in the fishery are likely to require antifouling between two and three times a year, depending on usage.

ii) Discharge of chemicals, fuel or bilge water

The small size of the vessels used in the fishery would generally preclude the need to have large volumes of chemicals on board, and would probably be restricted to fuel and oil, chemicals common to all aquatic vessels. As on any vessel, accidental discharges of oil or fuel are likely to occasionally occur, however, serious discharges would be very rare. The release of small volumes of fuel or oil into the high-energy environment in which the fishery is practiced is unlikely to have significant consequences for flora or fauna. Modern engines and fuel systems are compact and easily managed, particularly on the small vessels used in the fishery, reducing the likelihood and magnitude of spills. Furthermore, the size of the vessels used means that larger than usual catches often have to be temporarily held on board in open boxes or in the hull, providing fishers with a strong incentive to keep their boats as clean as possible.

Bilge water and ice slurry are the only products that would be deliberately discharged from vessels. Within the Sydney region, there are numerous bilge water and effluent pump out facilities, but very few outside of the Sydney area. Bilge water is likely to consist predominantly of seawater, along with small amounts of fish waste, fuel and oil. Bilge water would probably be discharged on every trip for purse seiners and boat-based garfish haulers, and less frequently by beach-based haulers. If not discharged in the open ocean, it is likely that beach-based hauling vessels would have their bungs removed at boat ramps or beaches. The intermittent and predominantly saline nature of bilge water discharge from the vessels used in the fishery is unlikely to have a significant effect on receiving waters.

iii) Dumping of debris

There is very limited scope for the transfer of rubbish from vessels to beaches or marine environments as there is very little use for such materials in the fishery. There are, however, occasional reports of debris left on beaches during the travelling season, the peak of activity for the fishery (L. Blade, NSW Fisheries, pers. comm.). Bait is caught on site, which means there are no plastic bags or containers aboard, common features on recreational vessels and some other commercial vessels.

As stated above, only purse seiners and boat-based garfish haulers are likely to spend much time at sea, and any material that could be accidentally deposited into the water would be restricted in both volume and frequency. Commercial fishers are becoming increasingly conscious of any obvious pollution within their working environment. It is therefore likely that most incidents would be very minor.

Table F5. Summary of the potential sources of pollution attributable to the Ocean Hauling Fishery, their characteristics, likely magnitude and probable frequency of occurrence.

Source	Characteristics/ issue	Magnitude	Frequency
Antifouling treatments	Toxic chemicals leached into water,more toxic forms particularly harmful to sessile invertebrates	Low - less harmful compounds now in use; also slower rate of release into the environment	Low - less than one treatment per vessel per year
Chemicals, fuels etc.	Toxic chemicals discharges into water, variable effects depending on compounds	Low to Moderate - depending on actual incident	Spills - Low; Bilge water - High
Debris	Solid material, generally non-toxic but may interfere with marine life	Low - minor accidental dumpingonly; fishers increasingly aware of gross pollution problems	Low - gear is always attended and unlikely to be damaged
On-board processing waste	Organic material likely to be consumed by marine life, could have unknown trophic effects and a source of nutrients	Low to Moderate - most vessels in use to small to allow onboard processing	Low

b) Associated risks to water quality

The sources of pollution associated with fishing operations are likely to be of low magnitude and of low to moderate frequency. The number of vessels used in the fishery represent less than 0.5% of the more than 180,000 vessels registered by the Waterways Authority in NSW, and the vessels used in the fishery are predominantly trailer boats of between three and six metres. The collective potential for pollution from these vessels is likely to represent less than 10% of that associated with offshore recreational, charter boat and game-boat fishing. Furthermore, the fishery is done in the high-energy environment of coastal beaches and nearshore waters, which have a high assimilatory capacity and are

an open system. The volume proportional to that of pollutants potentially deposited by vessels, and exposure to weather, currents and waves, restricts the potential for any risks to water quality. Vessels in the fishery do not require any further management given existing and proposed controls as administered by the Waterways Authority and the Environment Protection Authority (EPA).

There is however, some potential for localised impacts from on-shore facilities associated with the fishery. Whilst any effects related to vessel maintenance are likely to be insignificant in relation to the number and sizes of vessels maintained within NSW generally, significant, highly localised effects from on-shore fish processing facilities (i.e. fishermen's cooperatives) are possible. Discharge from such facilities would primarily consist of organic waste derived from cleaning fish. This would be expected to attract scavengers and contribute nutrients to receiving waters. Similar effects are likely to be observed where fish cleaning facilities are provided at most boat ramps. The extent and magnitude of these effects have not been determined, but are considered to be highly localised and probably insignificant, negating the need for, or scientific or managerial worth of, studies into such effects.

7. Noise and Light

The following summary is based on the detailed consultant's report prepared by SMEC Australia Pty Ltd and presented in Appendix CF1.

a) Vessels of the fishery

The majority of boats used in the Ocean Hauling Fishery are small 'run-about' or 'punt' style vessels generally of aluminium, wood or fibreglass construction powered either by oars (28%) or petrol and diesel marine engines/motors. In some cases two motors are used per boat. The smaller capacity motor is used to enable navigation of the vessel at low speed during the process of shooting haul nets. Some larger and faster vessels also participate in the industry. These are of two types: 'jet boat' style vessels with motor sizes up to 70 horsepower; and larger vessels used for purse seining, including Commonwealth tuna fishers, and in the Ocean Trap and Line Fishery by fishers who hold endorsements for both fisheries. The majority of the vessels involved in the Ocean Hauling Fishery are also used in other fisheries with only ten vessels currently licensed for ocean hauling alone in New South Wales. Smaller vessels used in the fishery are often used in the Estuary General Fishery.

b) Noise impact on residents adjacent to beaches

Many of the beaches where ocean hauling occurs are fairly remote, and sometimes are only accessible by four-wheel drive. In these cases, National Parks or other nature reserves are the dominant surrounding land use, and residential use is generally limited to isolated dwellings or possibly a small village. The existence of National Parks or other nature areas often results in restrictions being placed on ocean hauling activities, predominantly through beach access controls. This also inadvertently limits the potential for noise disturbance due to beach access by four-wheel drive in designated areas and times.

Noise from the fishery may cause adverse effects to residents where houses are close enough to the beach front for the fishing activity to cause disturbance. Hauling that is done by hand generates very minimal noise, however, the use of winches to haul nets is likely to create substantially more noise. There is no data on either the proportion of hauls done by hand or winch, or on the level of noise generated by winches used in the fishery. Such data would improve the level of confidence associated with the assessment of impacts on residents, and on wildlife. With respect to residents, it is probable that there is only potential for disturbance during night-time operations. These are likely to be very infrequent as the fishery relies on being able to spot schools of fish and establishing a netting site, however, some hauls conducted late in the afternoon could carry on into the early evening. The potential for disturbance would be determined by a number of factors, namely the:

- size and type of boat motor; for those vessels that are engine powered (28% of vessels in the fishery are powered by oars), the median motor size is 60 horsepower and 90% of the motor powered fleet has motors sized below 200 horsepower
- duration and type of fishing activity
- number of people involved in the haul and other operators in the same area
- where beach-based hauling is done from winches on four-wheel drive vehicles, the number of four-wheel drives operating winches simultaneously (i.e. occasionally more than one vehicle may operate together on the same beach)

- position of the house, both its distance from the activity and intervening topography
- land-based activity in the vicinity of the house. A house in a coastal town or close to a main road could be expected to have a higher background noise level to an isolated farmhouse.

c) Noise impact on wildlife

Noise from fishing activities would only affect wildlife when:

- fishing is undertaken in areas where wildlife that is sensitive to noise are present
- noise from fishing activities disturbs wildlife either due to the volume or type of noise generated.

Noise impacts could result from fishermen's voices, the sound of equipment contacting boats, motors, winches and the splashing of water. As stated above, there is no data on the level of noise generated by winches and other machinery used in the fishery, nor of the associated likelihood of impact on wildlife. Wildlife that could be affected may include birds, terrestrial and arboreal mammals, aquatic mammals and non-target fish. Any such wildlife that is disturbed may:

- remain in the area but become inactive (i.e. hide)
- temporarily move away from the area to return when the disturbance has ceased
- permanently move away from the area (this is more likely if the disturbance is prolonged, intense or occurs frequently).

During the daytime, fauna that is sensitive to noise is more likely to occur at secluded locations. These areas are likely to be fringed by native plant communities such as coastal scrub, sclerophyll forest and woodland or rainforest. Such locations are likely to be relatively free of human activity and are more likely to harbour species sensitive to noise. These species may also occur in developed areas if these are relatively quiet and support suitable habitat.

The significance of the disturbance to wildlife would vary depending on the species and on the timing of the disturbance. The greatest impacts could be expected during the nesting or breeding season. At these times, any disturbance could impact upon the reproduction of a species and may endanger the viability of local populations (see section 2 of this chapter). This would particularly be the case if the disturbance were a frequent, regular or on-going activity. In most areas, this is unlikely in the fishery. Species most likely to be impacted by commercial fishing during the nesting or breeding season would include birds that nest in aquatic or riparian vegetation and non-target fish.

d) Noise mitigation measures

A potential for adverse effects caused by noise from the fishery on people and wildlife has been identified. This potential is not new, as the fishery has been a continuing industry for more than 100 years. There are a number of existing controls on the industry that have relevance to the mitigation of noise impacts from the fishery. These include:

- limited entry controls
- equipment controls, particularly limiting vessels to 45 horsepower
- total closures
- a code of conduct.

These controls were instigated for a number of reasons, including preventing disturbance to people living close to areas where fishing occurs and conservation. It is also proposed to continue to monitor the levels of complaint received concerning noise levels from the Ocean Hauling Fishery. Two authorities currently receive complaints, local councils (who tend to refer these to NSW Fisheries) and regional offices of NSW Fisheries. The number and type of complaints should be used as input into reviewing the existing controls.

e) Light impact on residents

The only potential for adverse effects from lights used in the fishery would be from spotlights and driving lights. Navigation lights, deck lighting or lights used for visibility purposes from beach-based activities would not have a potential for significant adverse effect. Spotlights would only cause an adverse effect where these were shone into houses adjacent to the beach. The activities of the fishery generally do not require intensive use of spotlights nor other high strength lights. It is not anticipated that this type of lighting would have a potential for significant adverse impacts.

f) Light impact on wildlife

Impacts from light upon wildlife are unlikely to be significant unless light beams repeatedly or continuously affect the same individuals. The severity of this impact would increase with the intensity of the light. There is limited potential for either of these to occur in the fishery, however, as the majority of operations take place during the day. Wildlife most susceptible to impacts from light would be those occurring in the water, nesting or roosting on the dunes or vegetation of the dunes, on aquatic vegetation or close to the water. Species would include aquatic mammals and reptiles, non-target fish, terrestrial mammals and birds. Nocturnal species could be impacted during foraging and diurnal species could be disturbed from their sleep.

g) Light mitigation measures

Mitigation measures outlined for noise impacts are generally applicable for reducing the potential for adverse effects from lighting. In summary these were:

- existing controls to limit the location of fishing
- monitoring levels of complaint
- code of conduct.

8. Air Quality

The following summary is based on the detailed consultant's report prepared by SMEC Australia Pty Ltd and presented in Appendix CF1.

The two identified sources of air pollution from the Ocean Hauling Fishery are emissions from boat engines and from four-wheel drive vehicles that are used for beach-based hauling. These emissions do not have a potential to significantly affect air quality as they:

- do not represent a concentrated source of inputs as they occur along the NSW coast
- vary according to both season and time of day
- are, in the case of the boats, generally from relatively small engines.

Mitigation measures to reduce air quality emissions are the same as those proposed to reduce energy and greenhouse inputs. These are discussed in the following section.

9. Energy and Greenhouse Issues

The following summary is based on the detailed consultant's report prepared by SMEC Australia Pty Ltd and presented in Appendix CF1.

a) Energy and greenhouse assessment

Energy and greenhouse effects are considered together as the only potential for greenhouse gas inputs is from the energy consumed in the boat motors and four wheel drive motors where winches are used for hauling from the beach. Overall, the numerical size of the fleet and the size of the boats and motors used means that the overall consumption of energy resources and subsequent greenhouse gas emissions is not significant. The Ocean Hauling Fishery consists predominantly of many small businesses operating in a low technology environment. Potential measures to reduce energy and greenhouse emissions may not be practicable for many of these ventures due to initial cost.

Renewable energy for fishing vessel operation is already used by 28% of the fleet through the use of oars. Further renewable energy use could include solar and wind energy, however, utilisation of these energy alternatives is not currently considered viable for vessels used in the fishery.

Potential measures to maximise energy efficiency and hence minimise the emission of greenhouse gases for vessels in the fishery have not been investigated in detail in Australia. These measures fall into two main areas, material and technology selection, and operational practice. Specific measures applicable to each of these aspects of commercial fisheries are outlined below.

i) Material and technology selection

Material and technology selection options may significantly affect energy usage and greenhouse gas emissions. Opportunities for the reduction of greenhouse impacts and improvement of energy efficiency within the fishery include:

- higher performance marine engines. The US EPA and the State of California EPA Air Resources Board (ARB) (http://www.arb.ca.gov) and the US EPA (http://www.epa.gov/oms/marine.htm) introduced parallel regulations commencing in 2001 requiring manufacturers to market improved performance marine engines. According to the ARB the regulations were introduced due to concerns that many conventional two-stroke marine engines burn fuel inefficiently and 'discharge up to 30 percent unburnt fuel into the environment'; the ARB recommend switching from a two-stroke to a more efficient four-stroke marine engine. ARB analysis shows that advanced technology marine engines burn up to 30 percent less fuel and oil
- matching equipment size and machinery to fish catch and journey requirements to minimise energy utilisation
- use of energy efficient lighting systems and controls
- the potential use of the Australian appliance energy rating system to assist consumers in selecting energy efficient marine engines and vessels (http://www.energyrating.gov.au). California's ARB has also introduced a marine engine and watercraft labelling system to indicate to purchasers which vessels 'meet', 'exceed' or 'greatly exceed' their new regulatory requirements.

ii) Operational practice

A number of decisions made during operational practice can have a significant impact on energy efficiency and greenhouse gas emissions. Relevant facets of operational practice within the fishery include:

- development of systematic and cyclic maintenance programs
- implementation of energy and greenhouse management processes, such as
  a) ongoing education of the ocean hauling fishing industry of energy and greenhouse mitigation strategies through the distribution of information through industry associations and the boat and fishing licence registration system
  b) energy and greenhouse audits
- ongoing consideration of new technologies as they become available and economically viable.

10. Potential Impacts on the Fishery

a) External activities

There are some external factors that have the potential to significantly affect the operational area, capacity and species of the Ocean Hauling Fishery. Some of those factors include:

- conflict with other beach users, including recreational fishers
- beach and offshore recreational fishers, including charter boats
- creation of National Parks, marine protected areas
- closures related to other jurisdictional agencies
- shift in target species within other fisheries
- pollution from point sources
- weather and oceanographic conditions
- other commercial uses of nearshore waters.

Most of the effort within the fishery is currently focussed on ocean beaches, which are utilised by a variety of other stakeholders, including residents and tourists, for swimming, sunbaking, walking, surfing and other recreational activities. The peak recreational use would be at weekends and public holidays, particularly in the summer months. Most of the activity within the fishery, however, is concentrated in autumn and winter during the spawning run of several species. This significantly reduces the potential for conflict with recreational users and thus the potential to have areas or seasonal closures imposed on fishers. This incidental control is enhanced by several measures within the draft FMS designed to mitigate conflict, particularly weekend and public holiday closures during November to February. Foremost amongst those is the designation of Recognised Fishing Grounds through the regional liaison process (discussed previously). With the exception of Regions 5 and 6, this process could close significant areas to fishers and restrict points and modes of access for fishers.

The regional liaison process and associated code of conduct for each region also mitigate potential effects due to recreational fishers, which usually entails complaints about fishers and could lead to closures or reduced fishing times to settle disputes. The potential impact of recreational fishing was discussed at length in Chapter B, and included effects due to targeting similar species and in similar or greater quantities than the Ocean Hauling Fishery. Offshore recreational fishers and those on charter vessels, including scuba divers, can also affect the area, environment and species targeted by fishers within the fishery. Conflict over access to bait grounds, such as Black Road at Narrabeen, can result in closures to commercial fishers. The presence of boats at offshore reefs may also make fishing impractical, due to the dispersal of schooling species through disturbance or by the attraction of predators targeted by recreational fishers.

The creation of closures for conservation reasons can work both for and against commercial fishers. An example of this is the establishment of marine parks, or the alteration of existing zones as in Solitary Islands Marine Park and Jervis Bay Marine Park, which would protect and conserve the environment and stocks of the fishery, but could significantly restrict the area available to the fishery. Within Solitary Islands Marine Park, beach-based hauling could be restricted to the six traditional hauling grounds identified through the regional liaison process and one other beach. The rest of the

beaches in the park, mostly considered shared beaches under the regional liaison process, would be closed to the fishery. Purse seining could be prohibited within the park.

Similar proposals for Jervis Bay Marine Park could see purse seining prohibited within Jervis Bay. Beach-based hauling could also be restricted to two beaches within the bay and three on the open coast. The NSW Government is committed to creating a marine park in each of the remaining bioregions for the State, and at the time of writing this report, one was proposed for Bioregion 1. The park could extend from Brunswick Heads to Lennox Head, but no zones were proposed at the time of this report.

Other potential closures that could affect the operational capacity of the fishery relate to species protected under State and Commonwealth legislation or international treaties (i.e. JAMBA and CAMBA birds). Currently, little is known about the abundance and distribution of most of these species. As management practices and research are developed for those species they are either likely to increase in number as a result of protective measures, or simply be better understood in the areas that they do occur. Either outcome could result in seasonal, location, total or technique closures to accommodate those species.

As previously discussed, there is considerable overlap between the recreational fishing sector and the Ocean Hauling Fishery. A change in the demand by other sectors for species of the fishery could have a positive or negative effect. A number of the species taken in the fishery are also important in other commercial fisheries and there is potential for them to increase the take of target species of the Ocean Hauling Fishery. Sea mullet are an important part of the Estuary General Fishery and with an increase in the price due to the development of the roe market in Asia, estuary fishers could increase their effort for mullet as they commence spawning runs down estuaries to the coast. There is also a Queensland mullet fishery that is likely to target similar stocks. Australian salmon is also taken in the Victorian bays and inlets fishery. Most of the bait species targeted in the purse seine section of the fishery, such as yellowtail and blue mackerel, are also targeted for bait by recreational fishers, in the Ocean Trap and Line Fishery and by Commonwealth tuna fishers. Lobster trappers also use mullet and luderick. Any changes in quotas for that fishery could affect the requirement for bait from this fishery.

For beach hauling methods, many point sources of pollution have been centralised to larger systems that discharge effluent either to below the waterline of adjacent rocky shores or to deeper environments considerable distances offshore. Purse seiners are most likely to be affected by the establishment of deepwater outfalls. Pollution can affect the area available to be fished, target species and the time that areas can be fished. Stormwater and sewage carry a wide range of pollutants, the most notable being pathogens, nutrients and sediment. Excessive pathogen concentrations, whilst of primary concern to swimmers, are also likely to affect fish and other aquatic life. Many types of pathogens (particularly bacteria) are not host-specific, and are capable of infecting aquatic animals. In regularly affected areas, it can reduce consumer confidence in seafood products. High nutrient concentrations can, under the right conditions, promote excessive growths of microscopic algae in the water. Such ‘algal blooms’ can become toxic, to the point that other aquatic life are harmed. Non-toxic blooms can reduce the effectiveness of fishing and in high densities, may force fish to seek alternate habitats. In addition to chemicals and organisms within sewage effluent, a large proportion is freshwater, which under normal conditions would either be limited in volume or occur as a diffuse source. In the case of deepwater outfalls, effluent is likely to be significantly fresher than the surrounding environment, which is likely to repel fish that are naturally found in those waters. The

movement of the effluent plume with currents or wind waves has the potential to shift any effects well beyond the physical structure of the outfall.

Weather and oceanographic patterns have the potential for much longer lasting effects on the fishery. In particular, oceanographic features such as the Eastern Australian Current and the Southern Oscillation Index (El Nino/La Nina) drive currents along the NSW coast. They are responsible for the transfer of larvae and adults along the coast, and many species are thought to respond to environmental cues, such as changing water temperature or offshore winds, to initiate spawning runs. Other weather features, such as sea-level rise and rising water temperatures as a result of global warming, are unlikely to affect the habitats of this fishery. An increase in water temperature, however, may favour those species that breed in and inhabit warm water over coldwater species.

Fluctuations in weather are also thought to cause dramatic shifts in baitfish recruitment, schooling behaviour, abundances and distributions. In addition to broad scale environmental factors, local weather patterns can also diminish the effectiveness of methods used in the fishery. For beach haulers, foul weather can inhibit both the selection of schools to fish and the actual deployment of nets. Purse seiners and other boat-based haulers have to contend with adverse sea conditions and the dispersal or altered behaviour of pelagic species. Natural variation in the distributions and abundances of target species is one of the reasons for large fluctuations in effort of fishers from season to season and year to year. As a very targeted fishery, there is little point fishing if the fish are not present.

The nearshore environment of the fishery is used by numerous stakeholders, and some of the larger operations that can limit the area of the fishery include offshore spoil disposal, offshore dredging of sand for building requirements, munitions exercises, shipwrecks, commercial shipping and yacht racing. Most of these effects are usually only of limited duration and generally only affect boat-based fishers, but serve to highlight the vast array of external aspects that can affect the operational capacity of the fishery.

b) Management measures to limit external factors

i) Landuse planning and development controls

As the factors that could affect the fishery are so diverse and cannot be readily attributed to a particular feature of environmental planning or development, there are no controls that serve to specifically limit their extent. Most of the external factors affecting the fishery relate to conflict resolution or resource allocation, and are generally managed within the draft FMS, primarily through management responses and the regional liaison process.

Pollution of the environment and the use of nearshore waters by commercial or government enterprise are probably the only factors that are readily catered for by development controls. In NSW, these are overseen by numerous Government departments, including the Department of Urban Affairs and Planning, Environment Protection Agency, NPWS, Waterways Authority, Department of Land and Water Conservation and the various water and sewerage authorities, such as Sydney Water and Hunter Water. Legislation, particularly the EP&A Act, *Protection of the Environment Operations Act, Coastal Protection Act, Marine Parks Act* and FM Act, are the major controls that should be able to limit the impact of pollution and use of nearshore waters on the fishery.

ii) Measures in the draft FMS

To minimise the impact of activities external to the Ocean Hauling Fishery on the resources harvested by the fishery, and on fishery related habitats, the draft FMS proposes the following responses or objectives:

- NSW Fisheries and commercial fishers will contribute to the development of policies or legislation established by other Government agencies to ensure that fish stock and habitat issues (including beach habitat) are properly considered in other environmental planning regimes
- the Ocean Hauling MAC will consider the impacts of activities external to the fishery on the resource and bring any detrimental impacts to the attention of NSW Fisheries and/or the relevant managing authority
- NSW Fisheries will continue to review and, where legislatively enforceable under the Fisheries Management Act 1994, place conditions on development applications referred to it by other determining authorities, in order to avoid or minimise impacts on fishery resources from coastal developments
- to monitor and provide an appropriate allocation of the fisheries resource between fishing sector groups, acknowledging the need of seafood consumers to access fresh quality fish
- to monitor and manage a fair and equitable sharing of the fisheries resource among commercial fisheries, including Commonwealth fisheries
- to promote harmony between the commercial fishery and other resource users, including recreational fishers, Indigenous fishers and local communities, through fair and equitable sharing of the fisheries resource
- to implement the draft FMS in a manner consistent with related Commonwealth and State programs aimed at protecting aquatic environments, and achieving the objects of the Act and the principles of ecological sustainable development
- to improve the community understanding and public perception of commercial ocean hauling fishing.

11. Data Requirements in Relation to the Assessment of Impacts on the Biophysical Environment

a) Data and research

It is apparent from this assessment that there are some serious shortcomings with the data that were available upon which to base the assessment. First, it is important to note that there have been no studies directed at assessing the impacts of the fishery on the biophysical environment in which it operates. Second, the data and information used in this assessment were obtained from a variety of sources with varying degrees of reliability and it was not possible to critically review that information. Most of the information was obtained from State and Commonwealth government agencies, scientific journals, books, other publications and personal communications. Third, in the absence of data focussed on the fishery, in similar habitats or methods of the fishery, it was often necessary to extrapolate from studies based elsewhere in Australia or from overseas. Those studies were invariably done in very different environments or of different methods to those of the fishery. As such, there is a fair degree of uncertainty associated with the assessment of impacts of the Ocean Hauling Fishery on the biodiversity and habitats of the coastal environment in which the fishery operates. Overall, it has been concluded that based on an assessment of the timing, area, methods, and fauna and their habitats of the fishery, that there is very limited scope for impacts on the biophysical environment, especially when considering other stakeholders and external factors. As stated, however, there was no data specific to the fishery to support that supposition. There is an obvious need for the collection of targeted, quantitative data to fill the vast gaps in knowledge about the fishery.

b) Knowledge gaps

There are several areas where we have little or no knowledge regarding the impact of the Ocean Hauling Fishery on the biophysical environment. These are:

- biodiversity and habitat issues
- threatened and protected species
- trophic structure
- fish health and disease
- external impacts, particularly recreational fishing.

The knowledge gaps, and the effectiveness of the management responses proposed in the draft FMS to provide more information about them, have been discussed under the relevant sections within this assessment. Overall, it has been concluded that the management responses are likely to be adequate for collating information about interactions with threatened and other fauna, the extent and types of habitat used, and resolving conflict as it relates to other stakeholders.

Of concern, however, is the reliance of the draft FMS on the observer survey to detect changes or effects on habitats, primarily sandy beaches, due to the fishery. Whilst this assessment concurs with the opinion of the draft FMS that the likelihood of impact is minimal, application of the precautionary principle would require that studies are initiated to investigate that belief. At this stage, the draft FMS does not propose any such research programs examining the effects of beach hauling methods, and considers it amongst the lowest priority areas for research.

The proposed observer survey may well be adequate for recording the numbers of directly or indirectly affected megafauna such as fish and birds, but will offer little information to prioritise areas of habitat that are damaged. Subjective observation should not be the basis for determining which habitats are damaged and the methods that warrant modification as proposed in the draft FMS. Given that beach-based hauling methods are thought to be the only methods that consistently affect the substratum, a sampling program should be established that could more adequately determine the degree of any impact, most likely in traditional hauling grounds, on habitats and fauna compared to areas that are closed to hauling.

c) Timetable for developing information

There would appear to be little purpose outlining how research programs into the effects of hauling on habitats could be developed, funded or scheduled given the current low priority for such research by the Ocean Hauling MAC and fisheries managers.

CHAPTER G. ECONOMIC ISSUES

This is the second formal incorporation of an economic assessment of a management strategy in the fisheries of NSW. It has been compiled from a limited amount of existing information, augmented by the results of economic and social surveys initiated by NSW Fisheries and undertaken by Roy Morgan Research (Roy Morgan, 2001a&b).

The following summary is based on the detailed consultant's report prepared by Dominion Consulting Pty Ltd and presented in Appendix CG1. The report on economic issues is in two sections; a review of existing information, and then an assessment of the draft FMS against the Planning NSW guidelines.

1. Existing Information

Existing information is available from NSW Fisheries records and provides information on licensing, effort and catches at the primary level. Price, at first sale in Sydney, is also available and this enables an imputed Sydney fish price to be generated. Potentially, all Sydney index data in this report may under state revenue by 50%, as estimated by the recent economic survey (Roy Morgan, 2001a), and by more than this in regions 2 and 3. Data on the fish processing industry is limited, being collected from annually renewed Registered Fish Receiver forms. The seafood processing, wholesale and retail industry in NSW requires further study.

An economic survey was undertaken by mail to enable a profile of the commercial fishers to be undertaken (Roy Morgan, 2001b). This had a response rate of 15.8%, 259 fishers from 1,640 completing the questionnaire, of which 59 were from ocean hauling endorsed businesses. This enabled the economic performance of businesses in the ocean hauling catching sector to be appraised and gave an indication of the position of industry to pay additional charges and purchase shares under the draft FMS.

A rapid social appraisal telephone survey was undertaken by Roy Morgan research (Roy Morgan, 2001a) and had a response rate of 50%, 870 fishers completing the questionnaire of which 222 ocean hauling fishers (25%) completed surveys. This enabled the assessment process to have up to date information on industry, its social profile and an indication of the potential social impacts of changes under the draft FMS which are examined in Chapter H.

The review of existing catch, effort and endorsement information, indicated the Ocean Hauling Fishery is based predominantly north of Sydney and there is substantial fishing in the south of the state also. The Ocean Hauling Fishery is seasonal with a high period in April to July and is predominantly one person businesses forming into teams, with business partnerships (7%) and a limited number of companies (2.4%). Approximately 17% of fishers work in other industries.

There were 374 businesses in the Ocean Hauling Fishery in 2001. For the 404 endorsement holders, 349 were actively fishing in a range of commercial fisheries in 1999-00 and 55 were latent. Of the 299 active fisher catch records (from 349 fishers who fished in the period), 151 could have fished in the fishery, but chose to catch fish in other fisheries for which they were endorsed. Of the residual 148, 21 fished only in the Ocean Hauling Fishery and 127 fished in ocean hauling and other fisheries, in the year 1999-2000.

The employment associated with ocean hauling endorsed fishing businesses was examined in the social survey. Between 615 to 975 persons were employed full time and part time in fishing businesses which hold an ocean hauling endorsement in 2001. There is no indication as to the extent of part-time employment in this seasonal fishery. This estimate also includes processing staff and needs further research as a statewide profiling exercise in order to avoid double counting of employment in the fishing and processing sectors.

The economic survey obtained data on industry operating costs, revenues and capital for one financial year only. The fishery is highly variable in activity and capital investment levels, some fishers having low capital investment. Survey returns were analysed to measure economic profit and to estimate a net economic contribution to the economy.

Estimates of operating profit were made, as many operators did not include owner's payment from fishing. An economic approach was used to review long term viability. The economic test of long term viability subtracts economic costs from revenues and tests for evidence of a surplus. The economic costs have operating costs, fixed costs, including opportunity costs of capital, labour and economic depreciation. Having imputed a 7% risk adjusted opportunity cost of capital and imputed labour costs for all days worked from survey information, an estimate of economic depreciation was applied to test for long run viability, evidence of capacity to replace capital in the long term. Given the variation in the scale and scope of fishing operations, results were divided into ocean hauling endorsed businesses receiving more than 20% of total revenue from ocean hauling and endorsed businesses with less than 20% of total revenue from ocean hauling.

Long run economic surplus exists for 25% of all ocean hauling fishing businesses examined, being greatest in the businesses which obtained more than 20% of total revenue from ocean hauling. These businesses had a net economic return of 3% in excess of a 7% opportunity cost of capital, while other businesses had negative net returns of –3% and did not cover the 7% opportunity cost of capital. The average net return across the entire ocean hauling businesses was –2%, the median being –12%.

Further economic annual surveying is required to monitor economic performance in the longer term. The businesses currently operating below the long term viability criteria, are effectively subsidised by forgoing returns on capital and particularly on labour. This may be to accommodate lifestyle, or indicate barriers to fishers exiting the industry, such as lack of alternative employment in rural areas.

For these less viable operators, increased charges and requirements to purchase shares, will significantly reduce operational viability. There is a large range of operator performance given numerous part time fishers, multiple fishing interests, and fishers with involvement in industries outside fishing, including subsidies from welfare. This is common in other rural industries, such as the NSW dairy industry, and requires on-going research on social structure of the industry and the economics of fishing households and communities.

Trends in licence values show no significant rise in ocean hauling endorsement values in the last eight years, but this is a limited measure of economic performance, due to the restriction on transfers of endorsements for five years and poor perceptions of management among fishers.

Limited information is available on non-Sydney fish market prices, but shows higher prices for female mullet in roe in the north of the State. Exports of seafood out of Australia by ocean hauling fishers, was estimated at 12.6% of gross sales (Roy Morgan, 2001b).

Regional economic information on the fishing industry is limited to several studies in northern and southern NSW in the late 1980s. Economic multipliers in the fishing industry are low and total effects are generally between 1.5 and 2.0 times the direct effect (Tamblyn and Powell, 1988; Powell *et al*., 1989). Existing information from expenditures outside local towns infers that approximately 70% of expenditure stays in the local communities, generating local multiplier effects (McVerry, 1996). This is an area for future research work. The social survey examined the type and location of major expenditure and regional purchase behaviour for major purchases made by ocean hauling fishers, showing the importance of business links between ocean hauling fishers, Sydney and Brisbane and between townships in the north and south of the state also. Fishing nets were the major purchase item for fishers.

2. Assessment

The assessment of the draft FMS draws on this background information and the responses under the draft FMS are ranked on their potential for larger scale economic impacts. There is insufficient cost and benefit information for a definitive ranking. The following issues are assessed:

- the intention under the draft FMS is to continue the annual 3% reduction in the number of fishing businesses seen under the Recognised Fishing Operation policy, to decrease effort in industry through the category 2 share management regime and give the remaining fishers improved fishing rights. For assessment purposes a 15% reduction in business numbers under the first five years of the draft FMS is envisaged, reducing 374 fishing businesses in 2001, to 319 in 2006, 55 choosing to exit. The basis of share allocation has yet to be decided. It is envisaged that minimum share holdings may translate into businesses having to pay between $600-$1,200 per year to remain in the fishery, in addition to new management charges. Some businesses will exit, the most likely being latent effort holders and those businesses grossing below $10,000 per year. Shares will be more readily purchased by the 25% of businesses in economic surplus. To the majority of fishers without an economic surplus, there is an incentive to increase effort to cover the new payments. It is essential to monitor latent effort and contain active effort levels within historical guidelines, as stated in the strategy. Given the low output associated with exiting fishers, the economic flow-ons from exiting businesses will be low. Social costs are reported in Chapter H, social issues
- the draft FMS addresses any reduction in species availability using short term effort controls such as closures. These may have economic impacts as the capacity of fishers to desist from seasonal fishing would be related to their financial commitments and alternative activities. The use of seasonal closures reflects the seasonal nature of the fishery and defers the need to restructure due to what may be a seasonal variation in species availability
- a minimum shareholding provision at the endorsement level will be implemented within ocean hauling for garfish net (hauling) endorsements. There are currently 82 garfish net haulers mostly in Regions 4 and 6. This endorsement is not traded separately and has a marginal value of several thousand dollars when attached to a general hauling net package. This may equate to $2,000-$4,000 share value. A 15% reduction has been envisaged for assessment purposes, equating to a payment of perhaps $400-$800 per year, for five years, to retain a garfish endorsement. It is likely that latent effort holders and those businesses grossing less than $10,000 per year, will sell. If 15% of 82 garfish endorsement holders exited in the next five years, 12 fishers would be impacted to some minor extent
- medium impact parts of the draft FMS are assessed, such as team based minimum shareholdings, category 2 share management, including upper limits on shareholdings in a region, improved marketing through fish penning and a new cost recovery framework
- low impact parts of the draft FMS involve changes in icing and food safety practices, allocation and effort containment issues, as well as some gear regulations.

The costs and benefits of the major elements of the draft FMS are appraised through an environmental account of the management of the fishery. To the estimate of economic surplus from fishing operations, the subsidised costs of management, research and compliance are added. Any

change in the level of stocks is also counted to give a statement of current fishery status under environmental accounting principles. New costs to industry from the draft FMS and share trading, are estimated and incorporated in the cost benefit analysis.

The fishery has a small economic deficit at the commencement of the draft FMS and seeks to have sound economic viability by 2006. Costs to fishers from new management charges and share purchase are substantial, as the fishery moves towards full cost recovery in the years following the plan (2006-2008).

The economic achievement of the objectives of the draft FMS depends on the category 2 shareholding proposal being as effective as envisaged in the plan. This is new territory in fisheries management and fuller economic investigation of share allocation and subsequent monitoring of restructuring is warranted. Mitigation may involve shares being related to an amount of total effort, as opposed to a share of access.

By 2006, changes arising from the draft FMS will alter industry operations and cost recovery policy will address subsidies, moving towards full cost recovery by 2008. The draft FMS enables this process to occur and monitors the health of stocks underpinning industry and fishery viability. The draft FMS is a first step towards a more economically sustainable fishery in accordance with ESD principles.

3. Conclusions

This economic analysis of the draft FMS is done against a background of little available information. An economic survey of fishers indicates an economic surplus for those businesses with more than 20% of revenue from the Ocean Hauling Fishery. The draft FMS will assist industry to remain economically viable, by following the rate of adjustment under the established RFO process and addressing sustainable harvesting by controlling effort through short term access closures and minimum shareholding provisions for species issues as required. The analysis of the costs and benefits of the management plan, indicate that the fishery will be more profitable by 2006-07. The level of achievement of the draft FMS, through the new category 2 share management regime, needs to be monitored. There may also be cumulative impacts on ocean hauling businesses from the restructuring of the Estuary General Fishery and from the recreational fishing area process. These will likely assist in reducing latent effort among ocean hauling endorsement holders at limited cost to ocean hauling fishers.

There are economic costs and social impacts for industry under the draft FMS, as 55 of 374 businesses are expected to exit the Ocean Hauling Fishery in the 2002-2007 period. Many of these will be low catch or latent effort businesses, leading to minor regional economic impacts due to their low output. The draft FMS should be seen as a significant step on the longer path towards achieving ESD objectives. The social issues are presented in Chapter H.

4. Data Requirements in Relation to the Assessment of the Impacts of the Economic Issues

a) Reference to technical data and other information relied upon to assess impacts

The data used in the assessment is from several sources. The catch and effort data is from NSW Fisheries and is logbook data joined with NSW Fisheries licensing data for tables that have endorsements. Effort data at the days fished level is complicated by the logbook system where fishing three methods in one day ends up being records as one day of effort against each of three methods. This limits the potential for accurate production modelling or bio-economic analysis. In the Ocean Hauling Fishery, the fishing teams and movement of fishers between teams impacts the collection of reliable fishery data as identified and addressed in the draft FMS.

A significant issue for fishers is the use of the Sydney index for price imputation on declared catches. The monthly average price for female mullet in Sydney Fish Market is less than prices for in the north of the state, and may on occasions be several times the Sydney price.

In contrast, the estimate of price at first sale does not deduct between 11% and 23% of gross revenue for market and handling expenses. Therefore to a fisher adjacent to Sydney landing to the fish market, the imputation by the Sydney Index is potentially too high to the extent of marketing fees.

The economic survey asked fishers to declare gross revenue from catch in 1999-2000 and this was compared with the predicted Sydney index for each fisher to see the inter-relationship. The Sydney index may under estimate actual prices in ocean hauling fishing businesses by 50% and more in some regions

There are also uncertainties in the value of fishery businesses and in endorsement values. Diversity among business packages mean the true value of access is difficult to determine. The move to share management will require examination of the structure of business and endorsement values.

b) Important knowledge gaps

Several gaps are apparent. The major one is the lack of an industry wide profile of the seafood industry in NSW, including processing, wholesaling and the movements and values of seafood in the marketing chain. This would enable an evaluation of the secondary stages of the fish catch including processors, exports, imports and employment derived from the NSW fish resource. It could also potentially extend to retailing.

Multiplier estimates could be verified and contribute to future assessments. The regional importance of the seafood industry in each zone could be evaluated. Part of this could use the Register Fish Receiver annual renewal forms to include more information on processing activity in relation to the fisheries under management.

Fish price information outside Sydney needs to be collected on a regional basis from processors involved with the mullet fishery and other points of sale. This is required as several of the future assessment issues, such as the optimal harvesting time of species, will require bio-value models using biological and size and price information for different species during their migrations.

Economic viability is part of the objectives of the *Fisheries Management Act 1994*. Business values, endorsement values and shares valuation is an area requiring more research. Similarly, longer term planning needs to be able to monitor the cost of operations and could use existing survey information to establish a representative fishing cost index. This would monitor cost changes for producers and could parallel the Sydney price index for fish revenues. Economic linkages between fishing communities have been briefly addressed in the current social survey and could be augmented through time.

Category 2 share management is a new allocation mechanism and may not be sufficiently binding on individual producer behaviour as it does not automatically limit effort or catch. This scheme needs monitoring.

An environmental and management cost and benefit account system needs to be investigated, relating value of the stocks to the fishery management regime.

c) Timetable for developing the data sets

Data needs can be addressed in the next five year period through development of a strategy for improving the following data:

- investigation of available fish price data and the accuracy of the Sydney index. This would include a direct comparison of Sydney and non-Sydney price differentials and comparisons of domestic and export markets. Price data is required to monitor fishery value and modelling resource management issue and mullet prices in the north of the state (first two years)
- examination of the viability of businesses, business values, endorsement and share values and the basis of share allocation prior to trading. Subsequently, monitoring of share values to ensure industry viability and the achievement of the draft FMS objectives (first year)
- surveying the economic performance category 2 share management and of businesses after the implementation of the plan (first two years)
- consider developing a state-wide fishing industry economic restructuring model for predicting and appraising fishing business adjustments across fishery administrative divides (immediate)
- revising the collection of catch and effort data to enable more sensible modelling of catch per unit effort and productivity data. This would involve changing the fishery data logbook system and needs to happen within five years in preparation for long term sustainability issues, including economic modelling and monitoring (immediate)
- developing an economic profile of the regional fishing and seafood processing industry in NSW. This could include marketing, economic infrastructure and regional benefits such as multiplier effects. This needs to be progressed by area and in conjunction with social community profiling as a basis for longer term planning (immediate)
- development of an environmental accounting approach to fishery management costs and benefits should be undertaken (first three years).

CHAPTER H. SOCIAL ISSUES

This is the second formal incorporation of a social assessment of a management strategy in the fisheries of NSW. It has been compiled from a limited amount of existing information, augmented by several NSW Fisheries initiatives, taken to augment available information through a social survey (Roy Morgan 2001a).

The following summary is based on the detailed consultants' reports prepared by Dominion Consulting Pty Ltd and Umwelt (Australia) Pty Ltd and presented in Appendix CH1 and CH2. The report on social issues is in multiple sections; a review of existing information, an assessment of the draft FMS against the Planning NSW guidelines, health issues, heritage issues, Indigenous issues and data issues.

1. Existing Information

The regional and community location of fishers was identified from licensing data and compared with the ABS data for a range of social indices, at the post code level. This included local population, unemployment and fisher employment data from the 1996 national census and the SEIFA index of disadvantage for rural communities (ABS, 1996). The fishing communities tend to focus around key estuaries and towns, though a significant number of fishers reside in smaller communities. More in depth studies of fishing communities is an area for future work. A rapid social assessment telephone survey contacted 222 ocean hauling fishers with a range of questions relevant to the draft FMS.

Total employment in businesses with an ocean hauling endorsement, is estimated as between 615 and 975 persons (full time and part time), though those directly associated with the fishery would be less. Some of the employees are probably in processing and there is no measure of the extent of part time involvement. This requires further studies as recommended.

A demographic profile of ocean hauling fishers was generated describing, age, education levels, marital status and dependent children and relatives. The way of life of ocean hauling fishers was investigated through questions on working hours in the normal, high and low seasons, and details of industrial injury through fishing. The ocean hauling fishers were found to be an aged, highly resident population, with substantial fishing experience and strong family involvement with fishing, 61% of fishers having had more than 2 generations of family in the fishing industry. However, 39% are first generation fishers. Fishers in excess of 60 years of age, are 21% of all ocean hauling fishers and a wide range of fishers of all ages are evident in the fishery.

The skill sets of fishers were examined through the social survey and only 38 from 222 (17%) worked outside fishing, 14% being capable of working in another occupation full time. Further investigation suggests that up to 25% of the ocean hauling fisher population could consider working in other industries full time or part time. However, approximately 71% were insistent about their identity as fishers and were unable, or unwilling, to consider re training. This "psychic income" from fishing and problems in mobility of fishers are similar to NSW dairy farmers and a range of issues are discussed. These require future research. Regional unemployment in NSW is higher on the North coast of NSW (14%) and areas outside Sydney, and is a significant issue for aging fishers considering alternative employment to fishing.

There is little independent opinion on community perceptions of fishing activities. In a community telephone survey in 1999, there was general concern among a random selection of the population for the well being of the fishery environment and for the need to manage and conserve fish stocks (Roy Morgan, 1999). Other community opinion about fishers, is less formal and is an area requiring development. Most commercial fishing activity is not observed by the public.

Recreational fishers are more aware of the commercial fishery and conflict over commercial fishing methods, such as hauling is common. The draft FMS seeks to reduce the conflict among commercial fishers and between commercial and recreational fishers. The recreational fishing area program is addressing these issues outside the FMS process.

The regional liaison process, which included commercial fishers, NSW Fisheries, local people, representatives of local councils, NPWS, recreational fishers and community groups, were established in 1995 to reduce conflict on ocean beaches. The process involved selecting traditional hauling grounds, shared and closed beaches within each region, as well as access points and a code of conduct for operating on ocean beaches. The process was not completed in regions 5 and 6. At this stage, although beach-based fishers operate under the code of conduct, other facets of the process have not been implemented. It is proposed under the draft FMS to implement all facets of the process, to establish and implement a code of conduct for boat-based haulers, and to continue the process in regions 5 and 6.

2. Assessment

The social assessment followed the Planning NSW guidelines, but as there is no established social impact assessment framework for fishery management plans, an approach was developed from guidelines and available literature. The draft FMS management responses were ranked into high and low impacts: firstly, those socio-economic issues arising from policy changes that could have broad impacts; secondly, issues of social process, where policy changes require these processes to function properly for management to be most effective.

The most highly impacting issues include the use of minimum business shareholdings, species closures and minimum shareholdings to assist garfish to recover. Each of these changes has the capacity to impact many families, local communities and regions, the assessment being able to examine regional and predicted family impacts from available data. Each of the impacts are assessed and mitigation is suggested where applicable.

The major social changes in the draft FMS involve the displacement of up to 70 fishers in the first five years through the implementation of minimum business shareholdings and garfish minimum shareholdings. These will probably impact part time, and older fishers as 21% of fishers are over 60 years old, and a diverse range of people, who are either latent endorsement holders, or fishing businesses grossing less than $10,000 per year.

The predicted social impacts assume a 15% displacement of business/fisher numbers over the first five years of the FMS. The numbers of dependants associated with up to 60-70 typical ocean hauling fishers is between 73 and 91. This is an upper estimate, as if older fishers exit the fishery, then the number of dependants reduce to between 23 and 30 persons. Exiting fishers are likely to be low catchers, or have other income sources, if they are latent effort. This reduces the proportion of social impact attributable to the exiting of fishers under the draft FMS. The cumulative impacts of the estuary general FMS may lead to more ocean hauling businesses exiting. The funds from the recreational fishing area process may impact the adjustment process indirectly and to an unknown extent.

The draft FMS will have different regional community impacts as indicated by the SEIFA index of disadvantage for fishing communities. On implementation of the draft FMS, the ocean hauling fishing communities in Far South Coast, Illawarra, Manning, Clarence, and Wallis Lakes are most vulnerable to changes from the socio-economic impacts under the draft FMS. Other communities outside Sydney and the Central Coast are also potentially disadvantaged to a lesser but significant extent. Social impacts on communities will also depend on the economic responses of fishers to category 2 share management, which will not be uniform. The social impacts of the draft FMS may be mitigated by the rate at which adjustment of minimum shareholdings occurs.

Other measures in the draft FMS will require functioning social processes to ensure effective management. Responses involving communication, compliance, codes of conduct and new gear regulation require cooperation between management and industry and a reduction in conflict to make the draft FMS successful. The draft FMS seeks to reduce conflict among ocean hauling fishers and between commercial and recreational fishers. This needs to be monitored to ensure the effective implementation of the plan.

3. Conclusions

This is the second social assessment of a FMS in NSW. Available information, data and specially commissioned survey results, are used to describe the fishers and communities in the fishery. It is notable that several rural areas away from Sydney on the north and south coast, are socio-economically disadvantaged and will be less resilient to impacts under the draft FMS.

Most of the social issues arise from reallocation under category 2 share management and will impact fishers, employees, families and communities associated with the exiting 55 ocean hauling businesses, with up to 70 fishers. It is predicted that older fishers, businesses earning less than $10,000 per year and latent effort holders, will be likely to exit, with low levels of regional economic impact, due to the small loss of output associated with these fishers. An estimated 60 to 70 fishers, with between 23-91 dependents, will be impacted to differing extents in proportion to their age and income dependence on the fishery.

The social impact will be noticeable in ocean hauling fishing communities, given the lack of alternative employment for many aged fishers, though elderly fishers will now be able to retire with a payment from the sale of shares. Other social aspects of NSW fishing communities require further research in the next five years. A priority should be to understand fishing communities, as a basis to appraise the impacts of successive fishery plans on a community. This would give greater clarity and reduce the impacts on fishing communities through a series of different fishery management strategies. The current FMS is a first step in moving towards ESD objectives in the management of the Ocean Hauling Fishery.

4. Health Issues

a) Health risks related to the environment

The seafood safety scheme is based on the premise that some species and/or activities represent a potentially higher food safety risk than others. The highest food safety risk is associated with bivalve molluscan shellfish because they can readily accumulate harmful contaminants (bacteria, viruses, algal toxins and heavy metals) from their environment and transmit these to the consumer. Bivalve molluscs are not retained in the Ocean Hauling Fishery and the species that are targeted in the fishery do not require any special management arrangements.

b) Handling and processing health risks

As food producers, the provisions of current NSW food legislation, namely the *Food Act 1989* and the *Food Regulations 2001*, bind participants in the fishery. Vessels are included in the definition of "vehicles" in the *Food Act 1989*. There are no specific provisions relating to seafood specifically in the context of this fishery but general requirements about hygiene and cleanliness, keeping good records and keeping products cool apply to the handling of all foods including fish.

The *Food Production (Seafood Safety Scheme) Regulation 2001* due to be introduced by December 2001 will require all seafood businesses, including those in the harvest sector to be licensed with SafeFood Production NSW and prepare a Food Safety Program in respect of their activities.

With respect to the fishery, this will apply from the point at which the catch is brought on board the vessel. Where the same business or individual further processes or handles products on shore (after landing) the Food Safety Program will have to encompass each and all of those other activities.

For most participants who simply catch fish and transport them to land, the basic requirements would already be understood and met since they involve good handling and hygienic practices. Given the range of scale and sophistication of vessels and businesses engaged in the fishery, however, it is likely that some improvements will need to be made, primarily of a minor nature. Most such changes would probably be accommodated in the draft FMS, which encourages better handling, icing, and value-adding methods.

Essentially the major food safety requirements on all participants in the fishery are keep the catch clean, keep it cold and keep good records. The current level of compliance is largely unknown but with the introduction of the Seafood Safety Scheme all participants will be licensed and subject to audit and inspection.

c) Health risks to fishers

There are a variety of occupational health and safety (OH&S) risks associated with the Ocean Hauling Fishery. Primarily, these include the use of boats, four-wheel drive vehicles and powered winches. Workcover administers the legislation that controls these activities and protects workers' health. The fishing businesses in the fishery are required by law to operate in a manner consistent with the OH&S legislation. The draft FMS is not required to provide additional specific management responses to OH&S issues.

5. Heritage Issues

The following summary is based on the detailed consultant's report prepared by Umwelt (Australia) Pty Ltd and presented in Appendix CH2.

a) European heritage

European heritage sites, reflecting the importance of maritime activities in the past development of NSW, are widely distributed along the NSW coastline, with some 1,500 shipwreck sites recorded. This assessment considers potential impacts of ocean hauling fishing activities on those European heritage sites that are listed in inventories maintained by the NSW Heritage Commission, the National Estate, and the Australian Shipwreck register.

Historic heritage has been differentiated between the transport and structural contexts. This differentiation is essentially dictated by the base source(s) or recording database(s) from which data has been derived. The transport context is specifically represented in the record of shipwrecks. The structural environment includes such resources as landing ramps, seawalls, breakwaters, piers and boat harbours, but also includes such developments as groynes and piles.

i) The interaction of commercial fishing with historic heritage resources

The activities associated with commercial fishing are limited to associated boating, foreshore access and the use of a variety of nets. The physical and spatial presence of heritage resources along ocean beaches is likely to have only a marginal effect on commercial fishing operations. With regard to shipwrecks, it appears likely that commercial fishing will have no impact on residual material evidence, having regard to the likely nature, bulk and mass of any residual material and the potential for sub-surface material to be covered by silt/sand.

It is considered that there is a low risk that activities in the Ocean Hauling Fishery will impact on heritage sites, although some shipwreck sites may present safety risks to ocean hauling fishers in boats.

b) Aboriginal heritage

There is abundant ethnographic and archaeological evidence for past use of beaches, headlands and nearshore waters by Aboriginal people, and of the importance of resources from these environments to Aboriginal economies and lifestyles.

Known Aboriginal sites are recorded in the NPWS Aboriginal Sites Register, and there are many hundreds of known sites located along beaches and in associated coastal dune systems. Middens are reported from many beaches, although the distribution of known midden sites is heavily influenced by the nature of the beach and dune system.

i) Interactions between the Ocean Hauling Fishery and Aboriginal heritage sites

Aboriginal sites along the sandy coastline are potentially at some risk of impacts by beach-based fishers, principally because of access to these areas by four-wheel drive vehicles. It should be noted, however, that beach haulers comprise only a small proportion of the four-wheel drive users of those ocean beaches that were traditional fishing and shellfishing locations for Aboriginal people.

Beach midden sites in many areas are also threatened by natural processes such as storm wave erosion of frontal dunes and the mobility of transgressive dune fields. Significant destruction of coastal dune sites also occurred during several decades of beach and dune mining for heavy mineral sands.

Commercial fishers access the traditional hauling grounds and shared beaches via access routes that have been agreed upon during the regional liaison process, which involved consultation with local councils and NPWS. The access routes are generally open to the general public. There are a few locations in each region where access is via a locked gate. It is assumed that in agreeing to access along various tracks to beaches, that NPWS has considered the risk that ongoing vehicle access could impact on Aboriginal sites. In addition, the closure of some beaches further reduces the risk of impacts on cultural heritage sites at those locations.

Where potential impacts on Aboriginal sites are known to exist, it is important that they are addressed by liaison and management actions at the local level. This will ensure compliance with the requirements of the NPW Act, and will also enhance cooperation and understanding of cultural concerns. An example is the presence of Aboriginal cultural heritage material at the boat ramp at Arrawarra. This ramp is also adjacent to a stone structure considered to be an Aboriginal fish trap.

In general, the physical evidence of past Aboriginal occupation along beaches is most severely threatened by land uses and activities other than ocean hauling fishing. Large midden sites in the Hunter estuary and north coast estuaries were exploited for lime in the nineteenth century, and sometimes also for road base. Many sites have also been destroyed by agricultural land uses, urban and tourist development and some have been destroyed by bank erosion (that may have natural or anthropogenic causes).

The overall risk that activities authorised by the draft FMS could detrimentally impact on Aboriginal cultural heritage evidence along NSW beach and dune systems is considered to be small.

ii) Protocols to reduce the risk of harm to sites

Notwithstanding the low risk of impact on Aboriginal cultural heritage, several management actions are proposed to ensure that risks to archaeologically and culturally sensitive areas are minimised. These include:

- consultation with local Aboriginal community representatives in relation to any proposed commercial fishery facility that would be located on an ocean shoreline. This would include maintenance of existing ramps, new launching ramps and regional boat storage or maintenance sites. In general, such facilities will require separate environmental assessment and development consent including assessment of potential impacts on Aboriginal cultural heritage
- preparation of cultural awareness information for holders of Ocean Hauling authorisations. In particular, these operators should be aware of the nature of pipi and other midden sites along ocean beaches, and that such sites are protected by the NPW Act
- ongoing consultation with local Aboriginal communities about developments in the commercial sector. This will occur, for instance, through Aboriginal representation on regional management advisory committees.

6. Indigenous Issues

The following summary is based on the detailed consultant's report prepared by Umwelt (Australia) Pty Ltd and presented in Appendix CH2.

It is important to note that there are several other concurrent policy development initiatives by NSW Fisheries that will affect the interaction of Aboriginal fishers with the Ocean Hauling Fishery. In particular, NSW Fisheries is currently working with the Aboriginal community to develop an Indigenous Fisheries Strategy, which will provide a new framework for the management of Indigenous fishing. The information presented in this assessment draws on the work in progress towards the Indigenous Fisheries Strategy, and outlines a process for ongoing review of regulatory relationships, but in no way pre-empts the outcomes of that strategy.

a) Current access of Aboriginal communities to coastal fishery resources

Commercial fishing has existed along the NSW coast since the mid-nineteenth century. Commercial fishing operations commenced around Sydney then moved to more remote areas early in the twentieth century. Thus, the interaction of traditional Aboriginal fishing activity on beaches with the commercial sector spans approximately 150 years in the Sydney area, and 100 years elsewhere on the NSW coast. In many Aboriginal communities, at least some members held general commercial fishing licences, and participated in the commercial sector, as well as fishing to support family and friends.

From the late nineteenth century, a number of beaches were closed to commercial fishing, generally to conserve or to allow the regeneration of fish stocks. Traditional Aboriginal fishers would have continued to have access to the aquatic resources of these beaches during periods of commercial closure.

Since the mid-1980s, NSW Fisheries has introduced a number of new regulations. The broad objective of these regulations was to enhance the efficiency of the commercial fishery, and introduce greater control over fishing effort and impact. The number of Aboriginal people who are licensed as commercial fishers in the Ocean Hauling Fishery and the relative scale of their fishing effort is unknown.

The introduction of greater regulation in the Ocean Hauling Fishery from the mid-1980s had several unintended consequences in relation to the access of Aboriginal communities to the ocean beach fishery. The impacts of the regulations continue to be of concern to Aboriginal fishers.

b) Management of Indigenous fishing and Ocean Hauling Fishery interactions

i) Outstanding issues of concern to coastal Aboriginal communities

The level of Aboriginal participation in the commercial fishery sector (based on interview data) appears to have declined substantially over the last twenty years. There are now perhaps less than 15 active fishing licences (estuary general and ocean hauling) held by Aboriginal families along the coast, however, the lack of commercial participation is not an indication of declining Indigenous participation in fishing generally. There are four main categories of outstanding issues of concern to

the Aboriginal community in relation to their participation in the management of fisheries in NSW (NSW Fisheries 2000) and each of these is also relevant to the impact of the draft FMS on Aboriginal communities:

- lack of recognition and accommodation of traditional Indigenous fishing practices
- declining participation of Aboriginal people in commercial, recreational and aquaculture fisheries
- insufficient meaningful presence and participation of Aboriginal people in the process for managing and conserving fisheries resources
- need for better communication and consultation with Aboriginal people.

Actions to address Aboriginal concerns in the draft FMS

The draft FMS identifies Indigenous people as stakeholders in the Ocean Hauling Fishery, noting that these interests arise from:

- direct participation in the fishery as commercial fishers
- traditional fishing practices, whereby people catch fish on behalf of themselves and their community
- lodging Native Title claims over beaches that are used for commercial fishing.

Existing legislation does not currently recognise Indigenous fishers as a separate sector of the fishing population, and this is a large part of the reason that none of the legislative reviews to date have given extensive consideration to Aboriginal community concerns.

The draft FMS does not specifically address the Aboriginal community's view that the evolution of the fisheries legislation in NSW has gradually but consistently undervalued the interests of Aboriginal people in the Ocean Hauling Fishery. The draft FMS does, however, foreshadow future amendments to the strategy to better accommodate Aboriginal community interests. For instance, objective 4.1 aims to monitor and provide an appropriate allocation of the fisheries resource between fishing sector groups.

In the draft FMS the performance indicator listed for appropriate sharing of the fishery resource is the catch level (including estimates) of the commercial, recreational and Indigenous fishing sectors. A trigger point for review is noted as a shift of relative catch levels of 25% between sectors over the term of the strategy.

It is important to note that such a shift in relative catch is unlikely to occur without significant changes to policies affecting access to the resource.

ii) Towards a NSW Indigenous Fisheries Strategy

NSW Fisheries has recognised that coastal Aboriginal communities have long standing and legitimate interests in the fishery resources of the coastline. The NSW Government now also acknowledges that Indigenous community interests in the coastal fishery are contemporary and do not relate only to past history. Existing fisheries management policies and legislation have restricted the traditional access of Aboriginal communities to natural resources.

A recent working paper prepared by NSW Fisheries (2000) indicates that consultation is progressing about how best to recognise and accommodate the rights and interests of Aboriginal

people in commercial fisheries. The working paper is part of the process for the development of an Indigenous Fisheries Strategy for NSW.

Interaction of the draft FMS and the Indigenous Fisheries Strategy

The time frame for the finalisation of the Indigenous Fisheries Strategy is not clear, and there are many complex issues to be resolved before the stakeholders agree to a sustainable strategy. It is most probable that the draft FMS will be assessed and will commence before negotiations about the Indigenous Fisheries Strategy are complete.

The preliminary indications are that the Indigenous Fisheries Strategy will address many of the issues that remain as outstanding concerns to the Aboriginal community in relation to the Ocean Hauling Fishery. It is also possible that the strategy will include a staged series of actions to gradually improve Indigenous access to the natural resources of beaches and other fisheries, so that any necessary changes to the draft FMS will also be gradual.

Ongoing review of the draft FMS will be essential to ensure that changes in the policy approach to Indigenous fisheries are adopted within the draft FMS. It is proposed that the draft FMS should be reviewed in two years, with particular attention to ensuring consistency between any Indigenous Fisheries Strategy that exists at that time, and the management protocols contained in the draft FMS.

c) Summary

As noted above, the risk of impacts on Aboriginal sites from ocean hauling activities is considered to be low at the whole of industry level, although specific local issues will need careful management.

Many of the concerns of Aboriginal communities about the impact of current commercial fishery regulations on their livelihoods and lifestyles are being addressed through the partnership with NSW Fisheries to develop an Indigenous Fisheries Strategy. This process may take some time, however, both to finalise to the satisfaction of all stakeholders and to implement through changes to other strategies and legislation.

In the short term, several actions are recommended to minimise the risks of adverse interactions between the Ocean Hauling Fishery, Aboriginal heritage and contemporary Indigenous community issues. These include:

- focussing on enhancing communication between NSW Fisheries and Aboriginal communities at all levels
- preparing cultural awareness material for fishers highlighting risks to Aboriginal sites and how these can be minimised
- ensuring close co-ordination of the preparation of new fishery management strategies for commercial, conservation, recreational and Indigenous sectors, to enhance opportunities for identifying innovative cross sectoral management options
- exploring opportunities for further Indigenous fishery or recreational fishery development on beaches that are currently subject to a low level of commercial fishing activity
- the draft FMS should be reviewed after two years, so that changes to Indigenous fishery policies can be accommodated.

7. Data Requirements in Relation to the Assessment of the Impacts on the Social Issues

a) Reference to technical data and other information

Prior to this study there was little social information on commercial fishers in NSW. The survey data comes from a rapid social appraisal questionnaire executed by a telephone survey, which is a first step towards the incorporation of social information in the management of fishers in NSW. The survey is not a definitive social profiling exercise. Given the complexity of the fisheries production inter-relationships, multiple communities and political climate among industry members facing significant allocation issues, the survey sought to gain a rapid over view of social issues raised under the draft FMS.

The survey revealed some inconsistencies in answers involving fisher income and these have been investigated by matching with the available Sydney index information and preliminary results from the economic survey.

b) Important knowledge gaps

The social profile of ocean hauling fishers can be augmented through time by further studies. Regional analysis of fisher communities is a priority integrating with economic information on the importance of the fishing activity to the community infrastructure of towns in NSW. Other approaches examine community linkages such as expenditures by businesses, employees, employee residential locations, social infrastructure services and existing social networks (Fenton and Marshall, 2001). Future social survey work should address community structure and inter-relationships at a regional level and articulate with regional economic studies previously recommended in Chapter G. It is important to understand the fishing community in order to appraise the impacts of the fishery management strategies being developed in the next few years, which will have cumulative effects on fishing communities.

c) Timetable for developing the data sets

More comprehensive social profiles and regional analysis should be commenced in the next two years to assist in monitoring the impacts of adjustment and in preparation for appraisal of future management strategies. The survey information recently obtained can have existing NSW Fisheries data added to it for analysis, but has a limited shelf life.

More complete regional industry and fishing community studies need to be undertaken recognising the fishing communities can be cumulatively impacted by multiple fishery management strategies. In time it is desirable for the fishing community profile and characteristics to be more clearly identified. This would enable impacts from different draft FMS to be monitored. In the longer term repeating social impact assessments for each fishery draft FMS risks ending up as a piecemeal and duplicative process if progress is not made in more fundamental fishery community profiling and monitoring in the next five years commencing as soon as possible.

CHAPTER I. JUSTIFICATION FOR THE PROPOSED COMMERCIAL FISHING ACTIVITY

1. The Need for the Ocean Hauling Fishery

This section examines the need for undertaking the fishing activity proposed in the draft Fishery Management Strategy (FMS) and the consequences of not undertaking the activity. The Ocean Hauling Fishery exists because it satisfies a number of significant community needs, each of which are discussed separately below.

Should the Ocean Hauling Fishery not continue, some of the resources used by the fishery would become available to other uses. Increased catches by other resource harvesters would offset the overall cost of not undertaking the Ocean Hauling Fishery. The possible benefits to other sectors would be different for the different species of fish and methods used for their capture. The likely possibilities are discussed below.

Some of the value lost by not continuing the seasonal mullet fishery would transfer to other stakeholders. The beach hauling fishery for mullet in Queensland would benefit from those fish that migrate to that state but would normally have been captured in the NSW fishery. The fish that are no longer captured in any fishery could add to the stock and reduce the risk of overfishing. If there were additions to the mullet stock, fishers in the Estuary General Fishery may experience increased catches of mullet.

Many of the very small pelagic species (e.g. anchovy) harvested using the pilchard, anchovy and bait net are not taken by other methods and in other fisheries. These products of the Ocean Hauling Fishery would be unavailable should the fishery not continue to operate. The stocks of these species may benefit from the reduction in fishing mortality.

The bulk of landings from the purse seine sector of the Ocean Hauling Fishery are species that are also taken in other fisheries, but in much smaller quantities. For example, yellowtail and blue mackerel are taken by line for bait by recreational fishers and commercial fishers in the Trap and Line Fishery. Those same species are target species for both the Small Pelagic Fishery and the South East Nontrawl Fishery, managed by the Commonwealth. It is not known how stocks of these species are distributed between NSW and Commonwealth waters nor is it possible to predict whether benefits of not undertaking the Ocean Hauling Fishery would flow to Commonwealth fisheries through stock building and/or increased access to stocks.

Most of the benefit from harvesting eastern sea garfish would not flow to other fisheries should the Ocean Hauling Fishery cease to operate (there is a small recreational fishery) however stocks of the species would be rebuilt.

General purpose hauling in the fishery targets a range of species in addition to mullet and all these species are taken in other fisheries, generally in larger quantities than taken by the Ocean Hauling Fishery. The other fisheries that would expect to benefit, either directly from reduced

competition for the stocks or indirectly from any stock building would be the Ocean Trap and Line Fishery, the Estuary General Fishery and recreational fishers.

a) Employment

There have been no targeted social surveys undertaken in relation to the NSW fishing industry, and there is little available information on which to estimate social impacts of fisheries management changes. The economic and social survey undertaken by Roy Morgan Research and analysed by Dominion Consulting Pty Ltd on behalf of NSW Fisheries has provided some information however, which allows a preliminary assessment of the nature and scale of employment associated with the fishery.

There are currently 374 fishing businesses in NSW that hold one or more endorsements to fish in the Ocean Hauling Fishery, comprising approximately 410 individual licensed fishers. Including the number of people who assist in the operation of fishing businesses with entitlements in the Ocean Hauling Fishery (both directly and indirectly), there are between 615 and 1,086 persons employed in association with ocean hauling. This does not include people employed in subsidiary industries such as fish processing, transport or the retail sector. The ocean hauling community tends to focus around ports associated with key estuaries and coastal towns, however a significant number of fishers reside in communities adjacent to the coast throughout NSW.

While the total employment estimate shows a significant number of people who are involved in the fishery, fishers operating in NSW generally operate in a number of different fisheries. The endorsement holders that actively fish in the Ocean Hauling Fishery only include about 15% who operate solely in this fishery and 85% operate in fisheries in addition to ocean hauling. Chapter G and associated appendices document the relative activity of entitlement holders in the Ocean Hauling Fishery.

It is not known how fishers would change their business structure if the Ocean Hauling Fishery ceased to operate, however it is reasonable to expect that the number of people who would have to find alternative employment would be between 600 and 1000. This is in the knowledge that 74% of ocean hauling fishers believe they would be unable to gain employment outside of fishing, and 78% of these people have stated that they would not consider retraining (see Chapter G). A proportion of ocean hauling fishers would be expected to concentrate their activities in other fisheries or seek alternative employment.

The availability of fishery resources used by the Ocean Hauling Fishery to other users, should the fishery cease to operate, would be likely to have only a small impact on employment in any of the alternate harvest sectors. Mullet fishers in Queensland may become more profitable (see below) but are likely to have the capacity within existing hauling crews to take advantage of any increased production One exception could be the processors of mullet roe in Queensland, where business might be expected to shift should there be a large reduction in production of mullet with roe in NSW. It is also possible that the Commonwealth Small Pelagic Fishery, which is apparently not very active off NSW waters, could become more active and create some new employment if competition from NSW purse seine fishers was removed. None of the other expected changes to the availability of stocks, should the Ocean Hauling Fishery not operate, are likely to give rise to new employment elsewhere.

b) Supply of seafood to the community

The Ocean Hauling Fishery provides, on average, approximately 3,200 tonnes of fresh seafood annually for general consumption by the community and for export to overseas consumers. There are no data available on the exact proportion of the ocean hauling catch that is exported, although the economic survey indicates that approximately 12% of gross sales (from all fisheries, see Chapter G) from businesses with ocean hauling entitlements is exported from Australia. The supply of fish to local markets by commercial fishers satisfies demand from consumers who do not wish to, or are unable to, venture out and catch the fish themselves. The Ocean Hauling Fishery also provides access to consumers of some species that are not widely caught by anglers (e.g. sea garfish).

A survey of the importance of local seafood to the catering and tourism industries in NSW has shown 40% of businesses felt it was important to offer seafood to visitors that had been caught in NSW. Fifty percent of businesses promote the local product (Ruello, 1996). A repeat survey four years later has indicated this trend has continued to increase and the importance of fresh local seafood to both consumers and businesses has increased (Ruello & Associates Pty Ltd, 2000). This trend is also found in north Queensland where 78% of restaurateurs said customers expect local seafood on the menu (JCU, 1993).

The importance of commercial fishing to local communities is often overlooked. Between 1991 and 1999 annual per capita fish and seafood consumption (from all sources) in Sydney increased by 12.7%, from 13.5 kg to 15.1 kg edible weight. In-home consumption rose by 8.4% while the increase in out-of-home consumption was much greater at 19.0% (Ruello & Associates Pty Ltd, 2000).

The Ocean Hauling Fishery supplies many species of fish that generally have a lower per unit value than many species taken in other fisheries (e.g. Australian salmon compared with tuna). The sale of these types of species supplies a low value species market niche that is quite different to that of the high value species.

A viable ocean hauling commercial fishery will continue to satisfy the high community demand for seafood.

Some of the seafood products produced by the Ocean Hauling Fishery are not likely to be available through other fisheries should the Ocean Hauling Fishery cease operation. These include the large quantities of blue mackerel and yellowtail caught using purse seines. Similarly, it is not apparent how sea garfish or the very small pelagics (e.g. anchovy) could be produced without ocean hauling methods. The roe from the mullet fishery would still be available, but to an unknown degree, through the fishery for that species in Queensland. It is not known to what degree the supplies of fresh tuna taken by Commonwealth tuna fisheries that operate from NSW ports would be impacted by the absence of NSW bait should the Ocean Hauling Fishery cease to operate.

c) Supply of fish products for other markets and uses

The harvest of the Ocean Hauling Fishery is mainly used for human consumption, however, the Ocean Hauling Fishery also contributes substantial volumes of fish product used in other ways. Small pelagic species such as pilchards are caught and packaged for use as bait by recreational fishers, providing a significant opportunity to add value to the product. Ocean hauling fishers also capture bait for sale to other commercial fishers. The bait gathered by Commonwealth tuna fishers is important for that fishery but the degree of dependence by that fishery on bait gathered from NSW waters is not

known. Some produce caught in the fishery (mainly Australian salmon) is processed for use as a protein source in various agricultural, aquaculture and pet feeds.

Should the Ocean Hauling Fishery cease to operate, much of the product that is used for purposes other than human consumption may not be available. Australian salmon and the very small pelagic fishes are unlikely to be supplied from outside NSW waters or without ocean hauling methods. The Commonwealth Small Pelagic Fishery may get access to and produce some extra catch from Commonwealth waters adjacent to NSW.

d) Economic benefits

The average value of the catch from the Ocean Hauling Fishery is estimated to be worth approximately $5.2 million annually (see Appendix CG1 in Volume 4 for an explanation of the basis for this figure). This revenue for the fishery provides an important source of employment for fishers and has multiplier effects in regional communities. Economic multipliers in the fishing industry are, however, low and total effects are generally between 1.5 and 2 times the direct effect (Tamblyn and Powell, 1988; Powell *et al*., 1989).

The economic survey conducted during the preparation of this EIS and other studies conducted on the expenditure of fishers in NSW (see McVeery, 1996) have shown that 27% of fishing business expenditures move outside the region of operation, leaving approximately 70% of the first sale value of catch within the communities where fishing takes place. This translates to approximately $3.6 million of fishing revenue generated from the Ocean Hauling Fishery that is potentially spent in the local regions. Most of these economic benefits would be forgone if the Ocean Hauling Fishery did not exist.

Some of the economic benefits from the Ocean Hauling Fishery would be produced elsewhere were the fishery to cease operation. There could be greater catches of mullet from the Estuary General Fishery, but the value of increased catches to that fishery is largely unpredictable. Mullet are caught year-round in estuaries, but generally at a much lower value than those taken in ocean hauling. More mullet produced in the estuary fishery may depress the price received for that species. The fishery for mullet in Queensland would be likely to increase in value from increased catches.

The fisheries that depend on bait from the Ocean Haul Fishery would have to source bait elsewhere, presumably at some additional cost. The potential replacement harvesters of stocks currently taken in the Ocean Hauling Fishery are unlikely to generate new economic activity but are more likely to gain additional catch from existing operations, increasing profit. One example could be increased catches of bream by trap fishers who target bream.

2. Sensitivity Analysis

Chapter D presents discussion and argument about alternative management strategies. From this, it is apparent that there are few high level feasible and economically viable or appropriate alternatives to the suite of controls proposed in the draft FMS. Therefore, the sensitivity analysis focuses on the 89 proposed management responses in section 4 of Chapter C.

The alternative management regimes discussed in Chapter D to address each of the key management issues typically involves using one of the responses already proposed in the draft FMS, but to a much greater (or lesser) extent relative to other controls. Consequently, the sensitivities of most of the alternative management regimes are covered in the sensitivity analysis carried out with respect to the management regime proposed in the draft FMS. There are a few exceptions to this and they are discussed at the end of this section.

In each case, a qualitative sensitivity analysis has been undertaken as insufficient quantitative data exists for all three components of ecologically sustainable development (ESD): biological, economic costs and benefits, and social (Table I1). The qualitative analysis has been undertaken as proposed in the DUAP guidelines for environmental assessment of commercial fisheries (DUAP, 2001).

In this analysis, the qualitative sensitivity is the relationship between the degree of change in the management responses (the variable) versus the likelihood of achieving the draft FMS goals (the desired outcome) within an ESD framework. In this context, each of the management responses has been assessed in terms of its likelihood in achieving the following target:

The proposed harvest strategy in the Ocean Hauling FMS aims to manage the fishery in a way that maintains sustainable fish stocks and a healthy ecosystem, while maximising the biological and economic yield and appropriately sharing the resource.

In this sensitivity analysis, the linkages between goals and responses which are presented in the draft FMS (in section 4 of Chapter C) have been incorporated as the cross reference between a specific management response for a goal and the other six goals. That is, in the analysis, goals 1, 2, 3, 7 and 8 relate to biological considerations, goals 5, 6 and 8 relate to economic factors and goals 4, 6 and 7 relate to social factors.

A common mistake in interpreting the analysis in Table I1 is to confuse ‘sensitivity’ with the ‘impact’ of the management response on the biophysical, economic and social environment. The clearest way to interpret the table is to remember: “if a little change in the management response causes a big change in the likelihood of achieving the above target, sensitivity is high. If a little change in the management response causes a little change in achieving the target, the sensitivity is low.”

Table I1. Qualitative sensitivity analysis of the proposed FMS management responses.

(H = high sensitivity, M = medium sensitivity, L = low sensitivity, ? = unknown sensitivity,
- = not applicable)

	Ocean Hauling Management response*	Biological	Economic	Social
1.1a	Design & implement scientific observer program	H	L	?
1.1b	Modify practices using best available knowledge to reduce by-catch	H	-	H
1.1c	Use best-practice for handling incidentally captured species	M	-	M
1.1d	Continue restrictions on the use and dimensions on fishing gear	M	L	L
1.1e	Continue prohibition on use of explosives	H	-	?
1.2a	MAC to contribute to reviews of habitat management policy or habitat protection plans	M	L	L
1.2b	Modify gear use that detrimentally impacts on habitat & threatened species	M	-	M
1.2c	Continue prohibition on damaging marine vegetation	H	-	M
1.3a	Limit species taken by each gear gear type	H	L	H
1.3b	Improve understanding of ecosystem functioning & fishing impacts	-	?	M
1.3c	Contribute to relevant biodiversity monitoring programs	L	L	M
1.3d	Participate in selection & management of MPAs	M	L	H
1.3e	Continue prohibition on marketing 'noxious fish'	M	-	-
1.3f	Promote research and pursue research priorities	M	L	M
1.4a	Implement measures required for marine pest or disease management	H	M	L
2.1a	Monitor quantity, length, age etc. of target species in fishery	M	L	M
2.1b	Conduct stock assessment of target species in the fishery	H	L	M
2.1c	Limit size & dimensions of all gear to that prescribed in Appendix C1	M	M	M
2.1d	Continue to use size limits on selected species	M	M	L
2.1e	Promote research that contributes to more reliable stock assessment	H	L	M
2.2a	Improve the management control of engine size on licensed boats in the	L	L	L
2.2b	Continue prohibition on use of unregistered nets	M	L	L
2.2c	Use species based closures as a short term control in the fishery	H	H	H
2.2d	Use minimum shareholdings to determine access	H	H	H
2.2e	Manage harvest of bait in NSW waters for Commonwealth tuna fishery	H	L	M
2.2f	Manage use of lift net for collection of bait in NSW waters	H	L	M
2.2g	Develop nomination policy for all sectors of fishery	L	L	L
2.2h	Maintain existing general licensing policies	M	M	M
2.2i	Develop index of relative fishing power & introduce management controls	M	H	M
2.3a	Establish business level minimum requirements for new entrants	M	M	M
2.3b	Restrict renewal of inactive licences	L	L	L
2.3c	Continue to use the transfer guidelines to prevent increases in effort	M	L	L
2.4a	Contribute to development of relevant policies by other government agencies	L	L	M
2.4b	MAC to consider impacts of activities external to the fishery	L	L	M
2.4c	NSW Fisheries to review development applications to minimise impacts	L	L	M
2.5a	Develop recovery plans for species where fishery is major harvester	H	M	M
2.5b	Contribute to development of recovery plan for overfished species if minor harvester	H	M	M
2.5c	Implement precautionary actions during development of recovery plan	H	H	M
2.5d	Consider size limit as part of recovery plan for silver trevally	H	-	-
2.5e	Restrict bullringing to the estuary general fishery	L	L	L
2.5f	Continue the zoning scheme for the fishery, and include the boat based sector	H	M	H
2.5g	Monitor impact of zoning boat based garfish hauling on stock	L	L	M
2.5h	Identify the level of active effort in garfish hauling & implement minimum shareholdings	H	H	H
2.5i	Remove the concession to use 25mm mesh in garfish hauling nets	M	L	-
2.5j	Extend summer weekend closures to a year-round weekend closure for garfish hauling	H	H	H

Table I1 (cont.)

	Ocean Hauling Management response*	Biological	Economic	Social
2.5k	Estimate mesh selectivity in garfish hauling nets	M	M	L
2.5l	Continue & expand current garfish research programs	M	L	L
3.1a	Modify catch returns to monitor threatened species interactions	H	L	M
3.1b	Implement provisions of relevant threatened spp recovery plans or TAPs **	H	L	H
3.1c	Continue prohibition on taking protected fish	H	-	H
3.1d	Continue prohibition of taking fish protected under other jurisdictions	H	-	H
4.1a	Assess size of non commercial and illegal catch & impacts	M	L	H
4.1b	Continue the requirement to adhere to species trip limits where applicable	M	-	L
4.2a	Monitor catches & management of fisheries under other jurisdictions	L	L	M
4.2b	Monitor catch of target species taken in other commercial fisheries	L	L	M
4.3a	Set maximum shareholding limits that sets a minimum number of business entities controling access in each region or method	-	H	H
4.4a	Participate in the development and review of the Indigenous Fisheries Strategy	-	L	H
4.4b	Respond to new information of cultural significance	-	L	H
4.5a	Continue use of time and area closures	H	H	H
4.5b	Review and improve code of conduct	L	L	H
4.5c	Establish a code of conduct for the Purse seine sector	L	L	H
4.5d	Define and declare recognised fishing grounds	L	L	H
5.1a	Provide for continued taking of target spp. following application of size limits	M	H	L
5.2a	Investigate the possibility of using holding pens for purse seine operations	M	H	M
5.2b	Develop a measure of economic viability at fishing business level	L	M	L
5.2c	Develop a cost recovery framework	-	M	L
5.2d	Develop a system to provide for additions to target spp lists	L	M	L
5.3a	Implement category 2 share management regime	-	H	H
5.4a	Co-operate with Seafood Production NSW-food safety programs	-	H	H
5.4b	Continue prohibition on processing or mutilation of fish	L	L	L
6.1a	Develop, implement and monitor compliance operational plans	M	M	M
6.1b	Implement an endorsement suspension and share forfeiture scheme	L	M	M
6.1c	Publish successful prosecution results to discourage illegal activity	L	L	H
6.1d	Continue the requirement to sell fish through a registered market	L	M	L
6.2a	Continue requirement to comply with fisheries officers directives	-	L	L
6.3a	Continue to use the MAC as the primary consultative body	-	L	M
6.3b	Continue to utilise the services of an independent chair in the MAC	-	L	M
6.3c	Monitor and assess access restrictions from other jurisdictions (parks,	-	L	M
6.4a	Manage consistently with other jurisdictional or resource management	H	M	H
6.4b	Provide for the issue of section 37 permits to assist research & other purposes	M	L	M
7.1a	Provide continuing education strategy for fishers and contact officers	L	L	H
7.1b	Make the FMS, EIS & other relevant documentation widely available to the public	L	L	H
7.1c	Produce brochures, newsletters, signs, education programs etc for fishery	L	L	H
7.1d	Respond to industry & public inquiries	L	L	H
7.2a	Publish educational information on protection of fish habitat	M	L	H
8.1a	Monitor catch taken by each net in the fishery	M	L	M
8.1b	Continue mullet stock assessment & monitoring	H	M	M
8.1c	Continue bream stock assessment & monitoring	H	M	M
8.1d	Determine priorities for research	M	M	L
8.1e	Allocate resources and seek funding in accordance with research priorities	M	M	L
8.2a	Continue requirement of fishers to enter catch returns	H	M	L
8.2b	Periodically review catch returns and implement appropriate changes	H	L	M
8.2c	Determine accuracy of species identification and make appropriate changes	H	L	M
8.2d	Ensure catch reporting accurately reflects the landings, composition and effort of crew	H	M	M
8.2e	Provide for teams to report fish observed, but not caught	H	L	M

* The management responses outlined here have been abbreviated for the purpose of completing the table. Please refer to section 4 of Chapter C for the complete wording of each response.

** TAPs = threat abatement programs

There are five management responses in Table I1 that show high sensitivity to all three facets of ESD. These proposals include three management responses to do with fishing closures and two that deal with the application of a minimum shareholding for access to fishing methods. The closures relate to using species-based closures as a short term response to a need to control active fishing effort, to the general application of fishing closures as needed and to the implementation of a weekend closure on hauling for garfish.

The sensitivity analysis indicates that fishing closures are a very effective tool for achieving the biological, economic and socially orientated goals in the FMS, as are the direct application of minimum shareholdings to limit access to a fishing method.

There are 11 of the 89 management responses which have a low sensitivity across all areas of ESD, mainly relating to very specific issues within the fishery or issues external to the fishery. For example, the responses relating to the registration of nets (2.2h,i) or the prohibition on mutilation of fish (5.4b).

There are several management responses that have a high sensitivity with respect to two facets of ESD, indicating that they are an important part of the overall proposed management strategy. These include:

- modifying fishing practices to reduce bycatch (1.1b)
- restricting the species taken in each net type (1.3a)
- implementing precautionary actions during the development of a recovery plan for overfished species (2.5c)
- continuing the zoning scheme for the fishery, and include the boat based sector in the zoning arrangements (2.5f)
- implementing the provisions of any threatened species recovery plans or threat abatement plans (3.1b)
- continuing the prohibition on the taking of protected fish, or fish protected from commercial fishing (3.1c and 3.1d)
- setting maximum shareholding limits that sets a minimum number of businesses in each region or method (4.3a)
- implementing the share management provisions of the *Fisheries Management Act 1994* (5.3a)
- managing the Ocean Hauling Fishery consistently with other jurisdictional or natural resource management requirement, such as the marine parks program, aquatic biodiversity strategy, threatened species program and others (6.4a).

These programs, along with the use of fishing closures, address each of the four key high risk areas that were identified in an early iteration of this EIS:

- potential for major effort shift
- bycatch reduction
- impacts on threatened and protected species
- protection of key habitats

a) Sensitivity of major alternative management approaches

The sensitivity of the aspects of the alternative management approaches discussed in Chapter D but not covered in Table I1 are presented in Table I2 below.

Table I2. Qualitative sensitivity analysis of the alternate management controls not already covered in the sensitivity analysis of the draft FMS proposals.

(H = high sensitivity, M = medium sensitivity, L = low sensitivity, ? = unknown sensitivity, = not applicable)

Alternate management control	Biological	Economic	Social
Introduce a total allowable catch	H	H	M
Reduce commercial fishing subsidies	M	M	?

The analysis in Table I2 indicates that introducing a total allowable catch would have a high sensitivity with respect to two of the three facets of ESD, and can be quite a powerful management control for the Ocean Hauling Fishery. The introduction of a total allowable catch for any species in the Ocean Hauling Fishery with the possible exception of sea garfish, however, is not appropriate at this stage based on the reasons outlined in Chapter D.

The reduction of commercial fishing subsidies has a medium sensitivity and likewise is not recommended over the proposals in the draft FMS.

3. Justification of Measures in Terms of ESD Principles

The manner in which the preferred rules in the draft FMS provide for an appropriate allocation of the resource and incorporate the measures necessary to achieve ESD, are discussed below.

a) Precautionary principle

The precautionary principle is defined in the May 1992 *Intergovernmental Agreement on the Environment* as "where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation" (Deville and Harding, 1997). The introduction of the precautionary principle has, as described by Deville and Harding (1997), shifted the 'onus of proof' regarding impacts away from regulatory bodies and more towards those whose actions may cause damage. Those undertaking the activity are required to provide a convincing argument that their actions will not have serious or irreversible impacts on the environment exceeding long-term benefits.

As recognised in the assessment guidelines under which this EIS was prepared, scientific research into the size and characteristics of fish stocks is inherently complex and costly. Fish populations and the aquatic environment inhabited by them are extremely dynamic. This means that the level of scientific uncertainty associated with fish stocks and aquatic communities is generally very high, especially for species that are of low commercial or recreational value. This situation is by no means unique to NSW or indeed Australian fisheries.

Many of the management rules that have historically operated in the Ocean Hauling Fishery, such as fishing closures and controls on gear use, have been adopted on a precautionary basis to provide an 'insurance policy' against over exploitation. The measures proposed in the draft FMS embrace this approach by continuing the existing controls on fishing and by proposing new initiatives to deal with the uncertainty surrounding the impact of gear types on bycatch and habitat. For example, Appendix C1 outlines a number of proposed amendments to gear dimensions and definition of how the gear is to be used. Explicit constraints on gear such as restricting the use of a general purpose hauling net to the beach and specifying maximum total lengths for garfish hauling nets and pilchard, anchovy and bait nets, are positive precautionary steps that will minimise the impacts (known and presumed) of these gear types on the environment. Additionally, the proposed research programs investigating the impacts of fishing gear on habitats and bycatch reduction, pro-actively address the information deficiencies in those areas.

The performance monitoring system established by the proposed FMS also provides a necessary safeguard in case there are changes in the operation of the fishery or fish stocks which could compromise the long term sustainability of the fishery.

b) Intragenerational equity

Intragenerational equity relates to distributing the costs and benefits of pursuing ESD strategies as evenly as practicable within each generation.

Intragenerational equity in the context of the Ocean Hauling Fishery is complex, due to the multi-species multi-method nature of the fishery but also because the many of the species retained by the fishery are taken in other commercial fisheries or by other sector groups, such as the recreational fishery. As well as the question of allocation of fish stocks, there are issues relating to the allocation

and management of often conflicting user activities (i.e. commercial fishing, charter boat/recreational fishing, boating, swimming, etc).

The proposed measures in the draft FMS distribute, as far as practicable, a fair and equitable sharing of the fisheries resource amongst fishers and the community. The operation of the fishery provides fresh local seafood to satisfy an ever increasing consumer demand for seafood. Fishing closures are used extensively to share the resource between users by specifying times or places when and where ocean hauling can occur (e.g. many areas of ocean waters and/or gear types are subject to fishing closures either permanently or seasonally).

The closures that exist or are proposed in the draft FMS promote equity of access to the physical environment used by ocean hauling fishers and others in the community. The negotiated closures, fishing grounds and access points and local rules incorporated in to the code of conduct all ensure fair access to the physical resources that surround the fishery.

The draft FMS contains proposals to assess the size of the non-commercial catch so that distribution of the resource is known, and performance measures to monitor and manage the distribution of catches of the retained species throughout time.

c) Intergenerational equity

Intergenerational equity relates to the present generation ensuring that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

In the context of the Ocean Hauling Fishery, intergenerational equity consists of ensuring that the fishery operates in a manner that minimises the impact of gear use on habitat, bycatch and threatened species, populations and ecological communities, as well as maintaining healthy and viable stock levels of the retained species.

The draft FMS contains eight broad goals, which if realised, will provide future generations with the same or improved opportunities to benefit from the valuable natural resources. Management measures proposed within the draft FMS to achieve the specified goals and hence intergenerational equity include:

- implementation of more secure fishing rights to promote resource stewardship
- modification of fishing gear and the manner in which the gear is used to minimise any impacts on the general environment (including bycatch and habitat)
- continued use of fishing closures
- introduction of new compliance and advisory programs to deter illegal activity and educate the broader community
- a comprehensive performance monitoring and review program, the results of which will be publicly available.

Furthermore, future generations will benefit from the data collected through the monitoring programs and future research proposed by the draft FMS. There will also be substantial benefits to future generations from the declaration of a comprehensive, adequate and representative system of marine protected areas (such as marine parks, aquatic reserves and intertidal protected areas) that includes a full range of marine biodiversity at ecosystem, habitat and species levels (Marine Parks Authority, 2000).

d) Conservation of biodiversity and ecological integrity

This principle incorporates the notion that conservation of biological diversity and ecological integrity should be a fundamental consideration in resource decision making. The draft FMS strongly adopts this principle, with one of the eight major goals being "to manage the Ocean Hauling Fishery in a manner that promotes the conservation of biological diversity in the coastal environment". There are four objectives beneath that goal which specifically aim to address the following issues:

- minimising the impact of the fishery on bycatch
- minimising the impact of the fishery on marine and terrestrial habitat
- reducing the likelihood of the fishery changing species, populations and ecological communities in a manner that threatens ecosystem integrity (i.e. composition and function)
- preventing the introduction and translocation of marine pests and diseases.

In order to achieve those goals and objectives, there are 14 management responses in the draft FMS that directly address biodiversity and ecological integrity issues, including modifying the gear permitted in the fishery and the use of gear, establishing a scientific observer program to record actual levels of bycatch and interactions with threatened species, using fishing closures, continuing and reviewing the code of conduct for the fishery, undertaking monitoring and research on ecosystem functioning, industry assistance in determining marine protected areas, and marine pest and disease management.

The draft FMS also contains proposals which attempt to monitor the impact of the fishery on biodiversity, such as the total area closed to ocean hauling fishing, bycatch levels, and mechanisms for taking action if the performance changes to a significant degree.

In conclusion, the proposed FMS contains a comprehensive package of measures for ensuring that the impacts of ocean hauling on biodiversity are properly managed.

e) Improved valuation, pricing and incentive mechanisms

This principle relates to the use of schemes like user pays and incentive structures to promote efficiency in achieving environmental goals. The Ocean Hauling Fishery, along with most other marine commercial fisheries in NSW, was proclaimed a category 2 share management fishery on 23 March 2001. This management framework provides for the issue of long term (15 year) shares to eligible fishers and provides for the existence of a market based trading scheme. The share management scheme for the Ocean Hauling Fishery will provide greater incentives for stewardship and long term sustainability of the resource because the value of shares when traded are likely to be linked to investors' views about the health of the fishery and the anticipated returns on investment.

The share management regime also provides greater flexibility for shareholders in the fishery to be able to trade shares with each other. This will enable fishers to change the structure of their fishing businesses more efficiently. It enables fishers to sell shares in the fisheries (or parts of fisheries) that they do not rely on in order to purchase shares in the fisheries (or parts of fisheries) that are important to their fishing businesses.

The share management scheme incorporates the notion of a user pays system as there is a $100 annual rental charge payable by each shareholder additional to the normal licensing and management fees, and the current Government policy is to phase in full cost recovery in the fishery between the years 2005 and 2008.

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