FINAL APPLICATION TO THE AUSTRALIAN GOVERNMENT DEPARTMENT OF THE ENVIRONMENT AND HERITAGE ON THE NORTHERN DEMERSAL SCALEFISH MANAGED FISHERY

Against the *Guidelines for the Ecologically Sustainable Management of Fisheries*

For Consideration Under Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999*

JUNE 2004

Department of Fisheries
Government of Western Australia

Fish for the future

DEPARTMENT OF FISHERIES, WESTERN AUSTRALIA
LOCKED BAG 39, CLOISTERS SQUARE WA 6850

TABLE OF CONTENTS

TABLE OF FIGURES

TABLES

1. INTRODUCTION TO THE APPLICATION

1.1 DESCRIPTION OF INFORMATION PROVIDED

This is an application to the Australian Government Department of the Environment and Heritage (DEH) to assess the Northern Demersal Scalefish Managed Fishery (NDSMF) against the Australian Government Guidelines for the ecologically sustainable management of fisheries. The submission of a successful application against these guidelines is now needed to meet the requirements under Part 13 and Part 13A of the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC), to enable the red emperor *(Lutjanus sebae*), Goldband snapper (*Pristipomoides multidens*), Spangled emperor (*Lethrinus nebulosus*) and Scarlet perch *(Lutjanus malabaricus*) and other relevant by-products of this fishery to remain on the list of exempt native specimens for the purposes of export, established under Section 303DB of the EPBC Act (previously Schedule 4 of the *Wildlife Protection (Regulation of Exports and Imports) Act, 1982*) past December 2004.

The information provided in this application covers all the elements specified in the *Guidelines for the Ecologically Sustainable Management of Fisheries* (located on the DEH website www.deh.gov.au/coasts/fisheries/assessment/guidelines.html) along with other information (at a variety of levels of complexity) considered relevant to those who wish to gain an understanding of the management of these fisheries. The application includes:

- Comprehensive background information on the history of the NDSMF, the biology of the primary species and a description of the current management arrangements, which provides the context for assessing this application (see Section 2 for details).
- A description of the National Ecologically Sustainable Development (ESD) Reporting Framework and methodology that was used to generate the information presented in the application (see Section 3 and www.fisheries-esd.com for details).
- Specific supporting statements relevant to each of the criteria within the Australian Government Guidelines. These criteria include the "General Requirements", which cover many of the governance aspects related to the management of the NDSMF, plus each of the objectives listed under "Principle 1" (target species issues) and "Principle 2" (broader ecosystem issues) of the Guidelines (see Section 4).
- Section 4 also has, where appropriate, specific links and reference to the detailed component reports contained in Section 5.
- At the end of Section 4 there is an OVERVIEW TABLE that outlines for each issue, which DEH Guidelines are relevant; if there is an operational objective, the availability of suitable data for the indicators; whether the current performance against the limit/measure chosen is acceptable; and a summary of what (if any) future actions are required.
- Section 5 includes a comprehensive account of the risk assessment outcomes and current performance presented in the National ESD format

as outlined in the Department's ESD Policy (Fletcher, 2002). This covers each of the environmental and governance issues relevant to this application for this fishery. These reports include either; the explicit objectives, indicators, performance measures, current and future management responses and justification for each major component; or a full justification for why specific management of this issue within the NDSMF is not required.

1.2 OVERVIEW OF APPLICATION

The NDSMF principally targets the higher value species, which include the goldband snapper, red emperor and cod species. In 2001 the fishery landed a total of 540 tonnes of demersal scalefish, for a catch value of $2.76 million. This value is higher than that reported in 2000 when 470 tonnes of demersal scalefish were landed with a total value of $2.63 million.

The fishery has been operating under a detailed and sophisticated management regime since 1997 using a comprehensive set of regulations that include input controls such as individually transferable effort allocations, gear restrictions and area closures. Each of these has been refined through time, and is subject to regular reviews to achieve the overall aim of successful management.

The *Fish Resources Management Act, 1994* (FRMA) provides the legislative framework to implement the management arrangements for this fishery. The FRMA, and the specific management plan for the fishery, adhere to arrangements established under relevant Australian laws with reference to international agreements as documented in Section 5.4.2.

The combination of having a large amount of relevant and accurate information on the biology of the main finfish species, the sophisticated suite of management arrangements in place and the proactive management used in the fishery has resulted in the maintenance of stocks as well as the successful continuation of the fishery.

The NDSMF, being a relatively small-scale trap and line fishery has minimal impacts on the broader ecosystem.

Consequently, the management regime for the NDSMF should meet the *Guidelines for the Ecologically Sustainable Management of Fisheries*. Detailed justification for this conclusion is documented within the remainder of this application.

2. BACKGROUND ON THE NDSMF

2.1 DESCRIPTION OF THE FISHERY

2.1.1 LOCATION OF THE FISHERY

2.1.1.1 LICENCE AREA

The waters of the NDSMF are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120° E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical mile) limit under the Offshore Constitutional Settlement (OCS) arrangements (Figure 1). The total gazetted area of the fishery is 483,600 km^2.

The fishery is divided into two fishing zones, Zone 1 (inshore) and Zone 2 (offshore) (Figure 1). The boundary between Zone 1 and Zone 2 approximates the 30 m depth contour. The inshore zone of the NDSMF encompasses a total area of 75,200 km^2 including the closed area around Broome. The offshore zone of the NDSMF encompasses a total area of 408,400 km^2. The deeper waters of Zone 2 (i.e. depths >200 m) are designated as a "research fishing zone" and encompass an area of 181,900 km^2. Fishing access to the research-fishing zone can only be facilitated through an agreed research framework. However, the demersal scalefish resources of these deeper waters are yet to be adequately investigated.

The inshore waters in the vicinity of Broome are closed to commercial fishing. The closed area extends from Cape Bossut to Cape Coulomb, inside a line that approximates as closely as possible the 30 m bathymetric contour.

2.1.1.2 FUNCTIONAL FISHING GROUNDS

Fishing vessels in Zone 2 of the NDSMF mainly use traps. However, handlines and/or droplines can also be used within the fishery. Fishing is currently focused on the area from the inshore boundary (a line approximating the 30 m depth contour) out to the 200 m depth contour, an area of 226,500 km^2 (Figure 1). Traps are deployed over hard bottom areas, areas of relief such as rises, ridges and reefs.

2.1.2 NUMBER OF LICENSEES

Separate zones were introduced into the fishery in 1998 along with formal management procedures. The catch in Zone 1 (the inshore zone) has always been low and variable and as a result the number of licences are restricted in this Zone to 4. In addition, these licensees also have effort restrictions in the form of only 5 lines allowed per boat.

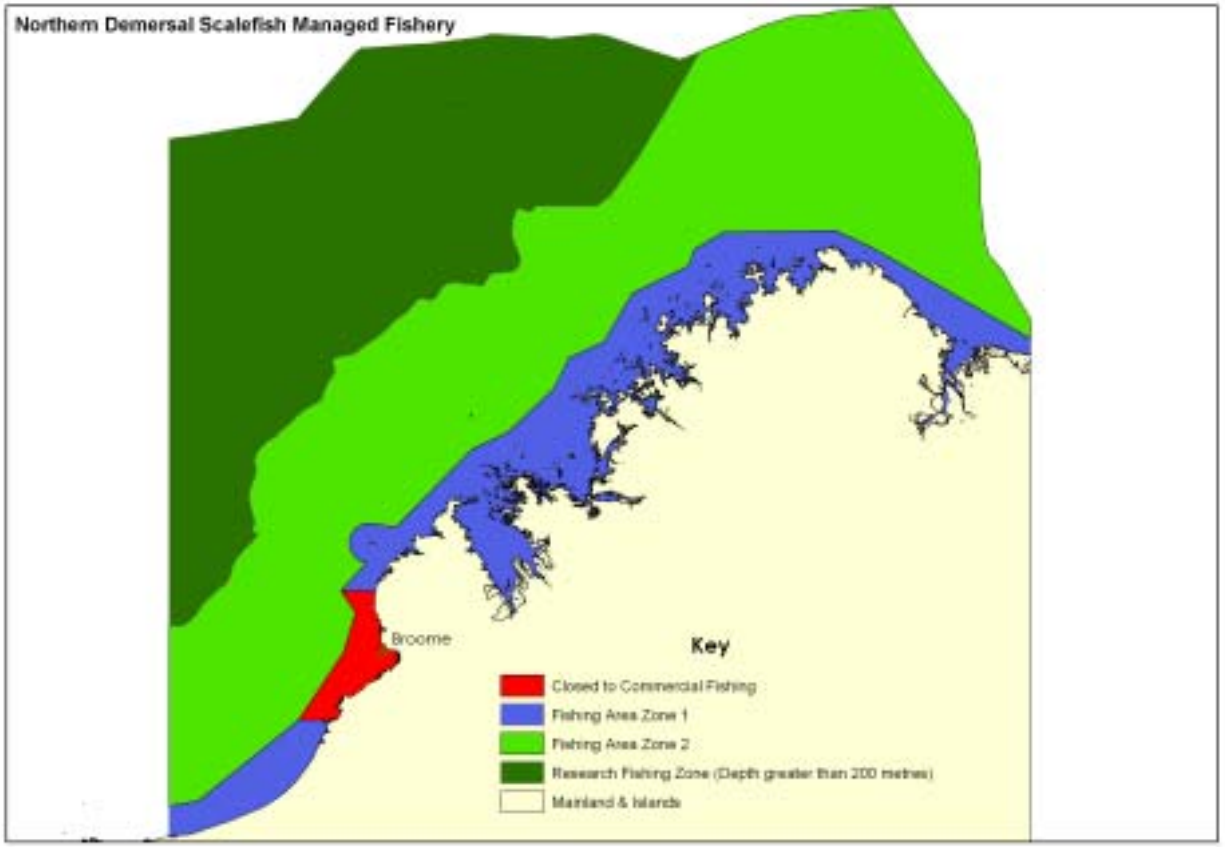


Figure 1 Location, boundaries and zones within the NDSMF in the Kimberley region of north-western Australia.

Since 1998 catch in this Zone has been less than 5 tonnes per year. In 2002 the total commercial catch in this zone was only 1 tonne from a total of only 66 boat days of fishing effort. Catfish (*Arius spp*.), black jewfish (*Protonibea diacanthus*) and golden snapper (*Lutjanus johnii*) dominate the landed catch from Zone 1. As the total catch from Zone 1 is very low, it is not considered further in this assessment.

Access to Zone 2 is currently limited to 11 licenses under an individual transferable effort (ITE) quota system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2001, six vessels (five trap vessels and one line vessel) collectively held and operated the effort individually assigned to the 11 licenses. In 2002, five vessels (all trap vessels, no line vessels fished in 2002) operated. Licensees in Zone 2 can fish with either fish traps or lines (handlines or droplines). The ITE allocation system is based on a standard number of trap (20 traps) or line (5 lines) gear units being used per standard fishing day. Thus fishers may choose to operate more than the standard number of gear units per day but the number of access days are reduced proportionally.

2.1.3 DESCRIPTION OF GEAR

2.1.3.1 GENERAL

Fish traps are currently the preferred method of fishing in the NDSMF. Line fishing is also undertaken, although no line fishing was undertaken in 2002. Traps are constructed from galvanised weldmesh, the mesh size is specified in Schedule 9 of the *Northern Demersal Scalefish Fishery Management Plan 2000* and must be 50 mm square, with the diagonal corners of each square being not less than 70 mm. The weldmesh is welded onto a supporting frame comprising galvanised steel rods or bars. Each trap must have an internal volume of equal to or less than 2.25 cubic metres. Dimensions are generally 1600 mm (length) by 1500 mm (width) by 900 mm (height). The trap volume was limited after consultation with fishers. Each trap has a single opening of approximately 100 mm by 900 mm, although the exact dimensions vary among vessels. There is no restriction on the number of traps that can be fished per vessel. However, as each licensee is allocated an annual effort quota in 'standard fishing days' that is based on the use of 20 traps or less, when the number of traps being fished increases, the number of allowable standard fishing days declines. Fishers are allowed to leave traps on the fishing grounds for extended periods, but they must be unbaited and have open doors (no ghost fishing).

2.1.3.2 OPERATING DESCRIPTION

Trap vessels generally operate with 2-3 fishers onboard including the skipper. The vessel leaves port and steams to retrieve traps from the area where the traps were left. The vessel then continues to steam to their nominated fishing ground. Fishers can travel quite long distances to reach their nominated fishing ground. For example, if the nominated fishing ground is in the vicinity of Browse Island (central Kimberley), then the travel distance is approximately 240 nautical miles from Broome to Browse Island. Once the nominated fishing grounds have been reached, they will be fished for the next 4-10 days, depending on the skipper and the tidal range. Fishers are quite

mobile and move traps over an extended area with between 60 and 120 trap pulls per day recorded (this is dependent upon the number of traps which vessels nominate to fish; the minimum is 20). The soak time of traps varies among vessels from 2-5 hours and traps are also set overnight. Typical catch rates are between 400-1000 kg of fish per day, depending on the amount of gear fished. The fleet is quite mobile and has the capacity to move long distances if fish are not being caught in the immediate vicinity.

The key target species are goldband snapper and red emperor. The catch is placed in brine tanks immediately post capture for chilling and is removed after several hours when it is transferred to a cold room. The catch is packed by species or species groups into polythene lined tubs. There is no further processing of the catch at sea. The catch is held at 1^{o}C - 4^{o}C in order to prolong shelf life. When fishing activity ceases the vessel usually steams back to either Broome or Darwin. Traps are offloaded either close to Broome or Darwin to make unloading the catch easier. Arrival in Broome is generally timed to coincide with the refrigerated truck departures for Perth. Vessels usually spend no more than 12 days at sea, due to the limited storage capacity, shelf life of fish and timing to coincide with freezer truck departures, which occur only three days per week (Monday, Wednesday and Friday).

2.1.4 SPECIES CAUGHT

2.1.4.1 TARGET

The target species in the fishery are red emperor and goldband snapper. In 2002, these 2 taxa collectively contributed to 57% of the total catch. In 2002, a total of 101 t of red emperor and 152 t of goldband snapper were caught.

2.1.4.2 BY-PRODUCTS

The NDSMF license allows for the capture of demersal scalefish, and all marketable scalefish are retained. At least 30 taxa contributed to the scalefish by-product catch in 2002. However, most by-product species are caught in very minor quantities (i.e. <10 t).

In 2002, scarlet perch (*Lutjanus malabaricus*), spangled emperor (*Lethrinus nebulosus*) and various species of cods and groupers (Family Serranidae) were the only scalefish taxa (apart form the target species listed above) with reported catches >10 t. Collectively, these 3 taxa contributed approximately 34% of the total catch in 2002. The fishery doesn't report by species for its cod/grouper catch, but it is known to include at least 16 species, with the majority of the catch consisting of 5 species (i.e. spotted cod, Rankin cod, eight bar cod, maori cod and duskytail grouper) (Newman *et al.* 2001).

Sharks are occasionally caught in the NDSMF. However, no shark catch was reported in 2001 or 2002.

The fishery does not catch invertebrates.

Under the *Northern Demersal Scalefish Fishery Management Plan 2000*, demersal scalefish (i.e. fish that can be landed by the fishery) are defined as all fish which are NOT in the families Scombridae, Istiophoridae, Xiphiidae, Coryphaenidae; NOT in the class Chondrichthyes; and NOT invertebrates of the Phyla Mollusca, Crustacea and Echinodermata.

The fishery takes in excess of 30 taxa, two taxa (red emperor and the goldband snapper complex) have been identified as target species and three taxa (scarlet perch, spangled emperor and the cod/grouper complex) have been identified as key byproduct species. Any of the other taxa that are landed by the NDSMF will be considered to be key by-product species in the fishery if their reported catch increases to a level in excess of 10 tonnes per annum. In addition, key by-product species will be considered to be key target species in the fishery if there reported catch increases to a level in excess of 100 tonnes per annum and fishers indicate that their targeting practices have changed accordingly.

2.1.4.3 NON-RETAINED SPECIES

Fishers do not record the discarded component of the catch. However, surveys on board industry vessels were conducted in 1998-99 and provided data about the composition of the retained and non-retained trap catch (Newman *et al.* 2001). The data supplied by fishers on their statutory monthly returns was also compared to that obtained from surveys aboard industry vessels. These comparisons showed that for those trips in which surveys were undertaken, the catch reports and compositions of the retained species supplied by fishers were a valid reflection of the observed catch.

The main component of the non-retained catch is starry triggerfish (*Abalistes stellatus*). This species represents about 85% of total discards. Some triggerfish are expected to survive after release. The discarded scalefish catch also includes minor quantities of triggerfish (Balistidae), bannerfish (Chaetodontidae), squirrelfish (Holocentridae) and lionfish (Scorpaenidae). These species are discarded because they are unmarketable or unpalatable. Very minor quantities of undersized target species (mainly red emperor) or other small scalefish are caught and discarded by the fishery.

Seasnakes and potato cod (*Epinephelus tukula*) are the only protected species known to be captured by the fishery. The catch of these species is rare and they are released alive.

The trap fishery has an incidental and negligible by-catch of epibenthos, such as gorgonians, which are occasionally detached from the bottom when the trap is retrieved. Positioning of the fishing vessel directly over the trap and pulling the trap up vertically can eliminate this incidental epibenthos removal and is the preferred method of trap retrieval. Fundamentally as a result of the gear design, the fishery has little impact on the habitat. Moreover, in comparison to fish trawling activities, the impact of fish traps on the benthos was not detectable (Moran *et al.* 1995).

The reporting requirements of the fishery are currently being modified with a planned move to reporting catches on a trip-by-trip basis. This will include an area for the

collation of any bycatch data and also compulsory reporting of any interactions with protected species.

2.1.5 BAIT USAGE AND PACKAGING

The bait used in this fishery is usually pilchards (*Sardinops sagax*) from the Western Australian purse seine fisheries. Discussions with fishers indicate that approximately 60 kg of pilchards are used per standard fishing day (using 20 traps per day). Therefore, approximately 48.5 t of pilchard bait was used in the fishery in 2002 (808 SFDs $\times$ 60 kg). The use of pilchard bait is sometimes enhanced by the addition of oily scalefish such as blue mackerel. This bait is widely dispersed over the area of the fishery. Bait packaging is discarded upon return to port in accordance with international conventions.

2.1.6 TRADITIONAL INVOLVEMENT IN THE FISHERY

Traditional use of the demersal scalefish resource is primarily artisinal and limited to the nearshore areas of Zone 1 of the NDSMF. In addition to concentrations of aboriginal people in the major population centres (i.e. Broome, Wyndam, Derby and Kunnunarra), there are up to 20 Aboriginal communities distributed along the Kimberley coastline.

The magnitude of traditional resource utilisation is unknown, however, at present there are no concerns regarding the quantity taken or method of capture by traditional users. There is no known traditional involvement in Zone 2 of the NDSMF.

2.2 HISTORY OF THE FISHERY

2.2.1 MANAGEMENT HISTORY

The first of the OCS arrangements between the Commonwealth and the State of Western Australia was implemented in June 1987. These arrangements defined the role of the Commonwealth and the State with respect to the management responsibilities of certain fisheries. Both trap and line methods of fishing off the Kimberley coast east of 120^{o} east longitude were affected by these arrangements. The trap and pot fishery, as defined in the OCS documentation, encompassed all species, except rock lobster, that could be targeted on the landward side of the 200 m isobath with traps and pots.

At this time the Kimberley Line Fishery was defined as targeting of all species of finfish with the exception of tuna using hand, troll and droplines. Arrangements for the management of this fishery as a result of the OCS arrangement were quite different from the trap and pot fishery. State jurisdiction for line fishing was extended from 3 nautical miles from the baseline to 12 nautical miles.

Under the authority of the *Fisheries Act 1905* Western Australia gazetted Notice No. 313 in 1988, the use of fish traps in Western Australian waters was prohibited unless

authorised to do so. As a result, 20 holders of Western Australian fishing boat licences were authorised to fish with fish traps off the Kimberley coast east of 120^{o} east longitude.

In 1992, both the Commonwealth and Western Australian fisheries agencies moved to manage fisheries off the far north west of Western Australia within their jurisdiction. The Commonwealth introduced the Northern Shark Fishery, which was actually a method-based finfish fishery based on longline and gillnet, and Western Australia introduced the Kimberley Trap Fishery. Dropline and handline fishing in both jurisdictions remained unmanaged in this area.

In February 1995, revised OCS Arrangements between the Western Australia and Commonwealth governments came into effect (Brayford and Lyon 1995). This resulted in Western Australia gaining greater jurisdiction over the fisheries resources off its coast. With the exception of tuna and tuna-like species, fish trapping and line fishing in WA waters east of 120^{o} east longitude, (the Kimberley coast) came under the jurisdiction of the Western Australian legislation.

On the implementation of these new Arrangements, the Western Australian Minister for Fisheries capped the number of line operators through the implementation of the Kimberley Demersal Line Interim Managed Fishery and appointed the Northern Demersal Scalefish Working Group. It was the role of this Working Group to advise the Minister on how to best manage the resource that was, at that time, utilised by two commercial fisheries (line and trap).

The Working Group handed its report to the Minister late in 1996, with some additional consultation in late May 1997. The resulting plan, the *Northern Demersal Scalefish Interim Managed Fishery Management Plan 1997*, was subsequently gazetted to take effect on 1 January 1998. Following additional consultation with industry and interest groups, the fishery moved to full management status on 1 January 2000 with the implementation of the *Northern Demersal Scalefish Fishery Management Plan 2000*.

2.2.2 RESEARCH HISTORY

Sainsbury *et al.* (1985) reported that research survey data on the fish community composition between the NW Cape and the Gulf of Carpentaria showed four major faunistic boundaries: NW Shelf (114^{o} - 123^{o} East); Kimberley coast (123^{o}- 128^{o} East); Timor Sea (128^{o} - 132^{o} East); and Arafura Sea (132^{o} - 142^{o} East). These regions have major differences in their fish fauna.

The Commonwealth Scientific & Industrial Research Organisation (CSIRO) conducted stock assessments for the scalefish fisheries of the NW Shelf and Timor Sea from 1980 to 1991. As the fishery gradually became dominated by domestic boats, the stock assessments were based on species of interest to the Australian market, such as large lutjanids (i.e. tropical snappers such as red emperor), and took the form of recommended total allowable catches (TACs) for large lutjanids.

Prior to the late 1990s there was a scarcity of specific research data on the demersal fish resources off the Kimberley coast. For the north-west coast as a whole (that is, from north of North West Cape to the border with Northern Territory), the only yield estimates available were the TAC estimates calculated by CSIRO for the North West Shelf region (114^o - 123^o East). Note that the NW Shelf region defined by CSIRO comprises the Pilbara fishery and the western section of the NDSMF in the Kimberley region. The last recommended TAC for large lutjanids for the NW Shelf was calculated in 1991. An annual yield of 840 t for the NW Shelf was considered a safe yield estimate, with an optimistic TAC of 1760 t. The difference in these two figures was a result of using two different stock assessment methodologies. The lower figure is the result of using the assessment considered to be the most appropriate method.

The demersal fish resources of the NDSMF have been subject to two very different periods of exploitation. A foreign Taiwanese pair trawl fishery was operating in the 1980s, followed by a smaller domestic Australian trap fishery from the 1990s to the present. Data on the history of foreign fishing in the NDSMF can be obtained from Nowara and Newman (2001).

Catch and effort in the Kimberley Trap Fishery stabilised after the introduction of management in 1992. The 1993 catch in the Kimberley Trap Fishery was 737 t. Total catch in the trap and trawl fisheries off the Pilbara coast in 1993 was 1713 t. In 1994, the catches were 543 t from the Kimberley Trap Fishery (709 t from all demersal fishing off the Kimberley coast) and 2693 t from the Pilbara coast. These catch values indicated that, if either of the CSIRO TACs was an accurate estimate of the sustainable yield, potential overfishing of the scalefish resources on the NW Shelf had been occurring across both the Pilbara and Kimberley fishery areas.

A summary of the key results arising from a major FRDC-funded research project that was completed in 2000 was reported in Newman et al (2001). This project provided detailed biological information on the two key demersal finfish species in the NDSMF, red emperor and goldband snapper. The results from this project indicated that the stocks of the two major target species are fully exploited and that a notional TAC of 800 t if achieved would have the fishery operating above optimum levels if the catch of these target species increased. This project has provided the foundation for detailed age-structured, stock assessment models to be developed for the two key species.

The current stock assessment analyses indicate that the maximum sustainable yield of the two target species can be obtained at current effort levels. However, higher levels of catch from the fishery may be possible if the fishers modify their targeting practices to increase their exploitation of a number of secondary (lower value) species, which are faster growing and more productive. In addition, there may be some potential for deep slope waters (>200 m) off the Kimberley coast to yield additional demersal fisheries resources (noting that this was the subject of a recent FRDC application that was poorly supported by industry, and still needs further investigation). If an additional stock of economically fishable demersal scalefish is identified in this region consideration should be given to separate zoning of the deep slope region and subsequently allocating additional fishing days access to this region within an adaptive management framework to allow the development of the demersal fish resources within the region. It is likely that a separate TAC will be required for

the deep slope region in association with other management controls as it is likely to comprise a different suite of species to those currently taken in the NDSMF.

2.2.3 CATCH AND EFFORT IN THE NDSMF

Statutory (compulsory) monthly catch and effort summaries are compiled by fishers and reported in the catch and effort statistics (CAES). Fishers report catch (kg) by species or species group. Catch location is reported by 1 degree blocks. A vessel monitoring system (VMS) has been operating since 1998 and provides data about vessel location during each trip. Fishing occurs throughout the year. However, fishing activities may be interrupted from December to April, as cyclones are more common during this period.

The level of compliance with both VMS and monthly returns is high. Random patrols are undertaken to validate catch reports are conducted both at sea and in port. The available compliance resources determine the frequency of random patrols.

The relationship between the total annual catch and effort data series from 1994 to 2002 for the aggregate species in the landings of the NDSMF is typical of many fisheries (Figure 2). In the initial development period of the fishery, catches increased with increasing effort as the fishery fished the accumulated surplus stock. Fishing down of this accumulated stock resulted in a decline in the levels of catch with respect to effort in the fishery.

Between 1995 and 1998 a number of line vessels operated for limited periods in the fishery as a number of licensees entered and left the fishery. Due to the variable levels of effort from both the trap and line vessels during this period catches varied from year to year as latent effort was activated. This activation of latent effort prompted management action in the fishery.

From 1998 to 2002, the catch and effort levels stabilised, suggesting that the level of catch was sustainable. Catches stabilised at 500-600 t and effort levels at 900-1100 days. This stabilisation suggests that future catch levels will primarily be driven by recruitment of the key species to the fishery.

Catch. The reported total catch for the NDSMF rose steadily after the initial development period of the fishery from 1990 to 1992, reaching a peak of 949 t in 1996 (Figure 3). A decrease in catch levels after 1996 partly reflected the introduction of management controls in 1998. From 1998 to 2002, the reported total catch of the NDSMF ranged from 434 to 577 t, with an annual average of approximately 505 t (Table 1). The catch decreased between 2001 and 2002 as a result of a reduction in the total amount of effort utilised in the fishery (a large amount of effort remained unutilised at the end of the year). The total reported catch was 434 t in 2002.

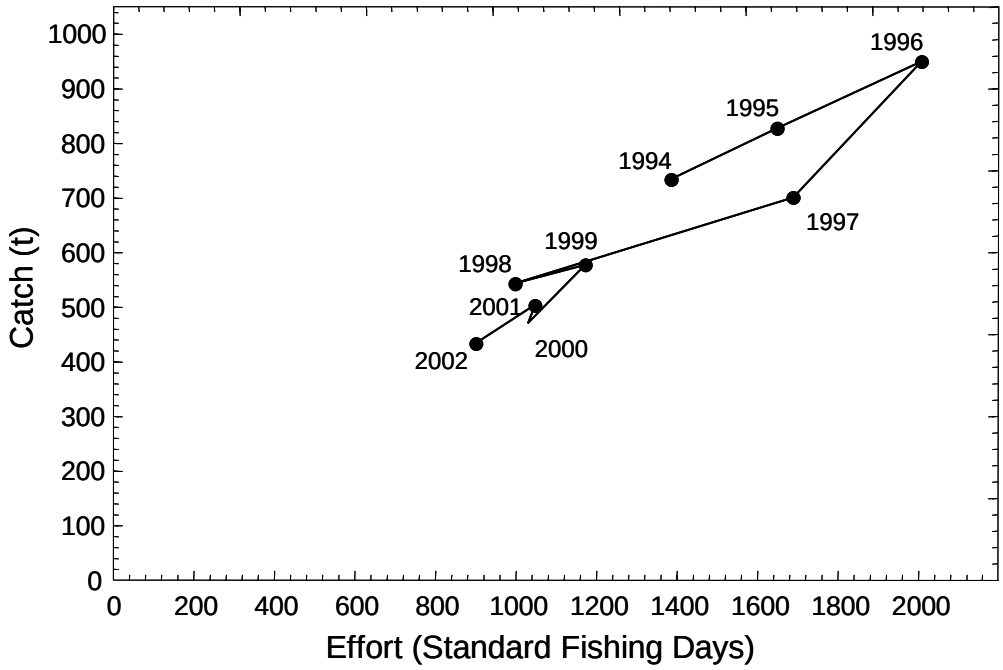


Figure 2 Relationship between total annual catch and total annual standardised trap fishing effort in the NDSMF in the period from 1994 to 2002.

The trap and line fishery in the NDSMF principally targets red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species), with many species of snappers (Lutjanidae), emperors (Lethrinidae) and cods (Serranidae) comprising a large component of the landed by-product (Table 2). The species composition of the annual catch has been similar in recent years. Red emperor and goldband snapper represented 23% and 35% of the total NDSMF catch in 2002 (Table 3).

Effort. Annual fishing effort quotas are allocated to Zone 2 (trap or line fishing) permit holders with the NDSMF. Vessels may use their allocated quota anywhere within the boundary of Zone 2. The five fish trap vessels that fished in the NDSMF in 2002 reported using between 20 and 40 fish traps per day. No line fishing was undertaken in the NDSMF in 2002. The effort allocated in 2002 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days. A standard fishing day is defined as using up to 20 traps or 5 lines per day. The number of standard fishing days (SFDs) reported using data from the VMS database was 900 SFDs, indicating that 860 SFDs remained unutilised in the fishery at the end of the 2002 fishing season. The number of days fished that is recorded in the VMS database is converted to standard fishing days and adjusted to take into account an allocation of travel days for travelling across sectors within the NDSMF.

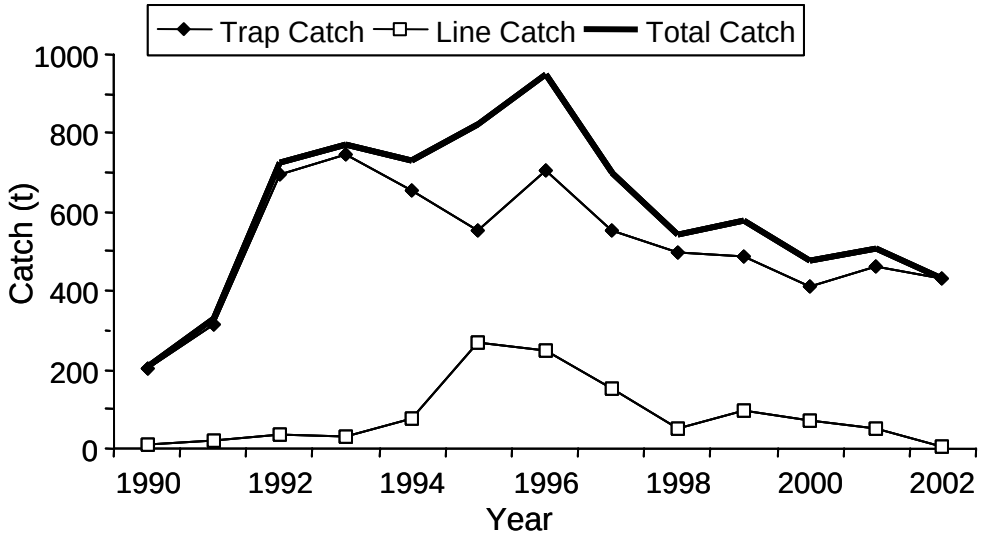


Figure 3 Catches of demersal scalefish in the NDSMF by line and trap from 1990 to 2002.

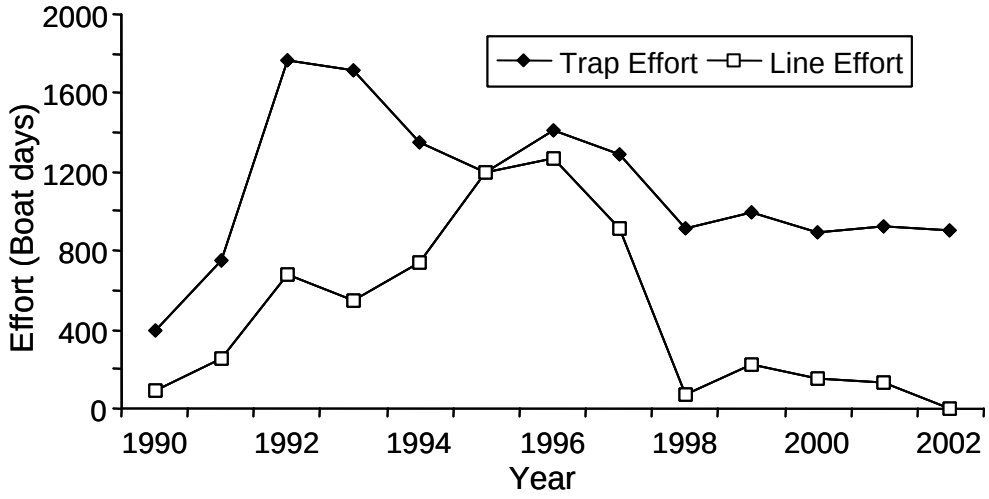


Figure 4 Effort in boat days used to catch demersal scalefish in the NDSMF by line (handline and dropline only) and trap from 1990 to 2002.

The fish trap effort (in boat days fished) within the NDSMF has on average been decreasing since 1992. The fish trap effort in 2002 was lower than that recorded in 2001 (Table 1, Figure 4). Since the introduction of management controls, fish trap effort has varied from 890 to 992 SFDs and a large proportion of the effort allocated to both line and trap vessels in the fishery has remained voluntarily unutilised in each fishing year. Furthermore, since 1998 the line effort in the fishery has been low and variable. Effort is widespread within the offshore zone of the NDSMF and is concentrated in depths of 70-130 m (Figure 5).

Catch rate. The introduction of management controls in 1998 resulted in an increase in catch per unit effort (CPUE) for trap vessels in the NDSMF (Figure 6). This

increase in CPUE was related to increases in efficiency as fishers sought to maximise their catch return from each day fished in the fishery as the available fishing effort was limited. Since 1998, however, the CPUE for trap vessels has stabilised in the range 457–504 kg/day, which is similar to the range prior to the introduction of direct management control through the effort quota system. The CPUE for line vessels (handline and dropline only) in the period from 1998 to 2001 declined from 527 kg/day to 316 kg/day and subsequently no line fishing was undertaken in the fishery in 2002. Prior to 1998 the handline and dropline CPUE was low and variable (Figure 6).

The trap CPUE averaged during 2002 was 478.1 kg per standard trap fishing day (20 traps x 23.91 kg/trap/day). The annual average trap CPUE in the fishery has ranged from 400-545 kg per day in the period from 1990 to 2002 (Figure 6).

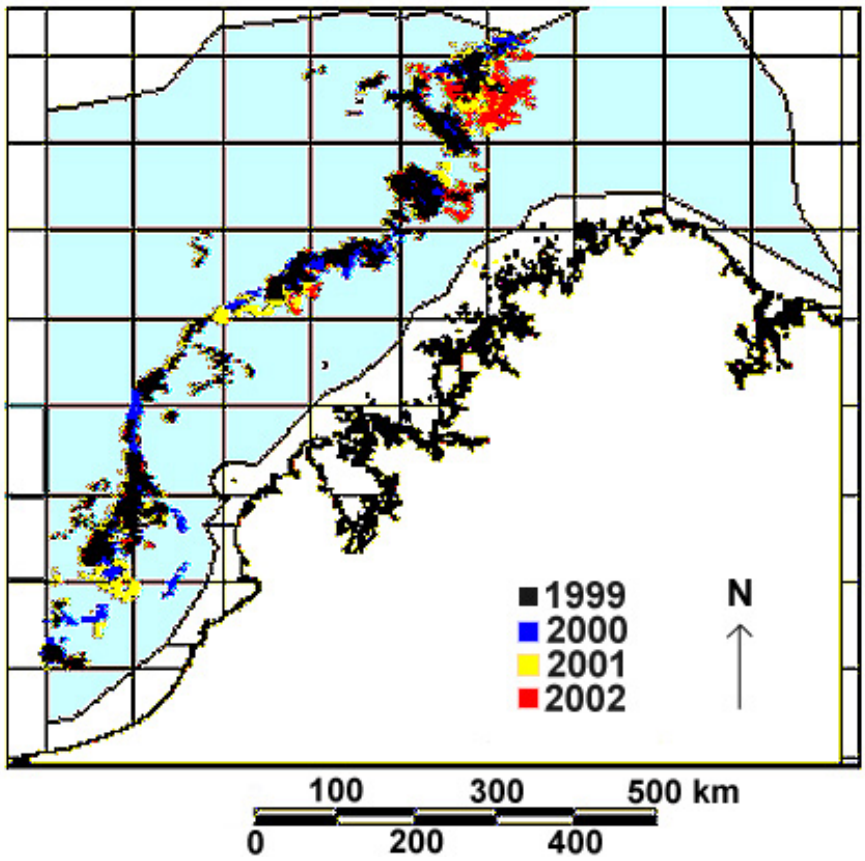


Figure 5 Spatial distribution of effort obtained from the VMS database for all vessels from 1999 to 2002. (area of the NDSMF fishery in light blue).

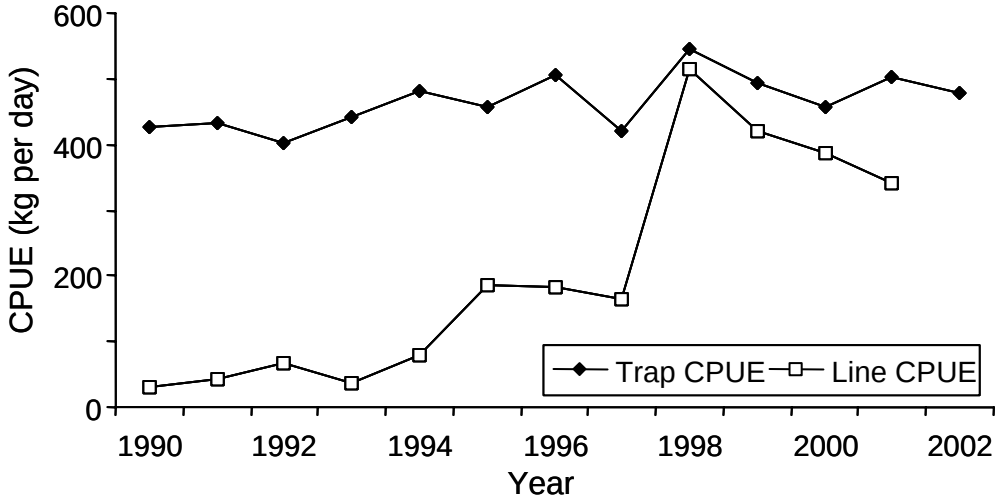


Figure 6 CPUE for trap and line vessels taking demersal scalefish in the NDSMF from 1990 to 2002 (Line catch and effort was zero in 2002).

Table 1 Catches (t) of demersal finfish and effort (days) by line and trap in the NDSMF since the introduction of full management arrangements in 1998.

Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	--	--	434	900	434

Table 2 Recent annual catches of major target and by-product species by the NDSMF.

Species	Target/ By-product	NDSMF annual catch (t)				
		1998	1999	2000	2001	2002
Goldband snapper *(Pristipomoides multidens)*	Target	233	292	189	209	152
Red emperor (*Lutjanus sebae*)	Target	109	101	90	95	101
Scarlet perch *(Lutjanus malabaricus)*	By-product	17	18	23	39	61
Spangled emperor (*Lethrinus nebulosus*)	By-product	26	27	32	36	35
Cod/grouper (Serranidae)	By-product	96	76	75	84	49
Total Demersal Scalefish Catch		**542**	**577**	**476**	**509**	**434**

Table 3 Catch of the key primary species and by-product species by method in the NDSMF in 2002 (percentages are contributions by each method to the total catch of each species in the NDSMF).

Species group		**Line**		**Fish trap**		**Total catch**
		Tonnes	%	Tonnes	%	Tonnes
Red emperor	*Lutjanus sebae*	--	--	101.1	23.30	101.1
Goldband snapper	*Pristipomoides multidens*	--	--	151.8	35.01	151.8
Cod species	*Serranidae*	--	--	49.4	11.39	49.4
Spangled emperor	*Lethrinus nebulosus*	--	--	33.9	7.82	33.9
Scarlet perch	*Lutjanus malabaricus*	--	--	61.3	14.13	61.3
Other species		--	--	36.2	8.35	36.2
All demersal scalefish		**--**	**--**	**433.65**	**100**	**434**

2.3 RECREATIONAL FISHERY

2.3.1 GENERAL DESCRIPTION

At present there is little recreational or charter boat fishing effort directed towards the deeper-water fish species in Zone 2 of the NDSMF that are the key species targeted by commercial fishers. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Zone 1, which is closed to commercial fishing. The magnitude of recreational fishing effort and catch are expected to be small relative to the total commercial catch.

A 12-month creel survey of recreational boat and shore-based fishing in the Pilbara and West Kimberley region was conducted in 1999-2000 (Williamson *et al*., in prep.). This survey included the west Kimberley area extending from the Pilbara-Kimberley boundary (120°E) to Broome. In the entire survey area (Onslow to Broome), the total annual recreational fishing effort was estimated to be 190,000 fisher days. The total recreational scalefish catch was estimated to be approximately 300 t. An estimated 12 t of spangled emperor and 6 t of red emperor were caught and retained by recreational fishers in the survey area. Boat- and shore-based recreational fishers do not catch significant quantities of the other species that are targeted by the NDSMF.

Recreational fishing records from charter boats were not included in the Pilbara survey. There are 85 fishing tour licences and 5 ecotour licences issued for the north coast bioregion (Pilbara and Kimberley coasts). In 2001, a compulsory logbook system was instigated to collect catch and fishing effort information from tour operators. These data are being analysed and will be available in 2003.

2.3.2 ISSUES ASSOCIATED WITH THE RECREATIONAL FISHERY

There are no significant issues associated with the recreational fishery and commercial fishers in Zone 2 of the NDSMF. The magnitude of both the recreational and charter boat catch along the entire Kimberley coast and the degree of overlap with the inshore zone of the NDSMF (Zone 1) remains to be investigated.

2.4 MAJOR ENVIRONMENTS

2.4.1 PHYSICAL ENVIRONMENT

The substrate which the fishery operates over is varied, consisting of areas of epibenthos (coral, sponges, gorgonians, sea whips), sparse beds of macro-algae and encrusting algae associated with harder substrate, limestone reefs, sparse sand habitats and soft mud. A diverse range of sessile benthic fauna (e.g. sponges) similar to the Pilbara region is likely to occur throughout the fishery (Wassenburg *et al.* 2002, Stephenson and Chidlow 2003). Trap fishing is expected to have a negligible impact on benthos.

2.4.2 SIGNIFICANT ENVIRONMENTAL CHARACTERISTICS OF THE AREA OF THE FISHERY

Protected/listed species that may occasionally be caught by the fishery are listed below (acronyms refer to the legislative Acts which afford each species its protected status).

- Sea snakes (EPBC)
- Potato cod (FRMA)

2.4.3 SOCIAL ENVIRONMENT

Five vessels fished in the 2002-fishing season (6 in 2001). Vessels operate with an average crew level of 3 people per vessel, indicating that 15 people were directly employed in the NDSMF in 2002. Landings by the fishery contribute to supporting the Western Australian fish processing industry.

2.4.4 ECONOMIC ENVIRONMENT

The NDSMF principally targets higher-value species, such as goldband snapper and red emperor (landed value to fishers is on average $6-9/kg for these target species). The fishery landed a total of 434 t of demersal scalefish in 2002, for a catch value of over $2.41 million. This estimate is based on the landed weight of each species recorded in the CAES system and the average price per kilogram of whole weight of

each species as supplied by fish processors (note value is calculated from prices based on a price survey undertaken in 2001, no price survey was conducted in 2002).

2.5 CURRENT AND PROPOSED MANAGEMENT ARRANGEMENTS

2.5.1 SUMMARY OF MANAGEMENT STRATEGIES AND JUSTIFICATION

The *Northern Demersal Scalefish Fishery Management Plan 2000* commenced on 1 January 2001, superseding the *Northern Demersal Scalefish Fishery Interim Management Plan 1997*.

The offshore zone of the fishery (Zone 2) is managed through an innovative input control system that allocates individual transferable effort quotas equitably among licensees. Other management arrangements include restrictions on the maximum number of hooks per handline and droplines, restrictions on the maximum internal volume of a trap and restriction on the size of mesh used in the trap. The total allowable effort is based on a nominal total sustainable catch (TSC) and is allocated on an annual basis. In 2002, the nominal TSC was 800 t of demersal scalefish and the total effort allocation was 1,760 days. The effort (in days fished) and the gear used in the fishery are monitored via a satellite-based VMS.

The nominal total sustainable catch in the NDSMF was set at an historical average catch level of 800 tonnes until the status of the key target species could be determined. The TSC is a targeted catch level and has not been exceeded since the management system was introduced.

The *NDSF Management Plan 2000* allows for the Department of Fisheries, Executive Director to determine the amount of effort to be allocated after consulting with authorisation holders. This is the method by which effort within the fishery can be adjusted to suit the nominal sustainable yield estimate provided by the Director of the Research Division. Scenarios in which the Executive Director may deem it necessary to alter the allocation may include a change in the sustainable yield estimate or a change in the efficiency of gear being used within the fishery. Provision has also been made in the management plan for the Executive Director of the Department of Fisheries (WA) to close the fishery if the TSC is exceeded.

A full description of the how the effort allocation is calculated each year and subsequently allocated among licenses can be found in the *Northern Demersal Scalefish Fishery Management Plan 2000*. Effort allocations are transferable among NDSMF Zone 2 Managed Fishery Permit holders, providing permit holders with the ability to configure their fishing business based on their individual needs.

The NDSMF is monitored via a vessel monitoring system. All vessels operating in the offshore zone of the fishery are statutorily required to have installed on that vessel an approved Automatic Location Communicator (ALC). The ALC consists of two components - a transceiver that relays to the base monitoring system, the location, the

speed and bearing of the vessel at any given point in time, and a computer that enables Department of Fisheries to communicate with the vessel and vice versa. The ALC is one component of the vessel monitoring system (VMS).

Since the commencement of formal management arrangements in 1998, the number of licences in Zone 2 of the NDSMF has been fixed at 11. However, the limitations on allowable effort in the fishery have resulted in vessels utilising more than one licence to operate within the fishery. Thus, the fleet size varies from 5-7 vessels operating in the fishery each year. The area around Broome is permanently closed to commercial fishing. This closure was introduced in an attempt to reduce conflict among commercial and recreational user groups. There are presently no areas permanently or temporally closed for ecological reasons in the NDSMF. However, consideration will be given to the implementation of either temporal or spatial area closures should they be required to maintain levels of spawning biomass of species within the fishery (noting that spatial area closures are part of the effective management package in the adjacent Pilbara fisheries).

The major target species (red emperor and goldband snapper) of the NDSMF are also the indicator species for the fishery and are considered to be representative of other long-lived target species (i.e. spangled emperor and scarlet perch) that are also vulnerable to over-fishing. Management actions to ensure sustainable catch levels of the indicator species are considered likely to afford similar protection to other long-lived species. The NDSMF is managed through an integrated management scheme, where issues are discussed at regular meetings involving fishers and Department of Fisheries staff.

In 1998 the fishery was separated into Zones. The targeting and capture of demersal scalefish in the inshore zone (Zone 1) has typically been characterised by low and variable catches. Since 1998 the catch in Zone 1 has been less than 5 tonnes per year. The *NDSF Management Plan 2000* ensured that those who had a history of line fishing in this inshore zone were able to continue fishing but at low levels.

There are primarily three mechanisms to restrict effort within the inshore zone. Specifically the management plan has limited entry to 4 permits, placed limits on the number of hooks that each operator can set (up to five handlines with no more than six hooks per line) and does not allow the use of power hauling equipment.

The establishment of an area of low commercial activity has been applauded by a number of other user groups in the Kimberley region. Specifically recreational, aquatic charter operators and aboriginal groups have supported this mechanism as an appropriate means of ensuring that resource sharing conflicts in the near shore areas are avoided.

2.5.2 LEGISLATION AND POLICIES AFFECTING THE FISHERY

Northern Demersal Scalefish Fishery Management Plan 2000

Fish Resources Management Regulations 1995 (FRMR)

Fish Resources Management Act 1994 (FRMA)

Environment Protection and Biodiversity Conservation Act 1999 (EPBC) – Part 13
Provides for the protection of species within one of four categories - threatened species; marine listed species; migratory species and cetaceans. Species listed as threatened under the Commonwealth EPBC must have a recovery plan prepared for them.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC) – *Part 13A*
Provides the export controls.

2.5.3 BYCATCH ACTION PLAN

A Bycatch Action Plan has not been developed for the fishery. The number of discarded species and the quantities of bycatch taken by the fishery are believed to be very low. However, there is scope for a Bycatch Action Plan to be developed for this fishery if the level of bycatch in the fishery becomes an issue in future years.

2.6 RESEARCH STRATEGY

2.6.1 RECENT/CURRENT RESEARCH

Continuous ongoing monitoring and evaluation of the status of the demersal fish resources of the NDSMF is required in order to provide adequate advice for the ongoing management arrangements required in the NDSMF. This includes monitoring of catch levels and catch rates in the fishery using both CAES data and VMS records. Data on growth rates, age structure, reproductive biology and yield analyses, together with catch and effort information gathered from the fishery, is used to assess the status of the key fish stocks in the fishery, principally red emperor and goldband snapper. Data collected during an FRDC-funded project in 1997-2000 is currently being incorporated into age-based stock assessment models to assess the long-term sustainable yield of the two key target species (Newman *et al.* 2001). As part of this review process the appropriateness of the present TSC is under review in order to provide a long-term sustainable catch level for Zone 2 of the NDSMF.

Major stock assessments, including risk assessment of management options for the key demersal finfish species in the NDSMF are undertaken every 3 years.

2.6.2 PROPOSED/FUTURE RESEARCH

The third largest component of the NDSMF catch is the cod group. Little information is currently available on the species composition and their relative abundance. A number of cod species that occur in the NDSMF are Indian Ocean endemics and little is known about the fishery biology of these species. This gap in the knowledge of the NDSMF represents an area of future research work.

There is also a need to undertake annual at-sea catch composition sampling to evaluate the species composition and magnitude of the landed catch and composition and magnitude of any bycatch or discarded species.

There is a need to obtain an improved understanding of the catchability of the key species in the fishery; this would facilitate improved stock assessments and management arrangements. In association with this is the need to evaluate areas outside the current main fishing area to determine if parts of the stock are not exposed to exploitation.

The future catch from the NDSMF may also involve the stocks from waters greater than 200 m depth. This area of the fishery is available as a research-fishing zone, and fishers have the option to explore the deeper waters, though to date industry has had little success in this zone. The resources in deep waters of the fishery are therefore unlikely to be substantial. Also, given the typically low production potential of deeper-slope reef fish, the sustainable catch from this zone is likely to be low.

2.7 BIOLOGY OF SPECIES

2.7.1 BIOLOGY OF TARGET SPECIES

2.7.1.1 LUTJANIDAE

The Lutjanidae family contains 17 genera and 103 species that are commonly known as tropical snappers (Allen 1985). Most species occur in tropical and sub-tropical marine waters and are associated with reef habitats. They are carnivorous, typically preying on bottom-dwelling organisms and foraging mostly at night. Most lutjanids are highly fecund, broadcast spawners. Females release numerous batches of eggs over an extended spawning period. Fecundity increases with female size. Specific fecundity estimates are not available for all lutjanids, but a 100 cm female may typically produce 5-7 million eggs per year. Eggs and larvae are pelagic and usually occur in shallow continental shelf waters (Leis and Carson-Ewart 2000). Larvae typically migrate to the surface at night and away from the surface during the day.

Red emperor (*Lutjanus sebae)* are widely distributed throughout the Indo-Pacific, ranging from eastern Australia to southern Japan and Western Australia, and westward to east Africa and the southern Red Sea (Allen 1985). Within Australia, red emperor range from Sydney, NSW, around the northern coast to as far south as Cape Naturaliste (33° 30'S), Western Australia.

No significant genetic differentiation has been observed among populations of red emperor across the north-west region of Australia based on allozyme studies (Johnson *et al*. 1993). In contrast, ratios of oxygen and carbon isotopes in otoliths of adults suggest very limited mixing of populations between the Pilbara and Kimberley regions (Stephenson *et al*. 2001). In summary, genetic homogeneity is probably maintained by the dispersal of pelagic eggs and larvae among regions, but juveniles and adults undertake limited movements. Limited movement by adults indicates that the current area-based management strategy for this species is appropriate and that

regional populations should be treated as separate stocks for fishery management purposes.

There may be some movement of red emperor offshore with increasing age. Juveniles (<20 cm length) are common in nearshore turbid waters and also occur on coastal or offshore reefs (Kailola *et al*. 1993). Sub-adult fish (>20 cm) are widely distributed across the continental shelf (Newman pers. obs.). Adults occur across the shelf to depths of at least 180 m and are associated with coral reef lagoons, reefs, epibenthic communities, limestone sand flats and gravel patches (Kailola *et al.* 1993). Adults may be solitary or form schools. They feed mainly on fish, benthic crustaceans and cephalopods (Allen 1985).

Spawning occurs from October to March in the Kimberley region, with the main spawning period in October (Newman *et al.* 2001). Similarly, spawning occurs from September to December in the Pilbara region (Stephenson and Mant 1999). Newman *et al.* (2001) estimated a mean age-at-maturity of 8 y for both males and females, reflecting a mean size at maturity of 46.1 cm TL (total length) for females and 49.1 cm TL for males in the NDSMF. In contrast in the Pilbara region, Stephenson and Mant (1999) estimated that the mean size-at-maturity for females at 419 mm TL at a mean age of approximately 3.8 y. In addition, the estimated length-at-maturity for red emperor from the Great Barrier Reef was estimated to be 54.8 cm by McPherson *et al.* (1992). The size at maturity in the Pilbara region is similar to the minimum legal length in WA of 410 mm TL, indicating that the current minimum legal length is appropriate for this species.

Red emperor, like all lutjanids are gonochoristic. That is, they do not undergo sex change. Sexes remain separate throughout life. However, there is significant differential growth between sexes, with males on average reaching a larger size at age than females (Newman and Dunk 2002). Red emperor, attain a maximum length of at least 100 cm (Allen 1985). Maximum age is estimated to be at least 40 y, although the oldest age observed in the NDSMF is 34 y (Newman and Dunk 2002). Newman and Dunk (2002) estimated the instantaneous rate of natural mortality (M) for red emperor to be in the range 0.104-0.122 in the NDSMF. Note the instantaneous rate of natural mortality (M) represents deaths of fish from all causes except fishing and is often expressed as a rate that indicates the fraction of fish dying in a year; for example, a natural mortality rate of 0.1 implies that $1\text{-}e^{-0.1}$ of the population (~9.5%) will die in any given year from causes other than fishing. Similarly, Stephenson and Mant (1999) estimated M, to be 0.10 in the Pilbara region. These estimates of natural mortality are similar to those estimated for *L. erythropterus* and *L. quinquelineatus* based on an analysis of catch curves from unfished populations on the Great Barrier Reef (Newman *at al.* 1996, Newman *et al.* 2000b). Note both these species had similar longevities to that observed in red emperor populations from north-western Australia.

Scarlet sea perch (*Lutjanus malabaricus*) are distributed throughout the Indo-Pacific region from Fiji to the Persian Gulf, and from Australia to southern Japan (Allen 1985). Within Australia, they are found from Shark Bay, WA, around the northern coast to Sydney, NSW. Movement of adult scarlet sea perch has not been studied, but is likely to be similar to other lutjanid species, which have restricted long-shore movement. Therefore, the current area-based management strategy for this species is

appropriate and regional populations should be treated as separate stocks for fishery management purposes.

Juveniles are solitary and mainly occur in shallow nearshore waters, often associated with seagrass. Some juveniles also occur across the shelf. There is considered to be a general offshore movement of juveniles with increasing age (Kailola *et al.* 1993). Adults are found in continental shelf waters to depths to at least 140m. They are associated with coastal and offshore reefs, shoals, and areas of flat bottom with occasional benthos or vertical relief. On the north-west shelf of WA, they are often associated with sponge and gorgonian habitats and are often found schooling with *L. erythropterus* (red snapper) (Kailola *et al.* 1993). Scarlet sea perch feed mainly on fish and benthic crustaceans (Allen 1985).

Scarlet sea perch have an extended spawning period. The timing of spawning varies among regions but there is a general peak in activity in spring/summer (Allen 1985). Scarlet sea perch are gonochoristic. That is, they do not undergo sex change. Sexes remain separate throughout life. However, there is significant differential growth between sexes, with males on average reaching a larger size at age than females (Newman 2002). Hence, males predominate among the larger individuals in the population, although the sex ratio does not change with age. The estimated length-at-maturity for scarlet seaperch from the Great Barrier Reef was estimated to be 57.6 cm by McPherson *et al.* (1992). The maximum length observed in the fishery is 802 mm, but they may reach 1000 mm (Allen 1985). Maximum age is estimated to be >40 y, although the maximum age observed in the fishery is 31 y. The rate of natural mortality, M, is estimated to be 0.11 (Newman 2002).

Goldband snapper (*Pristipomoides multidens*) are distributed throughout the Indo-Pacific region from Samoa to the Red Sea, and from Australia to southern Japan (Kailola *et al.* 1993). In Australia, they occur from Cape Pasley, WA (34^{o}S lat) across the northern coast to Moruya NSW. Within WA, commercial quantities are taken only from Shark Bay (25^{o}S lat) northwards (Newman *et al.* 2001, Newman and Dunk 2003).

Stable isotope ratio analysis of the sagittal otolith carbonate from assemblages of goldband snapper from waters off northern and western Australia revealed location-specific signatures and indicated that fish from all sites sampled within Australia were different (Newman *et al.* 2000c). Therefore the sampled populations comprise separate stocks for many of the purposes of fisheries management. Genetic studies have revealed that there is some gene flow among Australian populations of goldband snapper (Ovenden *et al.* 2002).

Adults occur in continental shelf waters in depths of 60-245 m, in association with offshore reefs, shoals, and areas of hard flat bottom with occasional benthos or vertical relief (Newman *et al.* 2001). Juveniles have been obtained from uniform sedimentary habitat with no relief. Juveniles and adults do not co-occur over the same habitat types. No cross-shelf movements are known, although adults may feed over a range of depths. They feed on the bottom and in the water column, consuming fish, crustaceans, gastropods, squid and salps (Allen 1985). The adults often form large schools.

Goldband snapper are gonochoristic (sexes are separate throughout life) and spawn in the NDSMF from January to April with a peak in March (Newman *et al.* 2001). They are multiple spawners, within a multiple male: multiple female spawning system. The length at maturity of goldband snapper was estimated to be 55.2 cm TL for females and 54.9 cm TL for males, corresponding to a mean age at maturity, of 8.2 years for females and 8.0 years for males.

Goldband snapper reach a maximum total length of 90 cm, although the maximum length observed in the NDSMF is 81 cm (Allen 1985, Newman *et al.* 2001). A maximum age of 30 y has been observed in the NDSMF (Newman and Dunk 2003). The rate of natural mortality is estimated to be in the range 0.10-0.14 (Newman and Dunk 2003).

2.7.1.2 LETHRINIDAE

There are 5 genera and 39 species of lethrinids in the Indo-Pacific region (Leis and Carson-Ewart 2000). They are commonly known as emperors. Juveniles of lethrinids typically occur in shallow inshore habitats such as seagrasses (Kailola *et al.* 1993). Fish move deeper with increasing age. Larger lethrinids are strongly habitat dependant, tending to aggregate on small patches of suitable habitat that can be fished down rapidly (Moran *et al.* 1993). Lethrinids are carnivorous bottom feeders. Eggs and larvae are pelagic.

Spangled emperor (*Lethrinus nebulosus*) re distributed from east Africa and the Red Sea to Samoa (Randall *et al.* 1990). In Australia, they are distributed from Rottnest Island, WA, across the northern coast to northern NSW (Kailola *et al.* 1993).

Populations of spangled emperor in WA are genetically similar, probably as a result of the dispersal of pelagic larvae (Johnson *et al.* 1993, Moran *et al.* 1993). However, they function as discrete populations because of limited movement by adults. Analyses of otolith microchemistry suggest movement of adults is restricted to a few 100 km and tagged fish have dispersed less than 80 nm over 3 y (Moran *et al.* 1993). Hence, the current area-based management strategy for this species is appropriate and regional populations should be treated as separate stocks for fishery management purposes.

Juveniles may form schools. Adults often form schools over sand or rubble (Randall *et al* 1990). The diet includes bivalve and gastropod molluscs, and sand dollars (Kailola *et al.* 1993).

Spangled emperor spawn from October to March, with some variation in the timing of spawning among years and among regions (Moran *et al.* 1993). Maturity is reached at approximately 38 cm FL (Moran *et al.* 1993). This is similar to the legal minimum length in WA of 410 mm TL (= 367 mm FL). Spangled emperor may be a protogynous hermaphrodite. However, if a sex change occurs, it probably takes place in young fish prior to reaching an age when they are targeted by the fishery (Moran *et al.* 1993).

Spangled emperor reach a maximum length at least 86 cm TL and a maximum age of 27 y (Kailola *et al.* 1993, Moran *et al.* 1993). Natural mortality, M, is estimated to be

0.155 (Moran *et al.* 1993). The age structure of lightly exploited populations suggests variable rates of annual recruitment of spangled emperor (Moran *et al.* 1993).

2.7.1.3 SERRANIDAE (SUBFAMILY EPINEPHELINAE)

In the Indo-Pacific region, there are 11 genera and 110 species of epinepheline serranids (Leis and Carson-Ewart 2000).

Spotted cod is usually a mix of species, but mainly consists of two small serranid species; the areolate grouper, *Epinephelus areolatus*, and the twinspot grouper, *E. bilobatus*.

Areolate grouper (*Epinephelus areolatus*) are widely distributed in the Indian Ocean and Western Pacific. Its range extends from the Red Sea and Western Indian Ocean south to Natal, South Africa eastwards throughout south-east Asia to Australia, Papua New Guinea, New Caledonia and Fiji (Heemstra and Randell 1993). This species is usually found near seagrass beds or on fine sediment bottom near rocky reefs, dead corals or sponge communities in depths top at least 200 m. The maximum total length is about 40 cm. There is no published information on the biology of this species.

Twinspot grouper (*E. bilobatus*) is known only from north-western Australia (Heemstra and Randell 1993). Twinspot grouper are found on coral reefs and rocky substrates to depths of at least 120 m. The maximum total length is at least 33 cm. There is no published information on the biology of this species.

Duskytail grouper (*Epinephelus bleekeri*) are an Indo-West Pacific species occurring from the Persian Gulf to Taiwan, Indonesia and northern Australia (Heemstra and Randell 1993). Duskytail grouper occur on shallow rocky banks but is not known from well-developed coral reefs. In north-western Australia juvenile *E. bleekeri* have been found around rocky nearshore reefs, whereas the adults are found offshore in depths to at least 120 m (Newman unpublished data). The maximum total length is about 76 cm. There is no published information on the biology of this species.

Rankin cod (*Epinephelus multinotatus*) occur in the Indian Ocean, from the Persian Gulf to Madagascar and to Australia. In Australia, they are found from Shark Bay north to Darwin. The Western Australian population is considered distinct from other Indian Ocean localities based on colour pattern and scale counts (Heemstra and Randell 1993). The eggs of *Epinephelus* spp are pelagic (Leis and Carson-Ewart 2000).

Johnson *et al.* (1993) found no abrupt genetic differentiation of populations between areas sampled in the north-west region of Australia but observed a cline across the range of the study. The cline is consistent with the possibility of limited larval dispersal. Ratios of oxygen and carbon stable isotopes in the otoliths of adults suggest some limited mixing of populations between the Pilbara and Ningaloo regions and between eastern and western areas of the Pilbara (Stephenson *et al.* 2001). Overall, the data suggest limited larval dispersal and limited adult movement. Hence, the current area-based management strategy for this species is appropriate and regional populations should be treated as separate stocks for fishery management purposes.

Juveniles occur on inshore reefs. Adults typically occur in deeper waters to a depth of at least 90 m. Rankin cod may occur solitary or in small groups. Rankin cod spawn from August to October. Immature fish are rare in the fishery, but limited data suggest that 50% of females are mature at age 2.2 y and at 391 mm FL.

Rankin cod are protogynous hermaphrodites, i.e. they change sex from female to male. Males predominate among the larger individuals in the population. Sex change is estimated to have occurred in 50% of females by 626 mm LCF (Stephenson and Mant 1999). Maximum length is approximately 100 cm (Heemstra and Randell 1993). Maximum age is estimated to be at least 23 y, although the oldest age observed in the fishery is 19 y. The rate of natural mortality, M, is estimated to be 0.18 (Stephenson and Mant 1999).

2.7.2 BIOLOGY OF SIGNIFICANT NON-TARGET SPECIES

2.7.2.1 TRIGGERFISH

Family BALISTIDAE
In the Indo-Pacific region, there are 12 genera and 30 species of triggerfish (Leis and Carson-Ewart 2000). Nine species occur in Western Australia. Most species are associated with coral or rocky reefs. They are mainly solitary in habit (Allen 1997). The diet typically includes hard-shelled items such as molluscs, crabs and echinoderms, but may also include gorgonians, corals, sponges, hydroids and algae. Triggerfish lay demersal eggs that are guarded by one of the parents (Leis and Carson-Ewart 2000). They typically have an extended pelagic juvenile phase.

Triggerfish are the main discarded component of the NDSMF catch.

Starry triggerfish *(Abalistes stellatus)* is the most commonly discarded species in the fishery and comprises 1.1% of the total catch by number (Newman *et al.* 2001). Starry triggerfish have a widespread distribution throughout the Indo-west Pacific, including waters to the north and south of the NDSMF. They occur across a wide range of depths and habitat types including coral and rocky reefs and soft sediments in coastal and shelf waters (Allen 1997, Newman and Williams 2001). They attain a length of 60 cm (Fishbase 2003).

Smaller quantities of *Sufflamen fraenatus* and *Abalistes sp.* are also caught by the NDSMF. *Sufflamen fraenatus* is distributed throughout the Indo-west Pacific region, whereas the distribution of *Abalistes sp*. is not known.

Abalistes stellatus and *Sufflamen fraenatus* are also taken as by-catch by the Pilbara Fish Trap Managed Fishery and the Pilbara Fish Trawl Fishery. In the Pilbara region, triggerfish are common across the depth range of the trap and trawl fisheries, i.e. 50 to 100 m (Stephenson and Chidlow 2003).

2.7.2.2 SEA SNAKES

Family HYDROPHIIDAE

Hydrophiidae, or true sea snakes, are the only family of sea snakes with breeding populations in Australian waters. There are a total of 54 species of Hydrophiids, 32 of which are found in Australian waters. Hydrophiids are viviparous (live young) and do not return to land to breed but may migrate to inshore or estuarine waters to give birth (Ward 2000). Brood sizes are generally <10 eggs (Heatwole 1999). Fecundity increases with female body size. Little is known about the status of populations of sea snakes in Australian waters, or about the basic ecology, movement patterns, life history strategies, reproductive biology and population genetics of most species of sea snakes.

The species of sea snakes caught incidentally by fish traps are not known. However, common species in the region are known from trawl catches. A total 19 species of sea snakes are recorded as caught by fish trawling in northern Australian shelf waters (Ward 1996a). Of these, *Hydrophis ornatus, H. elegans* and *Aipysurus laevis* are the most common. A total 14 species of sea snakes are recorded as caught by prawn trawling in northern Australian shelf waters (Ward 1996b, 2000). Of these, *Hydrophis elegans, H. ornatus, Disteira major, Aipysurus eydousii* and *Lapemis hardwickii* are the most common. In the 2002 Pilbara Fish Trawl Fishery by-catch survey (Stephenson and Chidlow 2003), only *Hydrophis elegans* was caught. This species reaches 200 cm in length. In general, sea snakes are most common in shallow shelf waters (i.e. <75 m), but the distribution of each species varies with depth.

The likelihood of survival is high for sea snakes that are released after capture. A study in the Gulf of Carpentaria found that 60% of sea snakes survive capture by prawn trawling (Wassenburg *et al.* 1994). Stobutzki *et al.* (2000) reported that in commercial prawn trawl shots of duration >180 min, the mortality of sea snakes ranged from 20-59%. Sea snakes caught by trawling are usually quite active when brought on deck, suggesting that they suffer limited harm during capture. The rate of survival after capture by trapping is expected to be higher than trawling as they are carried up in the traps rather than dragged in nets and are released back into the water quicker.

3. METHODOLOGY

3.1 SCOPE

This application is based upon the ESD report for the NDSMF. The ESD report was generated by assessing "**the contribution of the NDSMF to ESD".** This assessment examined the benefits and the costs of the NDSMF across the major components of ESD (see Table 4). In doing so, it will eventually provide a report on the performance of the fishery for each of the relevant ecological, economic, social and governance issues associated with this fishery. Given the timeframes involved, only the criteria required for the "Guidelines for the Ecologically Sustainable Management of Fisheries", which cover mainly the environmental elements of ESD (outlined below in Table 4) were generated for this application.

Table 4 Main National ESD Reporting Framework Components.
Nb: Only those ESD components in **bold*** are reported in this application.

National ESD Framework – ESD COMPONENTS
Contribution to Ecological Wellbeing
Retained Species*
Non-Retained Species*
General Ecosystem*
Contribution to Human Wellbeing
Indigenous Community Issues
Community Issues
National Social and economic Issues
Ability to Achieve
Governance*
Impact of the environment on the fishery

3.2 OVERVIEW

There were four steps involved in completing the ESD report for the NDSMF. It was based upon using the National ESD Reporting Framework, which is outlined in detail in the WA ESD policy paper (Fletcher 2002) and in the "*How to Guide*" (Fletcher *et al.* 2002) located on the website (www.fisheries-esd.com):

1. The issues that needed to be addressed for the fishery were determined through an internal workshop for the fishery, which utilised information generated through the external workshop held for the Pilbara Trawl Interim Managed Fishery (due to the similar species caught within each and that the fisheries are adjacent to one another). This process was facilitated by adapting the set of "Generic ESD Component Trees" into a set of trees specific to the NDSMF.

2. A risk assessment/prioritisation process was completed that objectively determined, which of these identified issues was of sufficient significance to warrant specific management actions and hence a report on performance. The justifications for assigning low priority or low risk however were also recorded.
3. An assessment of the performance for each of the issues of sufficient risk to require specific management actions was completed using a standard set of report headings where operational objectives, indicators and performance measures, management responses etc were specified.
4. An overview assessment of the fishery was completed including an action plan for activities that will need to be undertaken to enable acceptable levels of performance to continue or, where necessary, improve the performance of the fishery.

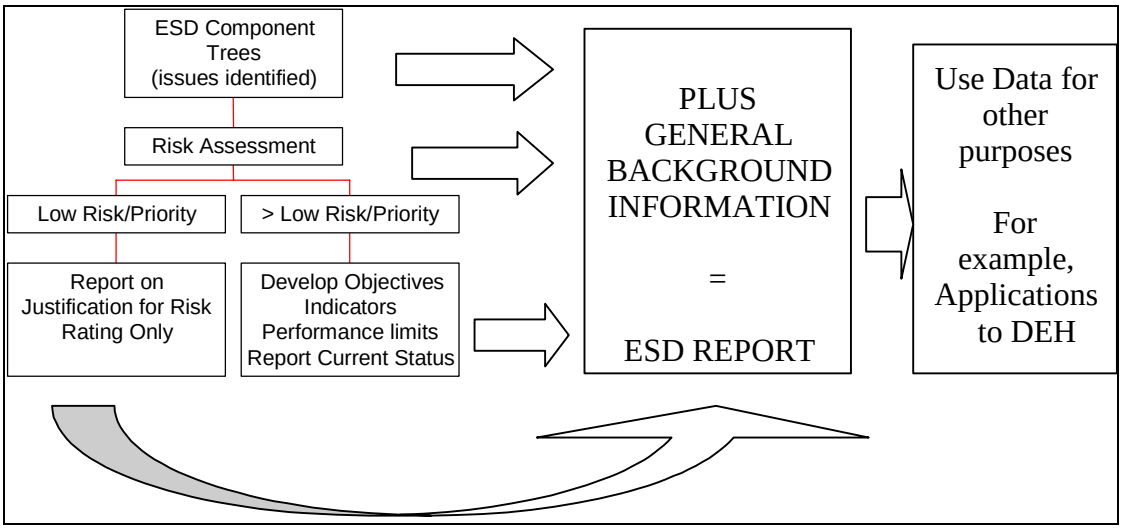


Figure 7 Summary of the ESD reporting framework processes.

3.3 ISSUE IDENTIFICATION (COMPONENT TREES)

The National ESD Reporting Framework has eight major components, which fall into three categories of the "contributions to ecological wellbeing", "contributions to human wellbeing" and the "ability to achieve the objectives" (Table 4). Each of the major components is broken down into more specific sub-components for which ultimately operational objectives can be developed.

To maximize the consistency of the approach amongst different fisheries, common issues within each of the components were identified by the SCFA and ESD reference groups within each of the major component areas and arranged into a series of "generic" component trees (See Fletcher (2002) and the www.fisheries-esd.com web site for a full description). These generic trees were used as the starting point for identifying the issues. These trees were subsequently adapted into trees specific to the NDSMF by expanding (splitting) or contracting (removing/lumping) the number of sub-components as required (see Figure 8).

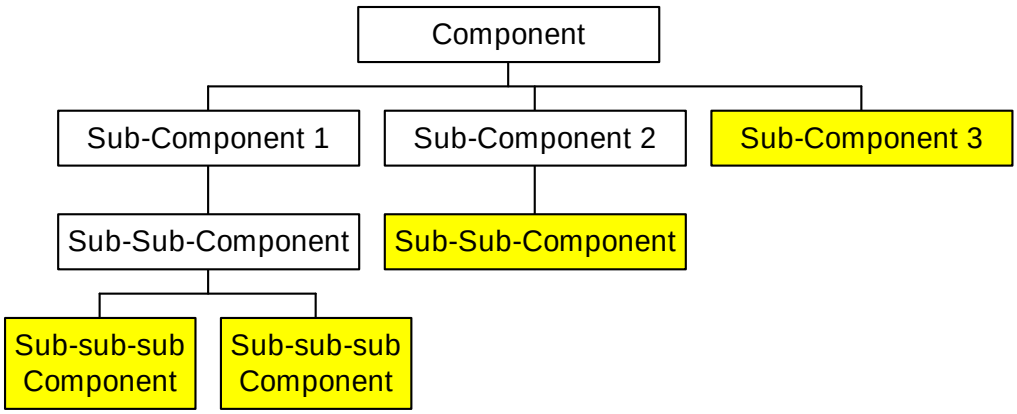


Figure 8 Example of a component tree structure.

3.4 RISK ASSESSMENT/PRIORITISATION PROCESS

After the components/issues were identified, a process to prioritise each of these needs was completed using a formal risk assessment process. The risk assessment framework that was applied at the internal workshop was consistent with the Australian Standard AS/NZS 4360:1999 Risk Management, concentrating on the risk assessment components. The general Risk Assessment process is well documented but in summary, it considers the range of potential consequences of an issue/activity and how likely those consequences are to occur. The combination of the level of consequence and the likelihood is used to produce an estimated level of risk associated with the particular hazardous event/issue in question.

Due to the similarities of this fishery with the Western Australian Pilbara Fish Trawl Interim Managed Fishery (which went through the full risk assessment process with one external workshop), only an internal workshop was held for this fishery. Consequently, the information collected through the other fisheries risk assessment process was applied and utilised to generate the application for the NDSMF.

An estimate of the consequence level for each issue was made by the group at this internal workshop. This level was from 0-5, with 0 being negligible and 5 being catastrophic/irreversible (see Appendix 2 for details of consequence tables). This assessment was based upon the combined judgments of the participants at the workshop, who collectively had considerable expertise in the areas examined.

The level of consequence was determined at the appropriate scale for the issue. Thus for target species the consequence of the NDSMF was based at the population not at the individual level. Obviously catching one fish is always catastrophic for the individual but not always for the population. Similarly, when assessing possible ecosystem impacts this was done at the level of the whole ecosystem or at least in terms of the entire extent of the habitat, not at the level of an individual patch or individuals of non-target species.

The likelihood of a consequence occurring was assigned to one of six levels from remote to likely. In doing so, again it was considered the likelihood of the

"hazardous" event (consequence) actually occurring based upon collective wisdom, which included an understanding of the scale of impact required.

From these two figures (consequence and likelihood), the overall risk value, which is the mathematical product of the consequence and likelihood levels (Risk = Consequence x Likelihood), was calculated. Finally, each issue was assigned a Risk Ranking within one of five categories: High, Moderate, Acceptable, Low and Negligible based on the risk value (see Table 5).

Table 5 Risk ranking definitions.

RISK	Rank	Likely Management Response	Reporting
Negligible	0	Nil	Short Justification Only
Low	1	None Specific	Full Justification needed
Moderate	2	Specific Management Needed	Full Performance Report
High	3	Possible increases to management activities needed	Full Performance Report
Extreme	4	Likely additional management activities needed	Full Performance Report

In general, only the issues of sufficient risk (Moderate, High & Extreme), - those that require specific management actions need to have a full performance reports completed. Nonetheless, the rationale for classifying issues as low risk or even negligible were also documented and formed part of the ESD report. This allows all stakeholders and interested parties to see why issues were accorded these ratings. This process is summarised in Figure 7 (above).

It is important to note that the Risk Assessment involves the completion of reports that contain the completed justifications for the scores generated. Thus, the scores determined within the meeting by themselves are insufficient.

3.5 COMPONENT REPORTS

Only the issues of sufficient risk or priority that require specific management actions have a full performance report completed (which form section 5 of this application). Nonetheless, the rationale for classifying issues as low risk/priority were also documented and form part of the report so that stakeholders can see where all the identified issues have finished.

For each of the lowest level sub-components (assessed as being of sufficient risk/priority to address), a detailed assessment of performance is generated. The SCFA Working Group in conjunction with the ESD Reference Group agreed upon a set of 10 standard headings each of which need to be addressed (Table 6). Added to this list a further heading, "**Rationale for Inclusion**", has been added. This specific heading allows the issues raised within the risk assessment process to be explicitly recorded. A full description of each of these headings is located in the WA ESD policy (Fletcher 2002), which is available on the WA Fisheries website.

Table 6 The National ESD reporting framework headings used in this report.

1. Rationale for Inclusion
2. Operational Objective (+ justification)
3. Indicator
4. Performance Measure (+ justification)
5. Data Requirements
6. Data Availability
7. Evaluation
8. Robustness
9. Fisheries Management Response
-Current
-Future
-Actions if Performance limit is exceeded
10. Comments and Action
11. External Drivers

The completion of these component reports was initiated after the internal workshop for the NDSMF. Progress towards completing these reports was subsequently made by a variety of Departmental staff. The draft application was sent to DEH and stakeholders including industry members and industry groups for review. This final application was generated after the review process.

4. ASSESSMENT OF THE NDSMF MANAGEMENT REGIME AGAINST THE AUSTRALIAN GOVERNMENT GUIDELINES FOR ASSESSING THE ECOLOGICALLY SUSTAINABLE MANAGEMENT OF FISHERIES

4.1 GENERAL REQUIREMENTS OF THE GUIDELINES

The management arrangements must be:

Documented, publicly available and transparent;

As per the FRMA "the Executive Director is to cause a copy of every order, regulation and management plan in force under this Act-

> *To be kept at the head office of the Department; and*
> *To be available for inspection free of charge by members of the public at that office during normal office hours."*

In addition to the legislative requirements, the current management regime, as documented in the formal set of management regulations, can be purchased by interested parties from the State Law Publisher and appear on the State Law Publishing website:
http://www.slp.wa.gov.au/statutes/subsiduary.nsf/Fisheries

Of more relevance is that any discussion papers and proposals for modifications to these management arrangements are distributed widely to stakeholder groups automatically and other interested individuals by request in hard copy format. Where appropriate, they are now also available from the Departmental web site www.fish.wa.gov.au.

Finally, once completed, the full ESD Report for the NDSMF will be made publicly available via publication and electronically from the Departmental website. This will provide increased transparency through explicitly stating objectives, indicators, performance measures, management arrangements for each issue and how the fishery is currently performing against these criteria. As a result, the Department of Fisheries is meeting this guideline.

Developed through a consultative process providing opportunity to all interested and affected parties, including the general public;

The Department of Fisheries is meeting this guideline through a variety of consultative processes. S64 and S65 of the FRMA define the requirement for procedures that must be undertaken before determining or amending all management plans. More specifically, the current management arrangements for NDSMF were developed through formal consultation with the industry.

The Department of Fisheries arranges annual meetings with industry members regarding the fishery. These meetings review data from the past seasons harvest and discuss management arrangements. In addition, for the Pilbara Fish Trawl Interim Managed Fishery (a fishery which retains similar species and lies adjacent to this fishery) a workshop was held to seek outside involvement in the development of the ESD report. This workshop included industry members, industry representative groups, non-government environmental organisations, scientific researchers and other state government agencies as well as a representative from the Australian Government Department of the Environment and Heritage. The information that was collected through the workshop in the development of the Pilbara Fish Trawl Interim Managed fisheries assessment report has been incorporated within this report. The issues identified for this fishery are similar to those affecting the NDSMF.

Historically the NDSMF MAC involved representation from indigenous, recreational and charter sectors. A new consultative mechanism has been proposed and if approved, will include all interested members of the local community by holding an annual consultative forum open to the general public.

Ensure that a range of expertise and community interest are involved in individual fishery management committees and during the stock assessment process;

The range of expertise and community interests that have been involved in the process of determining management and reviewing stock assessments is extensive. The groups that have been involved in the generation and review of the information contained in this application include:

- Department of Fisheries, WA;
- Western Australian Fishing Industry Council (WAFIC); and
- Industry Representatives.

As was previously mentioned in the above guideline, information generated from the workshop that was conducted for the Pilbara Fish Trawl Interim Managed Fishery was used in this application. The groups that were involved in the workshop, generation and review of the application for that fishery included:

- Department of Fisheries, WA;
- Department of Environment, WA;
- Department of Conservation and Land Management;
- DEH;
- The trawling industry;
- The line industry;
- WAFIC;
- The Pilbara Trap licensees;
- Recfishwest;
- Pilbara Regional Recreational Fishing Advisory Committee;
- Conservation Council of WA;
- Aboriginal Lands Trust;
- CSIRO; and

- Marine and Coastal Community Network.

As a result, the Department of Fisheries is meeting this objective. See Section 5.4.2.1 Consultation for more information.

Be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements are measured;

The Department of Fisheries is achieving this guideline through the ESD Component Reports. These reports (see Section 5 Performance Reports) contain the available objectives, indicators and performance measures for measuring and assessing the effectiveness of the management arrangements for the NDSMF. For some components, the objectives, indicators and performance measures are well established and the data are available to demonstrate levels of performance over time. For other components, the objectives, indicators and performance measures have only just been developed and/or the necessary data collection is only just being initiated. The status of this information is documented within each of the individual component reports within the National ESD Reporting Framework in Section 5.1-5.4.

Be capable of controlling the level of harvest in the fishery using input and/or output controls;

The FRMA and specifically the management plan for the fishery provide the legislative ability to control the level of harvest within this fishery. This is achieved through the use of a sophisticated and effective combination of input control measures based upon individually transferable effort allocations, area closures and gear restrictions. As a result, the Department of Fisheries is meeting this guideline. See Sections 5.4.1.1 and 5.4.1.2 for more information.

Contain the means of enforcing critical aspects of the management arrangements;

The Department of Fisheries employs operational staff to ensure compliance with the critical aspects of the management arrangements for the NDSMF. This includes at-sea patrols to ensure restrictions on gear and other operational rules are being adhered as well as inspections of catches at the point of landing and processing factories. In 1998, VMS was introduced into the fishery.

If a breach is detected with VMS it is reported to the compliance officers and management officers, who then investigate the offence. If it is warranted, a prosecution brief is formed, if only a breach of a minor provision, then a warning is given.

For the NDSMF, 15 offences were detected in 2001 regarding the ALC not reporting, and one offence was detected for exceeding fishing units. In 2002, two offences were detected regarding the ALC not reporting, and no offences have been detected so far in 2003. The lack of ALC reporting was considered to be only a very minor offence. The majority of these reports resulted from the licensees learning how to use the ALC system, and many experienced battery problems. In addition, the management plan at the time resulted in licensees having to nominate every trip. This was often very

confusing and time consuming, and as such the management plan has now been amended. No prosecutions were warranted regarding any of the above offences.

Given the value of licences, fishers themselves are also a source of information on illegal activities. A full summary of these compliance activities and their effectiveness is provided in Section 5.4.1.3. Through the combination of having employed operational staff as well as a good dialog with the fishers, the Department is meeting this guideline.

Provide for the periodic review of the performance of the fishery management arrangements and the management strategies, objectives and criteria;

The Department is meeting this guideline through the annual "State of the Fisheries" report and the five-year review of this document. There is an annual review of the performance of the major aspects for the fishery through the completion of the "State of the Fisheries" report. This is updated and published each year including periodic reviews by the Office of the Auditor General (OAG). It forms an essential supplement to the Department's Annual Report to the WA Parliament with the latest version located on the Departmental website www.fish.wa.gov.au. See Section 5.4.3.1 Assessments and Reviews for more information.

The ESD Component Reports contain a comprehensive performance evaluation of the fishery based upon the framework described in the ESD policy (Fletcher, 2002). The reports include the development of objectives, indicators and performance measures for all aspects of the fishery and status reports for those components that are not subject to annual assessment. The Department intends to complete and review externally this full assessment, including examination of the validity of the objectives and performance measures every five years.

Be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates; and

The Department of Fisheries is meeting this guideline through the development of this report. Capabilities for the assessment, monitoring and avoidance, remedying or mitigating any adverse impacts on the wider marine ecosystem are documented in the "General Environment" Section 5.3. This has been completed through a formal risk assessment analysis of the issues and, where necessary, the development of suitable monitoring programs.

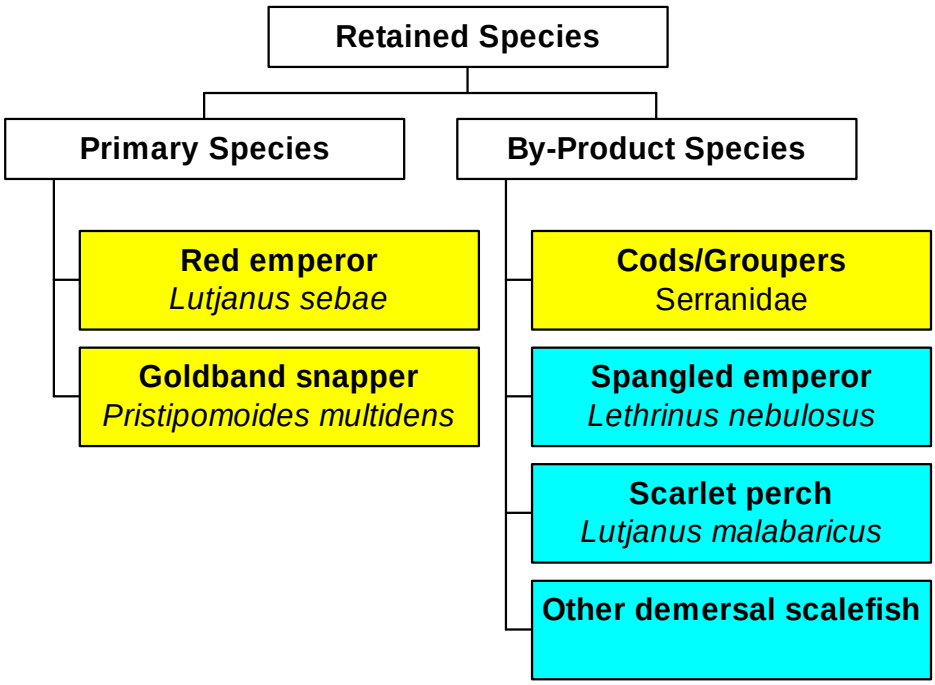
Require compliance with relevant threat abatement plans, recovery plans, the National Policy on Fisheries Bycatch, and bycatch action strategies developed under that policy.

The management regime complies with all relevant threat abatement plans for species where there is an interaction and therefore is meeting this guideline. In addition, the fishery also adheres to the *International Convention for the Prevention of Pollution from Ships* (MARPOL) and the *United Nations Convention on the Law of the Sea* (UNCLOS). Details are provided in the "non-retained species" section of the ESD report (Section 5.2).

PRINCIPLE 1 OF THE COMMONWEALTH GUIDELINES

OBJECTIVE 1. MAINTAIN VIABLE STOCK LEVEL OF TARGET SPECIES

The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.



The component tree detailing the retained species for the fishery is shown above. Each of the primary species and by-product species retained by the fishery has been assessed with appropriately detailed reports having been compiled on each of them. A **Moderate Risk** rating was given to the two primary species in the fishery, red emperor and Goldband snapper thereby requiring full reports (Section 5.1.1.1). For the by-product species, Cods/Groupers were also given a **Moderate Risk** rating resulting in a full report being developed (Section 5.1.2.1). Spangled emperor and Scarlet perch were both classified as **Low Risk** (5.1.2.2 and 5.1.2.3). The larger "other demersal scalefish" group of by-product species was given a **Negligible Risk** the justification for which is provided in section 5.1.2.4.

An assessment of the current performance for the NDSMF demonstrates that all of the fish species are being maintained at acceptable levels to maintain ecologically viable stock levels. Thus, in summary:

- The spawning stocks of the two primary species in the fishery are managed through three indicators; spawning biomass of virgin level for red emperor and goldband snapper, catch ratio and catch rate ratio.

- From 1999 to 2002 red emperor and goldband snapper have been within the acceptable performance limits for the species. In addition, the catch and catch rate indicators were consistent with spawning biomass assessments of each species.
- From 1999 to 2002 serranids (cods and groupers) were within the acceptable performance limits for the species group. However, a new system of catch reporting will be implemented by January 2005 whereby selected serranid catches will be reported by species which will yield species specific estimates of serranid catches on a per trip basis.
- The stocks of scarlet perch and spangled emperor are monitored through catch level and catch rate on an annual basis. The current level of assessment is considered adequate to manage the stock at a sustainable level, given the effort controls in place and the fact that no other fishing sector catches significant quantities of these species in the Kimberley region.
- The level of capture of other demersal scalefish by this fishery is relatively small (35 tonnes spread across at least 30 taxa of scalefish). Only three species groups had an annual catch of greater than 2 tonnes the remaining species were less than 2 tonnes per year and therefore this fishery would not have a significant impact on their dynamics.

Consequently, this fishery is meeting the requirement of Principle 1. The information relevant to this principle for these species is detailed below.

Information Requirements

1.1.1 There is a reliable information collection system in place appropriate to the scale of the fishery. The level of data collection should be based upon an appropriate mix of fishery independent and dependent research and monitoring.

Data are collected through a combination of fishery independent and fishery dependent systems to monitor the stock abundance within the fished areas.

Section 2.6.1 discussed the recent and current research projects, which have been undertaken for this region. Baseline research data on growth rates, age structure, reproductive biology and yield analyses, together with information gathered from the fishery, have been used to assess the status of the fish stocks that contribute to this fishery, principally red emperor and goldband snapper. This research work was undertaken in an FRDC-funded research project from 1997 to 2000. This information is now being incorporated into age-based stock assessment models to assess the long-term sustainable yield of the fishery, in particular the two key stocks. Ongoing monitoring of this fishery is being undertaken using both CAES data and VMS records.

The specific data requirements needed to assess performance for each of the relevant objectives are detailed in the relevant sections of the ESD reports in Section 5.1 Retained Species. Listed below are the current data collection systems in place.

Monitoring Program	Information Collected	Robustness
CAES for trap and line	Monthly or trip summaries	Moderate

sectors of the fishery	of trap & line catch (by species) and effort (days, number of traps). Monthly summaries available since the 1985; trip summaries will be available from January 2005.	
Age structure study	Determined the age structure and biological characteristics for red emperor and goldband snapper across the fishery. Collections taken from 1997–2000. Collections to be undertaken in future years across the fishery for stock assessment purposes.	High
Recreational catch surveys	Occasional recreational catch surveys. Last survey of Pilbara and West Kimberley region was conducted in 1999-2000. This survey extended only to Broome. No survey has been undertaken in the east Kimberley region.	Moderate
Compulsory logbooks	Required for the charter boat fishery. Trip summaries of catch and effort. Available since 2001.	Moderate
Observer surveys of catch composition	Surveys previously conducted in 1998-99. To be conducted every 2 to 3 years.	
Vessel Monitoring System	Monitors trap fishing location and effort since 1998.	High

Assessment

1.1.3 The distribution and spatial structure of the stock(s) has been established and factored into management responses.

The distribution for the two target species in this fishery is well documented. Section 2.7 of this report covers the biology of each species including their distributions. The current data for all these species suggests limited larval dispersal and limited adult movement within populations of each species thereby supporting the current area-based management strategy for this species in the fishery as well as regional populations being treated as separate stocks for fishery management purposes.

1.1.4 There are reliable estimate of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stocks. These estimates have been factored into stock assessments and target species catch levels.

Within the list of monitoring programs outlined above for the NDSMF data covering each of the sources of removal are outlined. While there is no indigenous fishery, landings by indigenous fishers are considered to take place in Zone 1. The magnitude of the indigenous take is not known although thought to be minimal. Since the formal introductions of management in 1998 no other commercial sectors are permitted to take demersal scalefish. Gear restrictions in other fisheries prevent the possibility of large amounts of demersal scalefish to be caught and landed. As a result negligible amounts of catch are reported by overlapping commercial sectors. There is a recreational fishery for these species caught by the NDSMF. Catches by all methods (trap and line) and sectors (commercial, recreational and charter) are included in the stock assessments of each target species, which include age-structured models of some indicator species.

Sector	Catch Data Collected	Frequency
Commercial	Fishers monthly or trip summaries (CAES). Catch, effort and location for the fishery.	Monthly or trip based during the season.
Charter Boat	Compulsory logbook with trip summaries of catch and effort.	Annually since 2001.
Recreational	Catch Surveys.	Occasionally; last survey done in 1999-2000.
Indigenous	No data available.	No data available.
Illegal	Estimated from compliance data.	Annually.

1.1.2 There is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and/or reproductive capacity. Review should take place at regular intervals but at least every three years.

1.1.5 There is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested.

The history for NDSMF (around 15 years) combined with the extensive catch and effort data and research that has been collected for this fishery has enabled a very reliable estimate of the sustainable yield to be calculated for the fishery. These have been translated into the indicators and performance measures used to manage and ensure the sustainability of the fishery.

The management for the fishery is adaptive and tailored to the major target species in the fishery. As previously mentioned, there are three indicators used to monitor the two target species for the fishery. These are reviewed annually and if triggered action is taken whether it be the review of the data or reduction in effort. In addition, this fishery is managed through zones therefore taking into account the distribution and allows the management to be tailored to the particular species or area.

The status of the breeding stocks and intra-annual variation for the two primary target species in the fishery are assessed and evaluated every year using a synthesis of information obtained from the fishery. A review of the performance for this fishery is conducted at least once a year. This review includes an assessment of the total catch by the fishery, the level of effort to take the catch, the distribution of effort, both spatially and temporally across the season and the calculated catch rates. These assessments are reported annually within the State of the Fisheries Report. No fishery independent data is available to determine the status of the breeding stock.

Using the indicators as described above in 1.1.2, 1.1.3 and 1.1.6, both of the primary species have been within the acceptable performance limits from 1999 to 2002 (see below – no indicators have triggered a review). Catch and catch rate indicators were consistent with spawning biomass assessments of each species (Table 4, Figure 9).

The trap catch rate of red emperor was relatively stable from 1998 to 2002, suggesting adequate spawning biomass levels (Figure 9). This suggestion was consistent with spawning biomass estimates. In 2002, the age-structured stock assessment model suggested that the spawning biomass of red emperor was approximately 54%. This level of spawning biomass is above the recommended level of 40% of the virgin spawning biomass and therefore the current breeding stock and catch levels were considered adequate.

The trap catch rate of goldband snapper increased after 1998 and also became more variable (Figure 9). These variations were assumed to reflect changes in efficiency by trap fishers as they attempted to maximise their return from each day spent in the fishery (as fishing days are limited). In 2002, the total spawning biomass of goldband snapper was estimated at approximately 41% of the virgin (1980) level. The estimated lower limit of the 95% confidence interval for the level of spawning stock biomass for goldband snapper was below the target level of 40% of the virgin spawning biomass, but was above the limit level of 30% of the virgin spawning biomass. Therefore, the current breeding stock and catch levels were considered adequate.

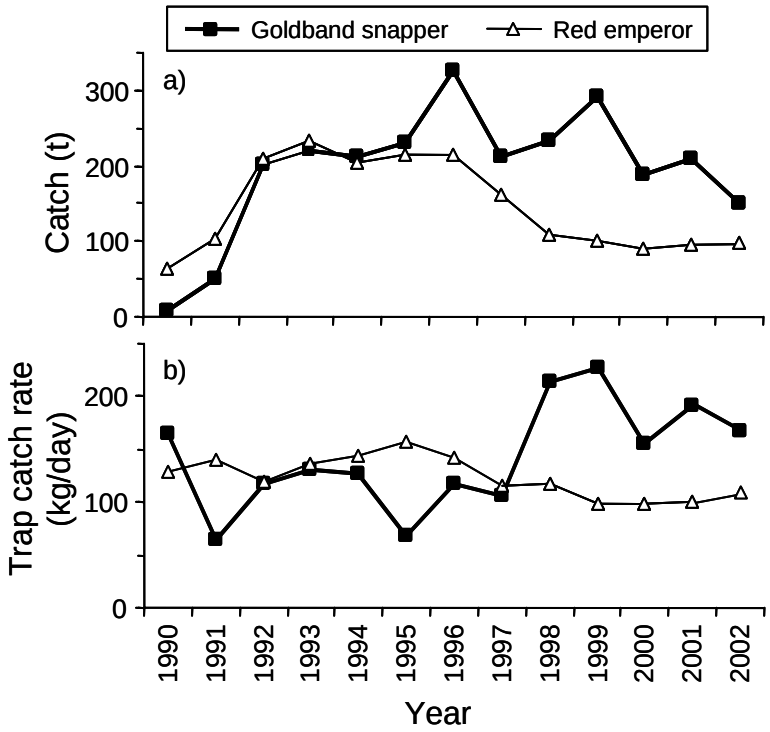


Figure 9 Annual a) catch levels and b) catch rates, of red emperor and goldband snapper in the NDSMF from 1990-2002.

Management Responses

1.1.6 There are reference points (target and/or limit) that trigger management actions including a biological bottom line and/or a catch or effort upper limit beyond which the stock should not be taken.

The Department of Fisheries manages the take for the two primary species through the spawning biomass of red emperor and goldband snapper, annual trap catch and catch rate of each species. Red emperor and goldband snapper are used as indicator species because they are the dominant target species (noting that resources are not available to do all species). It is assumed that management measures that protect stocks of these indicator species will afford similar levels of protection to the other long-lived species that are caught by this fishery. The validity of this assumption and the general success of management measures are assessed by monitoring the catch and catch rates for each major long-lived primary species. For both of the primary fish species caught, if the performance limits are exceeded the Department of Fisheries has a series of management actions which it could be adopted prior to the start of the next season or within a season depending on the situation.

There are a series of reference limits for each indicator used in this fishery for the two primary species caught. These are:

1) Spawning biomass of red emperor and goldband snapper should remain above a minimum limit of 40% of the virgin spawning biomass.

Evidence from other fisheries suggests that a limit of 30%, with a target of 40%, of the virgin biomass is appropriate to ensure sustainability of the fishery (Mace 1994; Mace and Sissenwine 1993; Die and Caddy 1997; Gabriel and Mace 1999). The spawning biomass of red emperor and Goldband snapper in 1980 are assumed to represent the virgin level.

2) Annual trap catch of the two target species should not increase > 20% above the average annual catch of the previous 4 years.
3) Annual trap catch rate of the two target species should not decrease in two consecutive years.

Table 7 below shows the recent values for the indicator species in the fishery.

	a) Spawning	**b) Catch ratio**				**c) Catch rate ratio**			
Species	**biomass in 2002**	**99**	**00**	**01**	**02**	**99**	**00**	**01**	**02**
Red emperor	54%	0.58	0.62	0.82	1.02	0.84	1.01	1.03	1.08
Goldband snapper	41%	1.16	0.71	0.90	0.66	1.07	0.69	1.23	0.87

Table 7 Recent indicators for red emperor and goldband snapper.
a) spawning biomass as a percentage of the 1980 virgin level; b) ratio of the total annual catch to the average total annual catch of the previous 4 years; c) ratio of the annual trap catch rate to the catch rate in the preceding year. (indicators did not trigger a review in any year).

1.1.7 There are management strategies in place capable of controlling the level of take.

A full description of the management arrangements is located in the *Northern Demersal Scalefish Fishery Management Plan 2000.* The formal *Northern Demersal Scalefish Fishery Management Plan 2000* commenced on 1 January 2001 superseding the *Northern Demersal Scalefish Fishery Interim Management Plan 1997.* A discussion of the main regulations and their justifications are located in Section 2.

The fishery is managed by input controls including individually transferable effort allocations, gear restrictions and area closures. The total effort allocation, based on a nominal total sustainable catch (TSC), is allocated on an annual basis.

A number of amendments were made to the management plan in 2001. These included an increase in the total number of units in Zone 2 of the fishery and the insertion of a provision in the management plan which afforded natural justice to the sole remaining objector pending from the old interim management plan. The unit consumption monitoring mechanism was also altered to increase flexibility to the Zone 2 licensees, and provisions were inserted that allow Zone 2 licensees to pay their fees by instalments.

Significant effort is put into ensuring adequate compliance with these regulations. This includes at-sea and aerial patrols to ensure closed season and areas, as well as operational rules are being adhered to. The use of VMS (since 1998) on the vessels has helped the Department of Fisheries monitor vessel location and speed thus

increasing compliance within closures while decreasing random patrol activities (full details on Compliance activities and their effectiveness are located in Section 5.4.1.3).

1.1.8 Fishing is conducted in a manner that does not threaten stocks of by-product species.

A full description of the information available and the levels of risk of impact on the by-product species group by the NDSMF are located in section 5.1.2. Four groups of by-product species were identified for this fishery only cods/groupers was given a high enough risk rating (**Moderate**) to warrant a full report. Scarlet perch and spangled emperor were given a **Low Risk** rating and other demersal scalefish received a **Negligible Risk** rating.

Cods/Groupers

A range of cod species (Family Serranidae: Subfamily Epinephelinae) is targeted by the NDSMF as they fetch high prices. Serranid catches in the fishery have not consistently been reported on a species-specific basis. However, recent fishery-independent surveys indicate that the serranid catch consists of at least 16 species. In 2002, the total serranid catch was 49 tonnes and so individual catches of each species are likely to be relatively low. Since quantities of serranids caught are not reported by species it is only possible to monitor the total serranid catch level and catch rate.

Table 8 Recent indicators for serranid species.
a) ratio of the annual total catch to the average annual total catch of the previous 4 years; b) ratio of the annual trap catch rate to the catch rate in the preceding year. Years in which these indicators would have triggered a review are shown.

	a) Catch ratio				**b) Catch rate ratio**				**Review?**			
Species	**99**	**00**	**01**	**02**	**99**	**00**	**01**	**02**	**99**	**00**	**01**	**02**
Serranids	0.53	0.61	0.85	0.60	0.65	1.10	1.09	0.66	no	no	no	no

Using the indicators, serranids were within the acceptable performance limits from 1999 to 2002 (Table 8). The total catch of serranids declined from 1996 to 2002, primarily as a result of fluctuations in the amount of effort utilised. Over this period, the catch rate of serranids remained relatively stable. Since the introduction of formal management arrangements in the fishery in 1998, the stable catch level and catch rates of serranids suggests that spawning biomass levels may be adequate. This species group will be more closely monitored in future years. More specifically, improvements in the catch reporting system and data from observer surveys of the NDSMF catch will yield species-specific estimates of serranid catches on a per trip basis.

Scarlet Perch

This species is generally not targeted by this fishery but is retained as by-products when the fishery is targeting other species. From 1997 to 2001, the annual catch of scarlet perch by the fishery was <8% of the total annual catch of the fishery, and ranged from 14 to 36 tonnes in this period (Figure 10). However, in 2002 the reported

catch of scarlet perch increased from 36 tonnes to approximately 61 tonnes. The catch in 2002 of scarlet perch represented 14% of the total scalefish catch in the NDSMF. It is not known whether this reflected greater availability or abundance. Additionally, shifts in targeting practice have not been reported. Nonetheless the Department of Fisheries will continue to monitor the catch of scarlet perch and if the total catch of scarlet perch increases on average to greater than 20% of the total catch it will then be considered a target species.

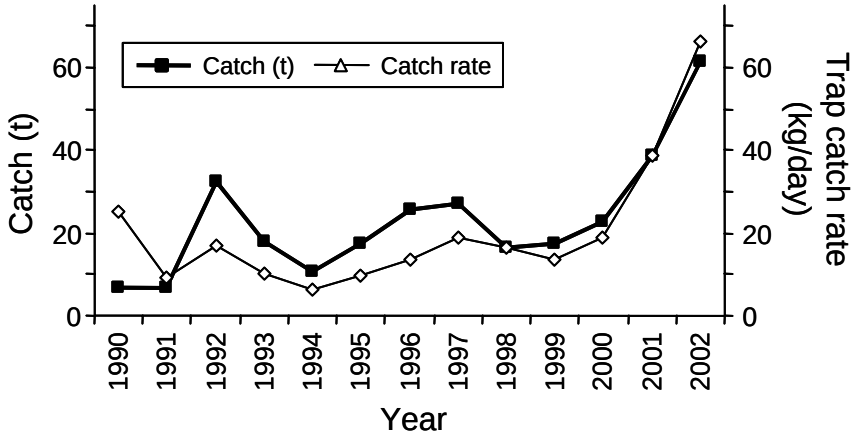


Figure 10 Annual total catch level and trap catch rate of scarlet perch in the NDSMF from 1990 to 2002.

The NDSMF catches of scarlet perch in the Kimberley region are considerably lower than the combined commercial catch by trawl, trap and line fisheries in the adjacent Pilbara region, where approximately 100 tonnes of scarlet perch is caught annually. In the Pilbara, catch rates have been stable since 1994, suggesting that catch levels in the Kimberley are likely to be sustainable.

The current level of assessment is considered adequate to manage the stock at a sustainable level, given the effort controls that are in place and the fact that no other fishing sector catches significant quantities of this species in the Kimberley region. The results of stock assessments will be reported in the annual status report for the NDSMF.

Spangled Emperor

The annual catch of this species by the NDSMF is relatively low. From 1997 to 2001, the annual catch of spangled emperor by the NDSMF was between 5 and 7% of the total annual catch of the fishery, and ranged from 25 to 37 t (Figure 11). In 2002, the reported catch of spangled emperor was 34 t, which represented 8% of the total scalefish catch in the NDSMF. The catch rate of spangled emperor declined from 1990 to 1992, but was relatively stable from 1992 to 2002. The catch rate trend was increasing in recent years.

Catches of spangled emperor by the NDSMF in the Kimberley region are lower than the combined catch by trawl, trap and line fisheries in the adjacent Pilbara region, where approximately 70 t of spangled emperor is caught annually. Catch levels and catch rates in the Pilbara have been gradually declining since 1998, suggesting that

catches are slightly above sustainable levels. Current catches in the Kimberley are not likely to be at maximum sustainable levels but will be monitored closely.

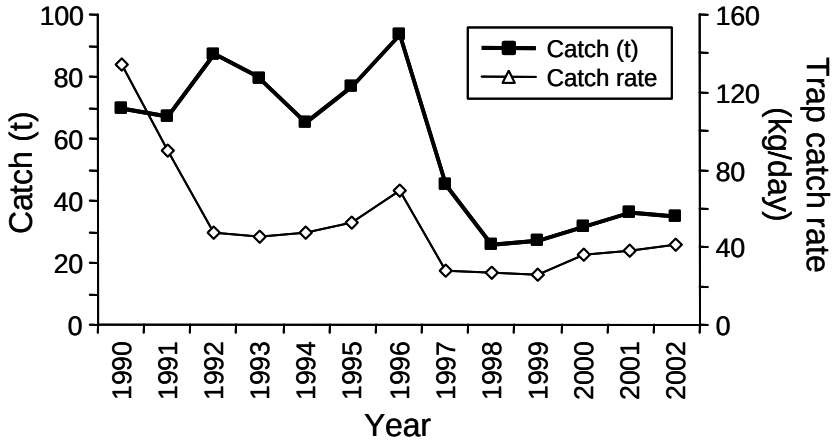


Figure 11 Annual total catch level and trap catch rate of spangled emperor in the NDSMF from 1990 to 2002.

The current level of assessment is considered adequate to manage the stock at a sustainable level, given the effort controls that are in place and the fact that other fishing sector catches only minor quantities of this species in the Kimberley region. The results of stock assessments will be reported in the annual status report for the NDSMF.

Other Demersal Scalefish

In 2002, the reported catch of 'other scalefish' (i.e. species caught in addition to those listed above as primary target species and key by-product species) was 35 tonnes, which represented 8% of the total scalefish catch by the NDSMF. In 2002, the annual catches of only 3 of these species groups, sea bream (*Gymnocranius spp*.), longnose emperor (*Lethrinus olivaceus*) and red snapper (*Lutjanus erythropterus*), were greater than 2 t (Table 12 in Section 5.1.2.4). These species are all widely distributed throughout the Indo-west Pacific (Allen 1997). Therefore, annual catches of less than 10 t are unlikely to have any substantial impact on the relative spawning stocks of each species.

The remaining species that contribute to the catch of 'other scalefish' are caught in relatively small quantities (i.e. <2 t per year). Each of these species has a broad distribution and so the low catches by the NDSMF are expected to have a negligible impact on the spawning stocks of each species. Some of these scalefish species are taken in moderate quantities by other Western Australian fisheries (Table 12 in Section 5.1.2.4), although they are each taken in only minor or negligible quantities in the Kimberley region.

Although the Department does not undertake annual stock assessments of 'other demersal scalefish' it does monitor annual catch levels of each species using CAES data and data from observer surveys of the NDSMF. Any significant increase in catch levels will be reported in the annual status report for the NDSMF. In addition any

significant increase in catch levels of other demersal scalefish will be closely scrutinised to determine if any management response is required.

1.1.9 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Management actions taken within this fishery over the past 15 years has been very effective and there is, therefore, a very high probability that they will continue to achieve the main objective of maintaining the spawning stocks for the major target species caught, which in turn is likely to maintain the stocks of other long-lived species taken by the fishery.

Since the commencement of the interim management arrangements in 1997 and the formal arrangements in 2000, the Department has implemented further management arrangements to control the level of harvest within the fishery and to maintain the stock levels. These have included:

- An increase in the total number of units in Zone 2 of the fishery.
- Insertion of a provision in the plan, which afforded natural justice to the sole remaining objector pending from the old interim management plan.
- The unit consumption monitoring mechanism was altered to increase flexibility to the Zone 2 licences.

The management responses that are currently in place for the fishery are very detailed, both for current actions, future actions and if the performance limits are reached/approached (see Section 5.1.1.1 and 5.1.2.1).

The use of indicators and performance measures for the major target species allow the Department to respond to changes outside the normal variations thus ensuring the maintenance of the spawning stock for all species. If the probability of these performance limits being reached increases, additional management arrangements can be implemented.

If a review suggested that performance limits were exceeded because of a decline in spawning biomass, the management response will be an adjustment of the effort allocations in the fishery.

OBJECTIVE 2. RECOVERY OF STOCKS

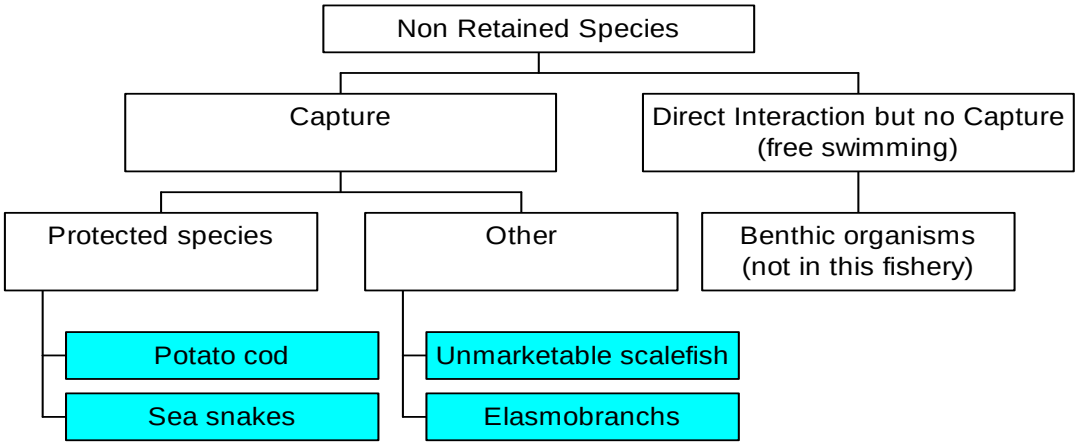
Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.

No stocks in this fishery are considered to be below their defined levels.

PRINCIPLE 2 OF THE COMMONWEALTH GUIDELINES

OBJECTIVE 1. BYCATCH

The fishery is conducted in a manner that does not threaten bycatch species.



Four non-retained (bycatch) species/groups were identified in this fishery and are shown above in the component tree. The impacts of the fishery were identified as having a **Negligible Risk** to all four species/groups of species. As a result of the risk ratings accorded to these issues only a brief justification was required (Section 5.2). The threatened and protected species (e.g. potato cod and seasnakes) are covered in Objective 2.2; the remaining non-retained species are covered under objective 2.1.

The minimal bycatch issues associated with this fishery and the negligible risks involved demonstrates that the performance of the fishery is not threatening any bycatch species, including protected and threatened species. Consequently, it is meeting both objectives 1 and 2 of Principle 2.

Information Requirements

2.1.1 Reliable information, appropriate to the scale of the fishery, is collected on the composition and abundance of bycatch.

There is limited information on the nature and volume of bycatch species for the NDSMF because fishers do not record discards but data from surveys aboard industry

vessels in the Kimberley region have been used to provide an indication of the likely species composition and quantity. Additionally, the observations of the 2002 Pilbara Fish Trawl Fishery Bycatch Survey also provides indication of the likely species composition in this fishery because the trawl fishery operates adjacent to the NDSMF although a different fishing method is used. Furthermore, there are the anecdotal reports from fishers to support the information collected in both of these adjacent fisheries (NDSMF and Pilbara Trawl fishery) in respect to bycatch. All this information has been used in the development of this report.

Assessments

2.1.2 There is a risk analysis of the bycatch with respect to its vulnerability to fishing.

A formal risk assessment for the identified non-retained/bycatch species was completed (see Section 3.2 for details on how this was completed). This assessment concluded that the NDSMF was of negligible risk to unmarketable scalefish and elasmobranchs. The bycatch species catch data is detailed in Newman *et al.* 2001. Table 13 in Section 5.2.2.1 has been adapted from this study and shows the composition of bycatch during the bycatch survey.

Unmarketable scalefish - Summary
ERA Risk Rating (C0 L6 NEGLIGIBLE)

Several species of scalefish are caught in small quantities and returned to the water by the fishery because they are of no commercial value. Data from surveys aboard industry vessels suggest that the annual discards by the NDSMF are equivalent to approximately 1.3% (by numbers) of the total retained catch (Newman *et al.* 2001). Therefore, assuming that the proportion of the non-retained catch by numbers is similar to the proportion of the non-retained catch by weight and is consistent through time, then the estimated weight of discards was approximately 6.4 t in 2001 and 5.6 t in 2002.

Starry triggerfish (*Abalistes stellaris*) is the most common non-retained species in the NDSMF and represents 85% of the non-retained catch (Newman *et al.* 2001). The level of catch and hence discards of starry triggerfish by the NDSMF fleet in 2001 and 2002 was estimated to be approximately 5.4 t and 4.8 t (85% of catch estimated above).

The remainder of the non-retained catch (i.e. excluding starry triggerfish) was estimated to have been approximately 1.0 t in 2001 and 0.8 t in 2002. These total quantities include several species, and as a result catches of individual species are very low. Data from surveys aboard industry vessels suggest that the remainder of discards mainly comprise bannerfish (Chaetodontidae), squirrelfish (Holocentridae) and lionfish (Scorpaenidae). The level of by-catch of trap and line fishing vessels in the NDSMF fleet will be recorded as part of any future observer surveys of the NDSMF. There is presently no data available on the survivability of bycatch species in the NDSMF. Any significant change in the species and/or level of bycatch in the NDSMF will be reported in the annual status report for the fishery. For more information see Section 5.2.2.1.

Elasmobranchs - Summary
ERA Risk Rating (C0 L6 NEGLIGIBLE)

Fishers occasionally land elasmobranchs i.e. sharks and rays. These species are vulnerable to overfishing because they have a highly K-selected life history (i.e. long-lived, slow to reproduce). However, in 2001 and 2002, no elasmobranch species were reported on statutory monthly returns. The species composition of any retained or discarded elasmobranch catch in the NDSMF is unknown. Discussions with fishers indicate that sawfish are not part of the landed catch in this fishery (S. Newman, pers. comm.). The impact of the NDSMF on each elasmobranch species is also likely to be negligible because the area of the fishery in which each species is vulnerable to capture by trapping is small relative to the total distribution of each species. Furthermore, the NDSMF management plan imposes a trip limit on the retained catch of shark. Under section 27 of the *Northern Demersal Scalefish Fishery Management Plan 2000*, a maximum of 2 whole sharks are permitted per trip. In addition shark finning is banned under statewide regulations. For more information see Section 5.2.2.2.

Management Responses

2.1.3 Measures are in place to avoid capture and mortality of bycatch species unless it is determined that the level is sustainable (except in relation to endangered, threatened or protected species). Steps must be taken to develop suitable technology if none is available.

2.1.4 An indicator group of bycatch species is monitored.

The combination of the low level of effort, area closures and the relatively small area in which the NDSMF operates, greatly reduces the impacts on all of these affected species.

Due to the minimal risks associated with this group of non-retained species, it is not necessary to monitor or implement further management for any of these species in the longer term.

2.1.5 There are decision rules that trigger additional management measures when there are significant perturbation in the indicator species numbers.

The risks associated with this group of species will be reassessed at the next major review of this fishery. This will occur within five years, as a requirement of the WA ESD policy.

2.1.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Given the relatively low levels of interactions for the NDSMF with non-retained species, it is more than likely that the current situation of having only negligible impacts on these species will continue. Nonetheless, as monitoring data becomes more available, the suitability of the current performance limits may need to be

reviewed. If the current performance limits are inappropriate and/or the level of interactions increases, appropriate alterations to the practices will be taken.

OBJECTIVE 2. PROTECTED/LISTED SPECIES

The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids and minimises impacts on threatened ecological communities.

Assessments

2.2.2 There is an assessment of the impact of the fishery on endangered, threatened or protected species.

A formal risk assessment for the identified non-retained/bycatch species was completed (see Section 5.2 for details on how this was completed). This assessment concluded that the NDSMF was of **Negligible Risk** to potato cod and seasnakes.

Potato Cod- Summary
ERA Risk Rating (C0 L6 NEGLIGIBLE)

Potato cod (*Epinephelus tukula*) are rarely caught in the tropical demersal finfish fisheries of WA, and hence are rarely caught by fishers using fish traps or lines in the NDSMF. Potato cod have been a totally protected fish species in Western Australia since 1 July 1992 (FRMR).

Potato cod occur throughout the Indo-west Pacific, including the NDSMF, but are relatively uncommon and are not caught in sufficient quantities to be of commercial fisheries significance. However, large individuals may command high prices on the live food fish market in Hong Kong and China. Various biological characteristics (e.g. slow growth, late maturity, extended longevity, low natural mortality, inquisitive nature/ease of capture) make potato cod vulnerable to over-exploitation.

The level of incidental capture of potato cod by fishers in the NDSMF is unknown, but anecdotal information indicates it is a rare occurrence. All potato cod caught by fish trapping are discarded. Released fish are unlikely to survive if caught from depths greater than 40 m. As part of the revised catch reporting system for the fishery, compulsory reporting of any interactions with protected species will be required from all fishers. Catch levels (if any) will be subsequently reported in the annual status report of the fishery. For further information see Section 5.2.1.1.

Sea snakes - Summary
ERA Risk Rating (C0 L6 NEGLIGIBLE)

Sea snakes are potentially vulnerable to overfishing because they grow and reproduce slowly. However, the impact of the fishery on sea snake populations is likely to be minimal because sea snakes are only occasionally caught by the fishery and are released alive (S. Newman, pers. obs.). The composition of the sea snake catch is unknown but is likely to include *Hydrophis elegans*. *H. elegans* is one of the most common species of sea snakes caught by the Pilbara Fish Trawl Interim Managed Fishery (Stephenson and Chidlow 2003) and prawn trawl fisheries in northern

Australia. The species occurs across northern Australia and New Guinea (Heatwole 1999).

No estimates of population size are available for local sea snakes but many species are commonly observed across northern Australia and none are listed as vulnerable. Apart from the impact of fishing, there are probably few other threats to sea snake populations. The likelihood of survival is high for sea snakes that are released after capture. A study in the Gulf of Carpentaria found that 60% of sea snakes survive capture by prawn trawling (Wassenburg *et al.* 1994). Stobutzki *et al.* (2000) reported that in commercial prawn trawl shots of duration >180 min, the mortality of sea snakes ranged from 20-59%. Sea snakes caught by trawling are usually quite active when brought on deck, suggesting that they suffer limited harm during capture. The rate of survival after capture by trapping is expected to be higher than trawling. The full rationale for the negligible risk rating for this issue is documented in Section 5.2.1.2.

2.2.3 There is an assessment of the impact of the fishery on threatened ecological communities.

There are no threatened ecological communities associated with these fisheries.

Management Responses

2.2.4 There are measures in place to avoid capture and/or mortality of endangered, threatened or protected species.

Although the impact on potato cod and sea snakes by the fishery is probably minimal, the performance of the fishery in regard to bycatch of these two species could be improved. As a protected species in Australia, all interactions with sea snakes by the fishery are required to be reported. Catches/discards are not currently reported. This report will recommend that skippers record details of the catch, release and mortality of protected species such as sea snakes. Incidental captures of protected species will be reported in the annual status for the fishery. In addition, as part of the revised reporting system, compulsory reporting of any interactions with protected species will be required from all fishers. Catch levels (if any) will be subsequently reported in the annual status report for the NDSMF.

2.2.5 There are measures in place to avoid impact on threatened ecological communities.

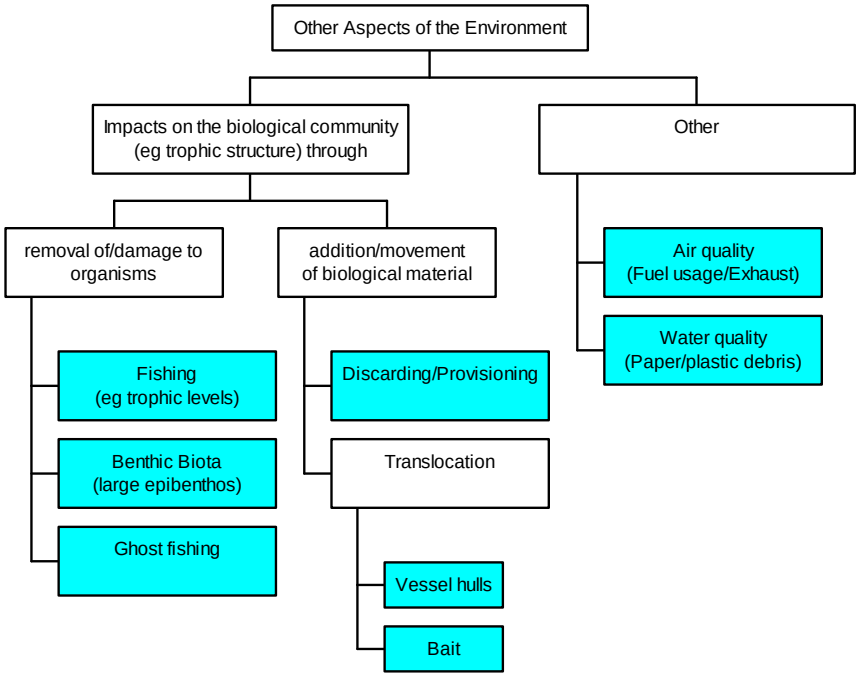
Not applicable.

2.2.6 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

Given the relatively low levels of interactions for the NDSMF with protected species, it is more than likely that the current situation of having only negligible impacts on these species will continue. Nonetheless, as monitoring data becomes available, the suitability of the current performance limits may need to be reviewed. If they are inappropriate and/or the level of interactions increases, appropriate alterations to the practices will be taken.

OBJECTIVE 3. GENERAL ECOSYSTEM

The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.



The issues that relate to the broader ecosystem which were identified for the NDSMF are shown above in the component tree. A risk assessment process subsequently assessed each of these issues with the information relating to each issue detailed in Section 5.3.

Of the eight issues identified for the NDSMF, three were of **Low Risk** (trophic interactions, translocation by vessel hulls and translocation by bait) the other four were rated as **Negligible Risk** (benthos, ghost fishing, discarding/provisioning, air quality and water quality). Consequently, the current performance for the NDSMF is meeting Objective 3 and this acceptable performance is likely to at least continue or improve in the future.

Information Requirements

2.3.1 Information appropriate for the analysis in 2.3.2 is collated and/or collected covering the fisheries impact on the ecosystem and environment generally.

Appropriate levels of information have been obtained for most of the issues identified, which has allowed a sensible assessment of the level of risk to be made. This information includes data collected, which is directly related to the NDSMF - in terms of levels of catch and effort, observer surveys, gear designs, and understanding of spatial and temporal closures. There are also a number of publications that provide

valuable information on trophic interactions in addition to the research that the Department of Fisheries has undertaken and is currently working on within other similar fisheries.

Assessments

2.3.2 Information is collected and a risk analysis, appropriate to the scale of the fishery and its potential impacts, is conducted into the susceptibility of each of the following ecosystem components to the fishery.

A formal risk assessment was completed (see Section 5.3 for details) on each of the identified issues relevant to the NDSMF (see component tree for issues). The identified issues were assessed and a summary of the outcomes is located in Table 9. Complete justifications are located in the performance reports in Section 5.3.

Table 9 Summary of risk assessment outcomes for environmental issues related to the NDSMF.

ISSUES	RISK	SUMMARY JUSTIFICATION	FULL DETAILS
Removal of/damage to organisms:			**5.3.1**
Fishing (eg trophic levels)	Low	Scalefish comprise the entire catch of the fishery. Most of the scalefish species are medium to large sized, generalist carnivores, feeding on smaller fish, crustaceans and molluscs. There is no evidence that any of these species play a keystone role in the ecosystem. In 2002 the fishery retained a total of 434 tonnes of demersal scalefish (504 tonnes in 2001). It is possible that scalefish removals by the fishery have small-scale, localised impacts in some areas of the fishery. However, overall catch rates of scalefish are stable across the fishery, which suggests that the scalefish recruitment has not been affected by removals and that the total biomass of medium-sized, generalist carnivores in the region is probably being maintained at a level sufficient to maintain trophic function. Tropical marine waters are characterised by communities of high species diversity. In such systems, the overall effect of piscivores on their prey is substantial but the removal of one species, or a small group of species, is minor (e.g. Hixon 1991). In the	5.3.1.1

		NDSMF, there is no evidence to suggest that the removal of scalefish by commercial fishing has directly resulted in a significant trophic effect (i.e. extinction, appearance of new species or other measurable shift in ecosystem function). The Department of Fisheries recognises that an assessment of trophic impacts by fisheries at a regional level, rather than at the individual fishery level, would be beneficial. Consequently, the Department will investigate the development of research to identify any detectable changes in the structure of coastal fish communities in this region over the last 40 years.	
Benthos	Negligible	Small numbers of attached epibenthos such as sea fans, seawhips, soft corals and coralline algae, may be damaged and removed by the actions of the fish traps and by the movement of traps by tidal action during the soak period. Overall, the amount of epibenthos that is retrieved by traps (i.e. is observed by fishers) is minimal. The amount of epibenthic material that is disturbed by traps, but is not retrieved (i.e. is not observed) is unknown. However, the level of disturbance is limited by the small number of vessels (6 vessels in 2001 and 5 in 2002) that currently operate over the large fishing area (226,500 km^2) within the fishery. The number of habitat types across the fishery is not known.	5.3.1.2
Ghost fishing	Negligible.	The number of traps lost at sea by the fishery is unknown, but discussions with fishers suggest that it is low. Ghost fishing by lost traps is unlikely to result in significant mortality of any scalefish species, because similar fish species have been observed in video surveys to be able to enter and exit traps with relative ease (M. Cappo, pers. comm.). Traps that are deliberately left at sea could catch small quantities of fish, but the doors are left open and the traps are unbaited.	5.3.1.3

Addition/Movement of biological material:			**5.3.2**
Discarding/provisioning	Negligible	The quantity of scalefish that is discarded is low, consisting mainly of triggerfish and some small sharks. It is estimated that the fishery discarded approximately 6.4 tonnes and 5.8 tonnes of scalefish in 2001 and 2002, respectively. There is no processing of the retained catch onboard and so fish waste products are not discarded at sea. The total area of the offshore zone of the fishery is 408,400 km^2. Fishing is currently focused on the area from the inshore boundary to the 200 m depth contour, an area of 226,500 km^2. Therefore, the rate of provisioning from discards is very low and was estimated at 28.3 g per km^2 in 2001 and 25.6 g per km^2 in 2002. This amount is extremely low, relative to the biomass of food sources naturally available to carnivores and scavengers in the region. Also 85% of the discards consist of triggerfish, many of which are expected to survive after discarding.	5.3.2.1
Translocation - vessel hulls	Low	Five vessels operated in the NDSMF in 2002 (6 in 2001). In addition to fishing in the Kimberley region, each vessel travels to Darwin approximately once per year for maintenance. Hulls are regularly anti-fouled which helps to prevent the translocation of organisms. Ocean currents on the north-west shelf are variable in direction and magnitude. However, the predominant flow is southward, under the influence of the Indonesian "throughflow" current and the Leeuwin Current (Cresswell 1991). Therefore vessels travelling between Darwin and the NDSMF are unlikely to translocate organisms beyond the range of dispersal that would occur through natural processes.	5.3.2.2
Translocation - bait	Low	Pilchards are used as bait by the fishery. Most of it is caught in the southern region in WA although some is imported from SA or elsewhere.	5.3.2.3

		While pilchards are known vectors of disease in Australian waters the risk of translocation of disease to the Pilbara region via pilchards is minimised by the following factors; bait is imported frozen, pilchards are temperate species, most pathogens are species-specific and the risk of introducing disease is dependent on the pattern of bait usage. In addition, regular use of small, dispersed quantities of bait (e.g. this fishery) less risky than occasional use of large quantities that are concentrated in space or time (e.g. use in aquaculture facilities) (Jones and Gibson, 1997; Jones 2000).	
Other Environmental impacts:			**5.3.3**
Air Quality (Exhaust fumes)	Negligible	There were 5 vessels operating in the fishery in 2002. The fishery extends from south of Broome to the Northern Territory. Therefore, the risk is negligible. All vessels have to meet survey requirements.	5.3.3.1
Water Quality (Debris)	Negligible	Fish trapping operations produce small quantities of plastic and paper debris that must be disposed of. The fishery operates under an international code of practice that specifies the appropriate disposal of debris at sea and the obligations of fishers under this code are clearly displayed on each vessel.	5.3.3.2

Management Response

2.3.3 Management actions are in place to ensure significant damage to ecosystems does not arise from the impacts described in 2.3.1.

The most important management method required to ensure that there is minimal impact on the broader ecosystem include maintaining significant biomass levels of scalefish and other by-product species. In most cases, this serves to achieve both objectives of having a sustainable fishery and minimising the potential for any trophic interactions. Other management measures such as gear restrictions, spatial closures, limiting the number of operating vessels, and future research also further minimise the potential for general ecosystem impacts.

With the proposal of future studies to be conducted to assess trophic impacts of fisheries at a regional level (i.e. development of research to identify any detectable changes in the structure of coastal fish communities) an increase of information will be generated to more accurately assess these issues in the future.

2.3.4 There are decision rules that trigger further management responses when monitoring detects impacts on selected ecosystem indicators beyond a predetermined level, or where action is initiated by application of the precautionary approach.

None of the issues identified for this category were of sufficient risk to require specific target levels as they are effectively covered by the other management arrangements and trigger points. If future studies prove that risk to any of these issues has increased a review will take place and management will implemented.

2.3.5 The management response, considering uncertainties in the assessment and precautionary management actions, has a high chance of achieving the objective.

The risk assessment identified that under current management arrangements there have been minimal or negligible impacts from the NDSMF on the broader ecosystem even after around 15 years of fishing. It is, therefore, highly likely that this fishery will continue to meet the objectives of having only acceptable levels of impact. If future studies indicate that further management is required for any of the issues, then appropriate actions will be developed.

OVERVIEW TABLE

The following table provides a summary of the material present in this report.

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	DEH Guidelines Covered	Actions
RETAINED SPECIES (Component Tree)						1.1	
5.1.1.1 Red emperor and Goldband snapper	Yes	i) Spawning biomass levels of both species. ii) Annual total catch levels for each species. iii) Annual trap catch rates for each species.	i) Spawning biomass should remain above 40% of the virgin spawning biomass with a lower limit of 30%. ii) Total annual catches should not increase >20% above the average annual catch of the previous 4 years. iii) Annual trap catch rates should not decrease in two consecutive years.	Acceptable	High	1.1.1 – 1.1.7	Continue and improve current monitoring, management and assessment arrangements.
5.1.2.1 Cods/Grouper	Yes	i) Total annual catch level of serranids. ii) Total annual trap catch rate of serranids.	i) Total annual catch not to increase >20% above the average annual catch of the previous 4 years. ii) Annual trap catch rate should not decrease in two consecutive years. iii) New system of catch reporting in January 2005.	Acceptable	Low-Moderate	1.1.1 – 1.1.7	New reporting system that will require serranid catches to be reported by species. Proposed future indicators and measures in Section 5.1.2.1 to improve the assessment.

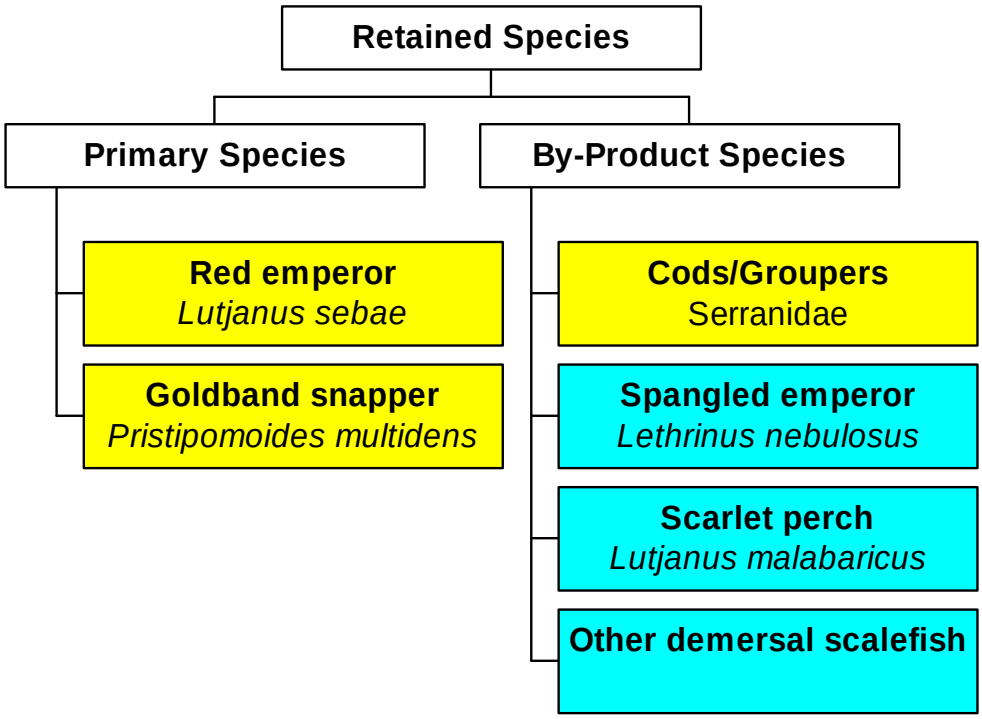
Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	DEH Guidelines Covered	Actions
RETAINED SPECIES (cont.)							
5.1.2.2 Scarlet Perch	No- Low Risk	N/A	N/A	N/A	N/A	1.1.1 – 1.1.7	Catches will be monitored annually.
5.1.2.3 Spangled Emperor	No- Low Risk	N/A	N/A	N/A	N/A	1.1.1 – 1.1.7	Catches will be monitored annually.
5.1.2.4 Other Demersal Scalefish	No- Negligible Risk	N/A	N/A	N/A	N/A	1.1.1 – 1.1.7	Continue and improve current monitoring, management and assessment arrangements.
NON-RETAINED SPECIES (Component Tree)						2.1 and 2.2	
5.2.1.1 Potato Cod	No- Negligible Risk	N/A	N/A	N/A	N/A	2.2.2 – 2.2.6	Introduce a revised catch reporting system to allow for compulsory reporting of any interactions with protected species. Review Risk at Next Major Assessment
5.2.1.2 Sea Snakes	No- Negligible Risk	N/A	N/A	N/A	N/A	2.2.2 – 2.2.6	Same as above.
5.2.2.1 Unmarketable Scalefish	No- Negligible Risk	N/A	N/A	N/A	N/A	2.1.2 – 2.1.6	Revised catch reporting system to include an area for the collation of bycatch data. Review Risk at Next Major Assessment
5.2.2.2 Sharks	No- Negligible Risk	N/A	N/A	N/A	N/A	2.1.2 – 2.1.6	Review Risk at Next Major Assessment

Issue	Objective Developed	Indicator Measured	Performance Measure	Current Performance	Robustness	DEH Guidelines Covered	Actions
GENERAL ENVIRONMENT (Component Tree)						2.3	
5.3.1.1 Fishing (Trophic Levels)	No- Low Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Investigate the development of research to identify any detectable changes in the structure of coastal fish communities in this region over the past 40 years.
5.3.1.2 Benthos	No- Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.1.3 Ghost Fishing	No- Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.2.1 Discarding/Provisioning	No – Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.2.2 Translocation by Vessel Hulls	No – Low Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.2.3 Translocation by Bait	No- Low Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.3.1 Air Quality	No- Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.
5.3.3.2 Water Quality	No- Negligible Risk	N/A	N/A	N/A	N/A	2.3.1 – 2.3.5	Review Risk at Next Major Assessment.

5. PERFORMANCE REPORTS

5.1 RETAINED SPECIES

COMPONENT TREE FOR THE RETAINED SPECIES



A yellow box indicates that the issue was considered a high enough risk to warrant a full performance report. A blue box indicates that the issue was considered a low risk, with no specific management required, and only a justification is presented.

5.1.1 TARGET SPECIES

5.1.1.1 RED EMPEROR AND GOLDBAND SNAPPER

Rationale for Inclusion:

The two main species targeted by the NDSMF are red emperor (*Lutjanus sebae*) and goldband snapper (principally *Pristipomoides multidens*). Fishers in the NDSMF have the option of either using fish traps or droplines/handlines. Trap fishing is currently the preferred fishing method and line fishing effort in recent years has been low and variable. Trap fishing is highly selective in targeting demersal fish such as tropical snappers (Lutjanidae), and so is capable of having a significant impact on the stocks of these species.

ERA Risk Rating: Impact on breeding stocks (C2 L5 MODERATE)

Red emperor and goldband snapper (Family Lutjanidae) have in common several life history traits – protracted longevity, slow growth, low rate of natural mortality, relatively large size and age at maturity – that make them more vulnerable to overfishing than other shorter-lived demersal fish species. These two species fetch high market prices and so are consistently targeted by trap and line fishers in the Kimberley region. In 2002, the median estimates of total spawning biomass of the two indicator species, red emperor and goldband snapper, in the Kimberley region were 54% and 41% of the estimated virgin levels, respectively. These levels were both above the recommended target level of 40% of the virgin spawning biomass and the breeding stock was considered adequate at the current catch levels. Whilst the estimated lower limit of the 95% confidence interval for the level of spawning stock biomass for goldband snapper was below the target level of 40% of the virgin spawning biomass, it was above the 30% limit reference point. The precise relationship between stock size and recruitment is unknown for each target species but assumed to be similar in form to other longer-lived lutjanid species.

Given the vulnerable nature of each of the target species to over-fishing, it was considered that the NDSMF could be having a **'moderate'** impact on the stocks of each long-lived target species but the likelihood of this occurring was considered to be only an **'occasional'** outcome given the management in place. This resulted in a risk rating of **MODERATE**.

Operational Objective

To maintain the spawning stocks of red emperor and goldband snapper at or above levels that minimises the risk of recruitment overfishing.

Justification:

An operational objective that maintains the potential for recruitment at historical levels is consistent with the statutory obligation under section 3 of the FRMA "to conserve, develop and share fish resources of the State for the benefit of present and future generations."

Indicators

1) Spawning biomass levels of red emperor and goldband snapper;

2) Annual NDSMF total catch levels of red emperor and goldband snapper; and

3) Annual NDSMF trap catch rates of red emperor and goldband snapper.

Red emperor and goldband snapper are used as indicator species in this fishery because they are the dominant target species. It is assumed that management measures that protect stocks of these indicator species will afford similar levels of protection to the other long-lived species that are caught by the fishery. The validity of this assumption and the general success of management measures are assessed by monitoring the catch and catch rates for each target species.

Trap catch rates are considered to be a more robust indicator of stock status than line catch rates, as they are more consistent and trapping is the main fishing method for each species.

Performance Measures

1) Spawning biomass of red emperor and goldband snapper should remain above 40% of the virgin spawning biomass with a lower limit of 30%.

2) Total annual catches of red emperor and goldband snapper should not increase >20% above the average total annual catch of the previous 4 years.

3) Annual trap catch rates of red emperor and goldband snapper should not decrease in two consecutive years.

Justification:

Evidence from other fisheries on longer-lived finfish species suggests that a limit of 30%, with a target of 40%, of the virgin biomass is appropriate to ensure sustainability of these types of fisheries (Mace 1994, Mace and Sissenwine 1993, Die and Caddy 1997, Gabriel and Mace 1999). Biomass levels of < 40% tend to coincide with declining catch rates of long-lived, tropical, demersal fish species. The spawning biomass of red emperor and goldband snapper in 1980 are each assumed to represent thier virgin levels.

Data Requirement for Indicator

Data Required	Availability
Catch & effort by trap & line sectors of the fishery.	Monthly or trip summaries of trap & line catch (by species) & effort (days, number of traps). Compiled by licensees & stored in CAES system. Monthly summaries available since 1985; trip summaries will be available from January 2005. VMS – monitors trap fishing location & effort. Operational since 1998.
Catch by recreational fishery	Occasional recreational catch surveys. Last survey of Pilbara and West Kimberley region was conducted 1999-2000. This survey extended only to Broome. No survey has been undertaken in the east Kimberley region.
Catch & effort by charter boat fishery	Compulsory logbooks. Trip summaries of catch & effort. Compiled by fishers. Available since 2001.
Age structure data	Age structure data for red emperor & goldband snapper, collected every 4 yr, would improve quality of assessments. Data not currently being collected.

Evaluation

Summary: The total catch by all fishing sectors (commercial, recreational and charter) in the Kimberley region are included in the stock assessment for each species. Assessments of red emperor and goldband snapper include age-structured modelling. In 2001, the total spawning biomass of red emperor was estimated to be satisfactory (54% of virgin level). The total spawning biomass of goldband snapper was estimated to be approximately equal to the target limit of 40%. Since the introduction of formal management arrangements to the fishery in 1998, the catch levels and catch rates of red emperor and goldband snapper have been stable. This is consistent with biomass estimates that suggest that the current effort and catch levels are adequate for maintaining the spawning biomass at adequate levels.

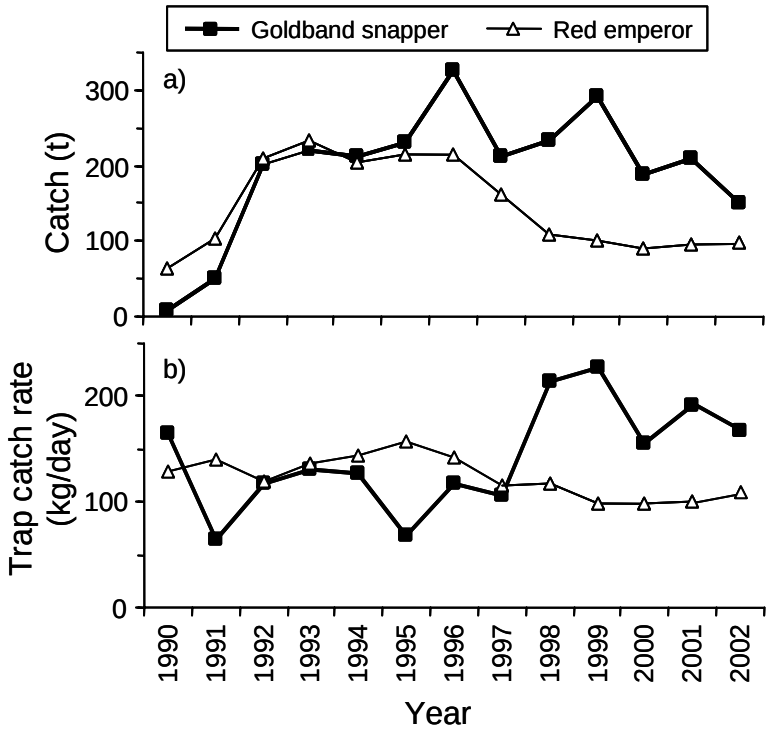


Figure 12 Annual a) catch levels and b) catch rates, of red emperor and goldband snapper in the NDSMF from 1990-2002.

Catch: From 1990 to 1997, the annual catch of red emperor in the NDSMF varied between 63 and 235 t (Figure 12). After the introduction of formal management arrangements in 1998, the annual catch of red emperor in the NDSMF has been relatively stable at approximately 100 t (Figure 12). In 2001, approximately 99% of the red emperor catch was landed by trap fishing vessels. In 2002, all the red emperor catch was landed by trap fishing vessels.

From 1990 to 1997, the annual catch of goldband snapper in the NDSMF varied between 9 and 327 t, peaking in 1996 (Figure 12). After 1998, the goldband snapper catch fluctuated between 189 and 292 t until 2002. In 2002, a large proportion of the allocated effort was unutilised and hence the overall level of effort in the fishery was low resulting in a reduced catch of 152 t. In 2001, approximately 84% of the

goldband snapper catch was landed by trap fishing vessels. In 2002, all the goldband snapper catch was landed by trap fishing vessels.

The NDSMF catches some small red emperors that are below the Western Australian legal minimum length (410 mm total length) and hence they are discarded. Fish traps catch these undersize individuals. Selectivity trials have indicated that escape gaps are not suitable for the release of undersize red emperor. No other target species are discarded in the fishery. Survival rates of released red emperor are unknown. Given that fishing is generally in waters in excess of 80 metres in depth, it is expected that these undersized fish have low rates of survivorship. However, undersize red emperors (below the size at sexual maturity) have a high rate of natural mortality (compared with adult fish) and so discards are likely to have a minimal impact on the red emperor stock.

Other commercial catches: No other commercial fishery in the Kimberley region catches significant quantities of the species targeted by the NDSMF. There is limited movement of adults of each of the target species, and subsequently the distinct assemblages in the Kimberley are separate to those in the Pilbara region, or the Northern Territory (Stephenson *et al*. 2001, Newman *et al.* 2000c). Therefore, catches by fisheries in other regions do not impact directly on NDSMF catches.

Recreational catch: At present there is little recreational fishing effort directed towards the deeper-water fish species in the NDSMF, which are the key species targeted by commercial fishers in the NDSMF. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome area, which is closed to commercial fishing. A creel survey of the Pilbara and West Kimberley coast conducted in 1999-2000 included the Broome area. This survey indicated that the estimated annual catch of red emperor by boat-based recreational fishers across the extent of the survey area was relatively low at approximately 6 t. Boat and shore-based recreational fishers do not catch significant quantities of goldband snapper. Therefore, at present, the magnitude of the recreational fishing effort and the catch taken is small relative to the overall commercial catch.

Fishing effort: The five fish trap vessels that operated in the NDSMF in 2002 reported using between 20 and 40 fish traps per day. No line fishing vessels operated in the NDSMF in 2002. The effort allocated in 2002 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days. A standard fishing day is defined as using 20 fish traps or 5 lines per day. The number of standard fishing days (SFDs) calculated from VMS data was 900 SFDs (all from trap vessels), indicating that 860 SFDs remained unutilised in the fishery at the end of the 2002-fishing season. Effort recorded via the VMS system records the number of days spent fishing within the boundaries of the fishery and is converted to standard fishing days with an adjustment to take into account an allocation of travel days for travelling across sectors within the NDSMF.

The average fish trap effort (in boat days fished) within the NDSMF has been decreasing since 1992. Since the introduction of management controls on effort in 1998, trap effort has varied from 890 to 992 SFDs and a large proportion of the effort

allocated to both line and trap vessels in the fishery has remained voluntarily unutilised in each fishing year.

Catch rates: The trap catch rates of red emperor in the NDSMF exhibited a declining trend from 1995 to 1997 (Figure 12). However, after the introduction of formal management arrangements, red emperor catch rates were relatively stable from 1998 to 2002, averaging 104.9 kg per standard trap fishing day (i.e. 20 traps x 5.0 kg/trap/day). Goldband snapper trap catch rates were higher in the period from 1998-2002, compared to 1990-1997. This increase is assumed to reflect increased targeting of this species group by trap fishers. In 1998-2002, catch rates of goldband snapper fluctuated between 156 and 228 kg per standard trap fishing day.

Stock assessment/Use of performance measures: Using the indicators as described above, red emperor and goldband snapper were within the acceptable performance limits from 1999 to 2002. Catch and catch rate indicators were consistent with spawning biomass assessments of each species (Table 10).

The stock assessments of red emperor and goldband snapper includes an estimate of spawning biomass (Figure 13 and 14). An age and sex structured model was developed that aims to give plausible trajectories of the red emperor spawning biomass which are consistent with the current information. It is assumed that the stock is closed, that there is no mixing of larvae and no migration after recruitment between adjacent fisheries.

The recruits (age 0 fish) to the fishery are determined annually and are considered to be related to the weight of spawning females in the fishery using a Beverton and Holt stock recruitment relationship. This operates on the principle that as the spawning stocks decreases, the recruitment will be lowered. A steepness parameter determines how much the egg production is diminished at low stock sizes. The steepness is considered to have values of 0.6 (more conservative), 0.7 (base case) and 0.8 (less conservative).

The inputs of the model are the biological data below as well as catch data 1980 to 2001 and effort data 1995 to 2002. The parameters, virgin recruitment (recruits in 1980), catchability, and vulnerability to the fishing gear of fish age 4, 5, 6, 7, 8, 9 years are estimated so that trajectory of biomass in the fishery is consistent with growth, catch removals, catch rates, and the snapshots of age structure.

In 2002, the age-structured stock assessment model suggested that the total biomass of red emperor was approximately 54%. This level of spawning biomass is above the recommended level of 40% of the virgin spawning biomass and therefore the current breeding stock and catch levels were considered adequate.

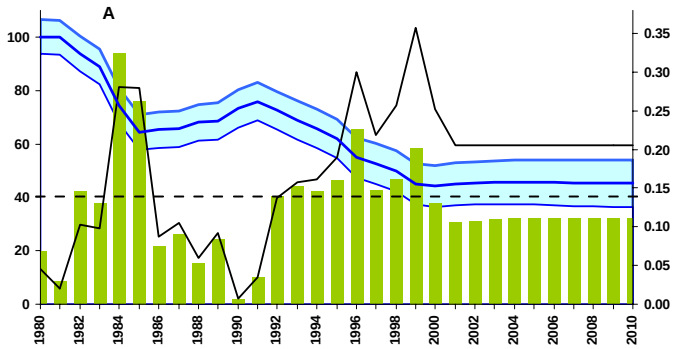


Figure 13 Goldband snapper estimated spawning biomass as a percentile (with 95% confidence intervals, in blue), catch ÷5 (green) both with scale on left axis, and fishing mortality (black) with scale on right axis for base case scenario, no efficiency increase, and effort=990 days after 2002.

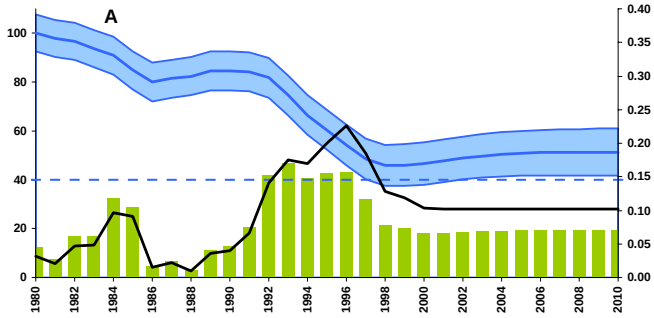


Figure 14 Red emperor spawning biomass (with 95% confidence intervals) (blue), catch ÷5 (green) both with scale on left axis , and fishing mortality (black) with scale on right axis for base case scenario, no efficiency increase, and effort=900 days after 2002.

Table 10 Recent indicators for red emperor and goldband snapper: a) spawning biomass as a percentage of the 1980 virgin level; b) ratio of the total annual catch to the average total annual catch of the previous 4 years; c) ratio of the annual trap catch rate to the catch rate in the preceding year. (indicators did not trigger a review in any year).

Species	**a) Spawning biomass in 2002**	**b) Catch ratio** **99 00 01 02**	**c) Catch rate ratio** **99 00 01 02**
Red emperor	54%	0.58 0.62 0.82 1.02	0.84 1.01 1.03 1.08
Goldband snapper	41%	1.16 0.71 0.90 0.66	1.07 0.69 1.23 0.87

The trap catch rate of goldband snapper increased after 1998 and also became more variable. These variations were assumed to reflect changes in efficiency by trap fishers as they attempted to maximise their return from each day spent in the fishery (as fishing days are limited). In 2002, the total spawning biomass of goldband snapper was estimated at approximately 41% of the virgin (1980) level. The estimated lower limit of the 95% confidence interval for the level of spawning stock

biomass for goldband snapper was below the target level of 40% of the virgin spawning biomass, but was above the limit level of 30% of the virgin spawning biomass. Therefore, the current breeding stock and catch levels were considered adequate.

Robustness
High

Catch levels and catch rates in the NDSMF are likely to be good indicators of changes in fishing practices that affect the key target species. However, catch rates of trap and line vessels in the fishery by themselves are considered to be only moderate indicators of stock size due to the likelihood of 'hyperstability' in the catch rate data. Hyperstability may occur due to the i) targeting of aggregating fish species, ii) high mobility of the fishing fleet, and iii) relative ease with which fish can be located (they are strongly associated with hard bottom habitats). Under these conditions, the catch rate may remain relatively constant and mask an actual decline in the abundance of the stock.

Catch rate data is also likely to be affected by the small number of vessels fishing (5 in 2002). A small number of vessels operating in the fishery (small sample size) tend to result in high variability in catch and effort data. In particular, catch rate is critically dependent on the number of skilled operators in the fishery, which may vary from year to year.

If the collection of age structure data for each of the key species was available it would provide a more robust indicator of stock status than is provided by catch data alone. Age structure data, used in combination with catch and catch rate data within age-structured models provides highly robust indicators of stock status.

Consequently, even without the age structure data for each key species the level of robustness of current indicators is considered adequate to manage red emperor and goldband snapper stocks at a sustainable level. This is due to the effort controls that are in place and the fact that no other fishing sector catches significant quantities of these species in the Kimberley region.

Fisheries Management Response

Current: The NDSMF fleet is primarily managed through an innovative effort control system, in the form of a limited number of fishing days allocated to each licensee. There are 11 licences in the fishery, but only 5 vessels operated in the fishery in 2002 (6 vessels in 2001). The number of fishing days allocated to fishers is reviewed annually and can be adjusted to change the total effort levels as required. Effort controls were implemented in 1998. Subsequent catch levels of red emperor and goldband snapper have been stable, suggesting that management strategies are effective and that catch levels are sustainable.

The magnitude of the catch of the charter and recreational fisheries in the Kimberley region have not been assessed but they are not expected to take significant quantities of the key target species of the NDSMF. Recreational catches are subject to bag and size limits.

Future: The fishery will continue to be monitored by analysis of catch and effort data from the CAES system and VMS. Catch rate information will be improved by more detailed reporting of catch location (current reporting of catch location is based on 1 degree blocks).

The CAES data that is currently collected on a monthly basis is under review. This data is to be modified in order to allow for individual trip returns. This will allow for more detailed spatial catch and effort data (and hence catch rate data) to be collected within the fishery. It is anticipated that after consultation with industry, that the modified CAES returns will be implemented by January 2005.

A proposal as to how to undertake ongoing monitoring of the age-structure of landings of red emperor and goldband snapper is being developed in consultation with industry, and monitoring will commence if funding is obtained.

Actions if Performance Limits are Exceeded: If performance measures are outside acceptable limits, a review will be conducted to determine the likely cause (e.g. market forces, other non-biological factors, recruitment, over-exploitation). If there is no evidence to suggest a decline in spawning biomass, then no action will be taken.

If the review suggests that performance limits were exceeded because of a decline in spawning biomass, the management response will be an adjustment of the effort allocations. The ability to implement these actions is provided through the FRMA and the *Northern Demersal Scalefish Fishery Management Plan 2000*. The authority to adjust effort is held by the Executive Director of Fisheries, Department of Fisheries.

Comments and Actions

The take of demersal scalefish in the NDSMF is fully regulated. The current breeding stock and catch levels of red emperor and goldband snapper are considered adequate and the management system is flexible to allow for both increases and decreases in fishing effort should they be required. The results of stock assessments and the performance of indicators described above will be reported in the annual status report for the NDSMF.

External Driver Check List

The target species in the NDSMF have a long history of exploitation from foreign trawl vessels to domestic trap and line vessels. Domestic market demand is strong and these species consistently fetch high prices. There is potential for the development of export markets and also for the exploration of deeper waters (greater than 200 m) within the boundaries of the NDSMF to increase catch levels. Deeper waters contain a different suite of species to those currently caught in the fishery.

Some fishers in the NDSMF have suggested that catch levels of target species may be related to environmental cycles such as ENSO events (El Nino-La Nina events). However, an insufficient time series of catch and effort data is currently available to assess the influence of these environmental phenomena on catch levels and catch rates.

5.1.2 BY-PRODUCT SPECIES

5.1.2.1 CODS/GROUPERS

Rationale for Inclusion:

A range of cod species (Family Serranidae; Subfamily Epinephelinae) is targeted by the NDSMF. Trapping is highly selective in targeting demersal fish and hence the NDSMF is capable of exerting a significant impact on the stocks of these species in the Kimberley region.

ERA Risk Rating: Impact on breeding stocks (C2 L4 MODERATE)

Cods and groupers have in common several life history traits – protracted longevity, slow growth, low rate of natural mortality, relatively large size and age at maturity – that make them more vulnerable to overfishing than other shorter-lived demersal fish species. They fetch high market prices and so are consistently targeted by trap and line fishers in the Kimberley region.

Serranid catches in the NDSMF have not consistently been reported on a species-specific basis. However, recent fishery-independent surveys indicate that the serranid catch consists of at least 16 species, with the majority of the catch consisting of 5 species (i.e. spotted cod, Rankin cod, eight bar cod, maori cod and duskytail grouper) (Newman *et al.* 2001). In 2002, the total serranid catch was 49 t and, as a result, the catch of any individual species was substantially less than this amount. The precise level of spawning biomass has not been directly estimated for any serranid species in the fishery. Similarly, the precise relationship between stock size and recruitment is unknown for each species.

At these levels of catch, it was considered that that fishery was only potentially capable of a 'moderate' impact on the stocks of each species. Given that the annual catches of individual serranid species are relatively low, the likelihood of this occurring was only rated L4 (**possible**). This resulted in a risk rating of **MODERATE**.

Operational Objective

To maintain the spawning stocks of serranid species at or above levels that minimise the risk of recruitment overfishing.

Justification:

An operational objective that maintains the potential for recruitment at historical levels is consistent with the statutory obligation under section 3 of the FRMA "to conserve, develop and share fish resources of the State for the benefit of present and future generations."

Indicators

1) Total annual catch level of serranids; and

2) Total annual trap catch rate of serranids.

Quantities of serranids caught by the fishery are currently not consistently reported by species. Therefore it is not possible to monitor the catch level or catch rate of individual species. It is currently only possible to monitor the total serranid catch level and catch rate.

Trap catch rates are considered to be a more robust indicator of stock status than line catch rates, as they are more consistent and trapping is the main fishing method for serranid species.

Future indicator:

3) Catch levels and catch rates of selected serranid species.

In future, catches of the major serranid species in the fishery should be reported by species. Selected species (or species groups) are likely to include Rankin cod, flowery cod, duskytail grouper, estuary cods (2 species), and spotted cods (2 species). The ratio of species within each species group will be determined from regular observer surveys conducted by Department of Fisheries staff on board industry vessels, and survey data used to estimate individual catches of these species.

Performance Measures

1) Total annual catch of serranid species by the NDSMF should not increase > 20% above the average annual catch of the previous 4 years.

2) Annual trap catch rate of serranid species by the NDSMF should not decrease in two consecutive years.

3) New system of catch reporting to be implemented by January 2005, whereby selected serranid catches are reported by species.

Future measures:

4) Total annual catch of each selected serranid species by the NDSMF should not increase > 20% above the average annual catch of each species over the previous 4 years.

5) Total annual trap catch rate of each selected serranid species by the NDSMF should not decrease in two consecutive years.

'Selected species' will be defined after the composition of the catch is more clearly understood.

Justification:

The dynamics of these by-product serranid species- i.e. they are relatively long-lived and relatively sedentary, are similar to the dynamics of the target stocks. Consequently the management arrangements that have been imposed to limit total effort, and, therefore the rate of exploitation on the target stocks, should also keep the rates of exploitation on these by-product species (which are not the main target of effort)) at levels that maintain their spawning biomass at levels that are appropriate.

The catches of serranids in the NDSMF are currently not consistently reported by species and it is estimated that at least 16 species comprise the total catch of serranids. In 2002, the catch was 49 t, and therefore the catches of each species are likely to be relatively low. The current performance measures are intended to constrain the total serranid catch to near current level to ensure that there is no change in targeting practices, until more information about the composition of the catch becomes available. Stable catch levels and catch rates since 1998 suggest that current catches are sustainable.

Data Requirement for Indicator

Data Required	Availability
Catch & effort by trap and line sectors of the fishery	Monthly summaries of trap and line catch (different species collectively reported as "cod") & effort (days, number of traps). Compiled by licensees & stored in CAES system. Available since 1985. Trip summaries of trap and line catch (by species) will be available from 2005. VMS – monitors trap fishing location & effort. Operational since 1998.
Catch by recreational fishery	Occasional recreational catch surveys. Last survey of Pilbara and West Kimberley region was conducted 1999-2000. This survey extended to Broome. No survey has been undertaken in the east Kimberley region.
Catch & effort by charter boat fishery	Compulsory logbooks. Trip summaries of catch & effort. Compiled by fishers. Available since 2001.
Observer surveys of catch composition	Surveys previously conducted in 1998-99. To be conducted every 2-3 years.

Evaluation

Summary: Specific biomass estimates are not available for any cod species in the Kimberley region and the precise species composition of the total NDSMF cod catch is unclear. However, since the introduction of formal management arrangements in 1998 to control effort in the fishery, the stable catch levels and catch rates of serranids are consistent with the performance measures imposed which suggests that the spawning biomass levels are likely to be adequate.

From January 2005, catches of selected serranid species will be reported by the NDSMF, on a per trip basis. These data, in combination with fishery-dependent surveys of catch composition will enable the catches of each serranid species to be estimated.

Catch. From 1990 to 1997, the annual serranid catch by the NDSMF ranged from 35 to 172 t, peaking in 1996 (Figure 15). After the introduction of formal management arrangements in 1998, the serranid catch declined and has been stable at an average of 79 t, until 2002. In 2002, a large proportion of the allocated effort was unutilised and hence the overall level of effort in the fishery was low resulting in a reduced catch of only 49 t. Approximately 98% of the serranid catch was landed by trap fishing vessels in 2001 and 100% was landed by trap fishing vessels in 2002. The reported serranid catch mainly consists of spotted cod, Rankin cod, eight bar cod, maori cod and duskytail grouper.

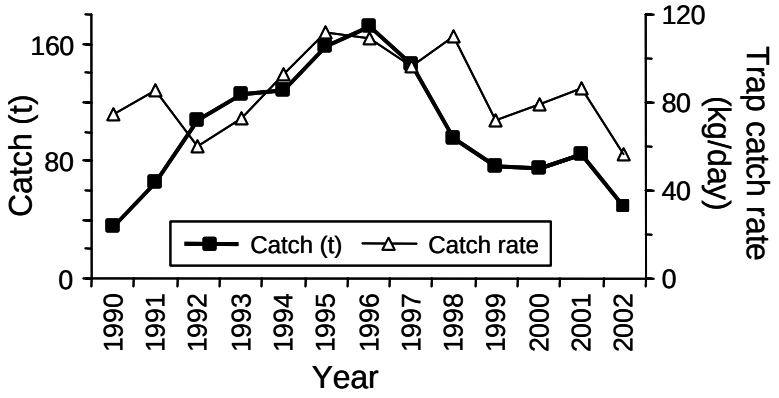


Figure 15 Annual total catch levels and annual trap catch rates of serranids in the NDSMF from 1990-2002.

Recreational catch: At present there is little recreational fishing effort directed towards the deeper water serranid species that are caught by the NDSMF. Recreational catches of key serranid species are negligible.

Fishing effort: The five fish trap vessels that operated in the NDSMF in 2002 reported using between 20 and 40 fish traps per day. No line fishing vessels operated in the NDSMF in 2002. The effort allocated in 2002 was 160 fishing boat days per licence, or a total of 1,760 standard fishing days. A standard fishing day is defined as using 20 fish traps or 5 lines per day. The number of SFDs calculated from VMS data was 808 SFDs (all from trap vessels), indicating that 952 SFDs remained unutilised in the fishery at the end of the 2002 fishing season. Effort recorded via the VMS system records the number of days spent fishing within the boundaries of the fishery and is converted to standard fishing days with an adjustment to take into account an allocation of travel days for travelling across sectors within the NDSMF.

The average fish trap effort (in boat days fished) within the NDSMF has been decreasing since 1992. Since the introduction of management controls on effort in 1998, trap effort has varied from 808 to 992 SFDs and a large proportion of the effort allocated to both line and trap vessels in the fishery has remained voluntarily unutilised in each fishing year.

Catch rates: From 1990 to 2001, the annual trap catch rate of serranids fluctuated between 56 and 112 kg per standard trap fishing day, and averaged 85 kg/day (i.e. 20 traps x 4.3 kg/trap/day). The overall trend during this period was stable (Figure 11). From 2005, annual catch rates of selected serranid species will also be calculated.

Stock assessment/Use of performance measures: Stock assessment of the serranid group is based on trends in catch level and catch rate. Catch level is calculated from known catches by all sectors (commercial, recreational and charter). Catch rate is calculated from trap fishing vessels.

Table 11 Recent indicators for serranid species: a) ratio of the annual total catch to the average annual total catch of the previous 4 years; b) ratio of the annual trap catch rate to the catch rate in the preceding year. Years in which these indicators would have triggered a review are shown.

	a) Catch ratio			b) Catch rate ratio				Review?			
Species	99	00	01	99	00	01	02	99	00	01	02
Serranids	**0.53**	**0.61**	**0.85**	**0.65**	**1.10**	**1.09**	**0.66**	**no**	**no**	**no**	**no**

Using the indicators as described above, serranids were within the acceptable performance limits from 1999 to 2002 (Table 11). The total catch of serranids declined from 1996 to 2002, primarily as a result of fluctuations in the amount of effort utilised. Over this period, the catch rate of serranids remained relatively stable. Since the introduction of formal management arrangements in the fishery in 1998, the lower stable catch level and catch rates of serranids suggests that spawning biomass levels are adequate. This species group will be more closely monitored in future years. Moreover, improvements in the catch reporting system and data from observer surveys of the NDSMF catch will yield species-specific estimates of serranid catches on a per trip basis.

Robustness
Low-Moderate

At present, the main difficulty in monitoring the status of serranids in the NDSMF is the lack of species-specific catch data. Total serranid catch level and catch rate are poor indicators of changes in stock size of individual species, and are also poor indicators of changes in fishing practices used to target serranids. A decrease in the catch of one species could be masked by an increase in the catch of another species. Therefore, the robustness of current indicators is considered to be **low**.

However, when species-specific catch data becomes available for serranids, then catch levels and catch rates in the NDSMF are likely to be moderate indicators of changes in fishing practices that affect each species. This data will be verified by regular fishery-dependent surveys of catch composition. Catch rates of trap and line vessels in the fishery are still likely to be relatively poor indicators of stock size due to the likelihood of 'hyperstability' in the catch rate data (see 5.1.1).

Catch rate data is also likely to be affected by the small number of vessels fishing (5 in 2002). A small number of vessels operating in the fishery (small sample size) tend to result in high variability in catch and effort data. In particular, catch rate is critically dependent on the number of skilled operators in the fishery, which may vary from year to year.

Overall, species-specific catch data reported per trip and data from observer surveys of the NDSMF will be combined to provide indicators of **moderate** robustness in the future. This is considered adequate given the relatively lower risk to these stocks compared to the target species.

The collection of age structure data for each of the key serranid species would complement existing catch data and further increase the robustness of indicators to a 'high' level. However, it is anticipated that indicators based on catch data alone will be adequate to manage stocks of key serranid species at a sustainable level, given the effort controls that are in place and the fact that no other fishing sector catches significant quantities of these species in the Kimberley region.

Fisheries Management Response

Current: The NDSMF fleet is primarily managed through an innovative effort control system, in the form of a limited number of fishing days allocated to each licensee. There are 11 licences in the fishery, but only 5 vessels operated in the fishery in 2002 (6 vessels in 2001). The number of fishing days allocated to fishers is reviewed annually and can be adjusted to change the total effort levels as required. Effort controls were implemented in 1998. Subsequent catch levels of serranids have been stable, suggesting that management strategies are effective and that catch levels may be sustainable.

In Western Australia, there is a maximum legal size of 30 kg total weight or 1200 mm total length for all cods and groupers (*Epinephelus* spp.). This size restriction applies to all persons fishing in Western Australian waters (FRMR). In Western Australian waters, only 5 species of the genus *Epinephelus* are known to reach a maximum length and weight in excess of this size limit. These species are giant grouper (*Epinephelus lanceolatus*), estuary cod (*E. coioides*), Malabar grouper (*E. malabaricus*), eight bar cod (*E. octofasciatus*) and potato cod (*E. tukula*; see section 5.2.1.1). The level of incidental capture of large cod species by fishers in the NDSMF is unknown but is considered to be rare.

The magnitude of the catch of the charter and recreational fisheries in the Kimberley region have not been assessed but they are not expected to take significant quantities of the key target species of the NDSMF. Recreational catches are subject to bag and size limits.

Future: The fishery will continue to be monitored by analysis of catch and effort data from the CAES system and VMS. Catch rate information will be improved by more detailed reporting of catch location (current reporting of catch location is based on 1 degree blocks).

The CAES data that is currently collected on a monthly basis is under review. This data is to be modified in order to allow for individual trip returns. An identification guide to allow for more detailed catch reporting on a species by species basis within the fishery is being developed. It is anticipated that after consultation with industry, that this identification guide will be implemented by January 2005.

Monitoring of the age-structure of landings of key serranid species is not proposed at present. However, consideration will be given to such monitoring after the composition of the catch is more clearly understood.

Observer surveys of the NDSMF catch were conducted in 1998-99 (Newman *et al.* 2001). In the future, the Department of Fisheries plans to conduct observer surveys at least every 2-3 years, to determine the species composition of the serranid catch, and in order to estimate the incidental catch of individual cods above the maximum size limit.

Actions if Performance Limits are Exceeded: If performance measures are outside acceptable limits, a review will be conducted to determine the likely cause (e.g. market forces, other non-biological factors, recruitment, over-exploitation). If there is no evidence to suggest a decline in spawning biomass, then no action will be taken.

If the review suggests that performance limits were exceeded because of a decline in spawning biomass, the management response will be an adjustment of the effort allocations. The ability to implement these actions is provided through the FRMR and the *Northern Demersal Scalefish Fishery Management Plan 2000*. The authority to adjust effort is held by the Executive Director of Fisheries, Department of Fisheries.

Comments and Actions

The take of demersal scalefish in the NDSMF is fully regulated. The current breeding stock and catch levels of the serranid species are considered adequate and the management system is flexible to allow for both increases and decreases in fishing effort should they be required. The magnitude and composition of the serranid catch in the NDSMF will be closely monitored in future years. The results of stock assessments and the performance of indicators described above will be reported in the annual status report for the NDSMF.

External Driver Check List

The target species in the NDSMF have a long history of exploitation from foreign trawl vessels to domestic trap and line vessels. Domestic market demand is strong and these species consistently fetch high prices. There is potential for the development of export markets and also for the exploration of deeper waters (greater than 200 m) within the boundaries of the NDSMF to increase catch levels. Deeper waters contain a different suite of species to those currently caught in the fishery.

5.1.2.2 SCARLET PERCH

Rationale for Inclusion:

Scarlet perch (*Lutjanus malabaricus*) is generally not targeted by the NDSMF, but significant quantities of this species are caught and retained as by-product by the fishery when targeting other species.

ERA Risk Rating: Impact on breeding stocks of scarlet seaperch (C1 L6 LOW)

Scarlet perch is similar to most other large lutjanid fishes in having life history characteristics (e.g. extended longevity, low rates of natural mortality and large size at maturity) that make it vulnerable to over-exploitation (Newman *et al.* 2000b, Newman 2002).

However, the annual catch of this species by the NDSMF is relatively low. In 2002, the reported catch of scarlet perch was approximately 61 t, which represented 14% of the total scalefish catch in the NDSMF (Table 12). From 1997 to 2001, the annual catch of scarlet perch by the NDSMF was < 8% of the total annual catch of the fishery, and ranged from 14 to 36 t (Figure 16). In the same period, the catch rate of scarlet perch by the NDSMF was relatively stable. However in 2001 and 2002 catch rates of scarlet perch increased substantially (Figure 16). It is not known whether this reflected greater availability or abundance. Shifts in targeting practice have not been reported. Scarlet perch are not reported in significant quantities by any other fishing sector (commercial or recreational) in the Kimberley region.

By comparison, NDSMF catches of scarlet perch in the Kimberley region are considerably lower than the combined commercial catch (by trawl, trap and line fisheries) in the adjacent Pilbara region, where approximately 100 t of scarlet perch is caught annually. In the Pilbara, catch rates have been stable since 1994, suggesting that the present catch level of scarlet perch in the NDSF is sustainable (assuming similar stock dynamics and levels of spawning biomass between the Pilbara region and the NDSF). Therefore, it was considered **'likely'** that the NDSMF will have a **'minor'** impact on the populations of scarlet seaperch. This resulted in a risk rating of **LOW**.

Action: Although the NDSMF is considered to have a minor impact on stocks of scarlet perch, the fishery still catches a significant quantity of this species and catches should be monitored annually. The NDSMF caught 61 t in 2002, which represented 38% of the total WA catch of scarlet perch. Stock assessment of this species is based on monitoring of catch level and catch rate. No estimates of spawning biomass are available for scarlet perch. The current level of assessment is considered adequate to manage the stock at a sustainable level, given the effort controls that are in place and the fact that no other fishing sector catches significant quantities of this species in the Kimberley region. The results of stock assessments will be reported in the annual status report for the NDSMF.

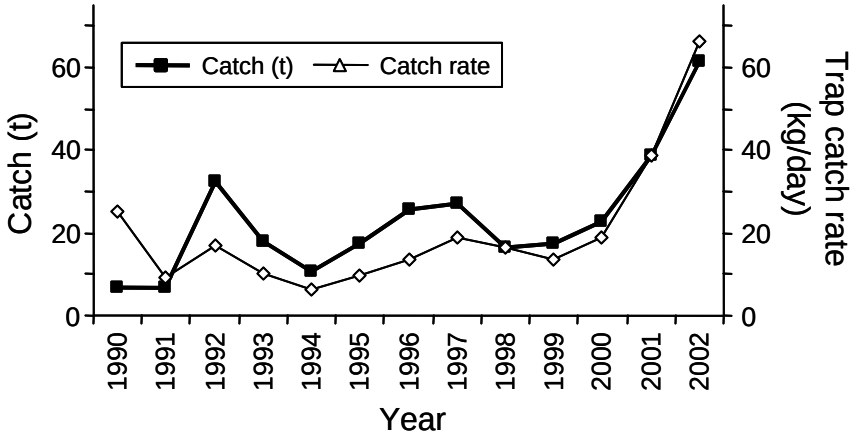


Figure 16 Annual total catch level and trap catch rate of scarlet perch in the NDSMF from 1990 to 2002.

5.1.2.3 SPANGLED EMPEROR

Rationale for Inclusion:

Spangled emperor (*Lethrinus nebulosus*) is generally not targeted by the NDSMF, but significant quantities of this species are caught and retained as by-product by the fishery when targeting other species.

ERA Risk Rating: Impact on breeding stocks of spangled emperor (C1 L6 LOW)

Spangled emperor is similar to most other large reef associated fishes in having life history characteristics (e.g. extended longevity, low rates of natural mortality, large size at maturity) that make it vulnerable to over-exploitation (Moran *et al.* 1993).

However, the annual catch of this species by the NDSMF is relatively low. In 2002, the reported catch of spangled emperor was 34 t, which represented 8% of the total scalefish catch in the NDSMF (Table 12). From 1997 to 2001, the annual catch of spangled emperor by the NDSMF was between 5 and 7% of the total annual catch of the fishery, and ranged from 25 to 37 t (Figure 17). The catch rate of spangled emperor declined from 1990 to 1992, but was relatively stable from 1992 to 2002. The catch rate trend was increasing in recent years.

By comparison, NDSMF catches of spangled emperor in the Kimberley region are lower than the combined catch (by trawl, trap and line fisheries) in the adjacent Pilbara region, where approximately 70 t of spangled emperor is caught annually. Catch levels and catch rates in the Pilbara have been gradually declining since 1998, suggesting that catches are slightly above sustainable levels. Current catches in the Kimberley are not likely to be at maximum sustainable levels but will be monitored closely.

Therefore, it was considered **'likely'** that the NDSMF will have a **'minor'** impact on the populations of spangled emperor. This resulted in a risk rating of **LOW**.

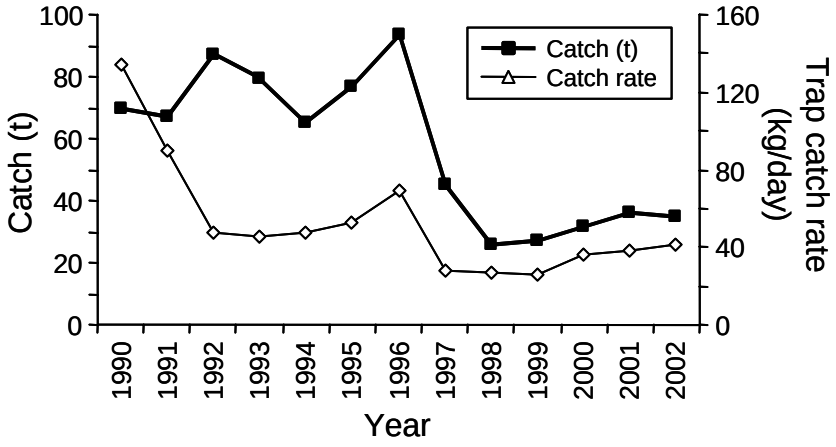


Figure 17 Annual total catch level and trap catch rate of spangled emperor in the NDSMF from 1990 to 2002.

The magnitude of the catches by charter and recreational fisheries in the Kimberley region have not been assessed but these sectors are expected to take minor quantities of spangled emperor. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome area, which is closed to commercial fishing. A creel survey of the Pilbara coast conducted in 1999-2000 included the west Kimberley (Broome) area. The annual catch of spangled emperor by boat-based recreational fishers in the survey area was estimated to be 12 t. Shore-based recreational fishers do not catch significant quantities of spangled emperor.

In Western Australia, there is a minimum legal length of 410 mm total length for spangled emperor. This size restriction applies to all persons fishing in Western Australian waters (FRMR). Recreational catches are also subject to bag limits.

Action: Although the NDSMF is considered to have a low impact on stocks of spangled emperor, the fishery still catches a significant quantity of this species and catches should be monitored annually. The NDSMF caught 34 t in 2002, which represented 18% of the total WA catch of spangled emperor. Stock assessment of this species is based on monitoring of catch level and catch rate. No estimates of spawning biomass are available for spangled emperor. The current level of assessment is considered adequate to manage the stock at a sustainable level, given the effort controls that are in place and the fact that other fishing sector catches only minor quantities of this species in the Kimberley region. The results of stock assessments will be reported in the annual status report for the NDSMF.

5.1.2.4 OTHER DEMERSAL SCALEFISH

Rationale for Inclusion:

At least 30 taxa of other scalefish (i.e. species caught in addition to those listed above as either primary target species or key by-product species) are reported on monthly returns in the NDSMF.

ERA Risk Rating: Impact on breeding stocks of other scalefish (C0 L6 NEGLIGIBLE)

In 2002, the reported catch of 'other scalefish species' (as defined above) was approximately 35 t, representing 8% of the total scalefish catch in the NDSMF. In 2002, the annual catches of only 3 of these species groups, sea bream (*Gymnocranius spp*.), longnose emperor (*Lethrinus olivaceus*) and red snapper (*Lutjanus erythropterus*), were greater than 2 t (Table 12). These species are all widely distributed throughout the Indo-west Pacific (Allen 1997). Therefore, annual catches of less than 10 t are unlikely to have any substantial impact on the relative spawning stocks of each species.

The remaining species that contribute to the catch of 'other scalefish' are caught in relatively small quantities (i.e. <2 t per year). Each of these species has a broad distribution and so the low catches by the NDSMF are expected to have a negligible impact on the spawning stocks of each species. Some of these scalefish species are taken in moderate quantities by other Western Australian fisheries (Table 12), although they are each taken in only minor or negligible quantities in the Kimberley region.

Therefore, it was considered **'likely'** that the fishery will have a **'negligible'** impact on the populations of 'other scalefish'. This resulted in a risk rating of **NEGLIGIBLE**.

Action: The Department of Fisheries does not undertake annual stock assessments of 'other scalefish' species caught by the NDSMF. This is considered appropriate because i) catch levels are very low, ii) effort controls are in place, and iii) relatively minor total catches of these species occur in the Kimberley region. However, the Department does monitor annual catch levels of each species using CAES data and data from observer surveys of the NDSMF. Any significant increase in catch levels will be reported in the annual status report for the NDSMF.

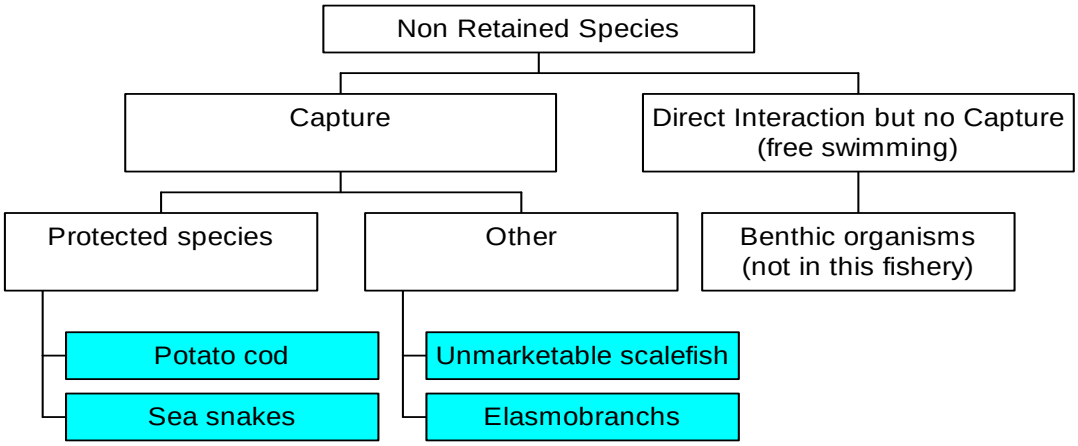
Table 12 Catches of all species reported by theNDSMF, and total WA state catch by all fisheries in 2002.

Common Name	Scientific Name	Trap catch (kg)	Total WA catch (t)	Trap catch (% of WA catch)	
Goldband Snapper	*Pristipomoides spp. (*mainly *P. multidens)*	151828	513.7	30	T
Red Emperor	*Lutjanus sebae*	101050	243.3	42	T
Scarlet perch	*Lutjanus malabaricus*	61259	162.4	38	
Spangled emperor	*Lethrinus nebulosus*	33920	188.9	18	
Cod	Serranidae	21976	93.5	23	
Spotted cod	*Epinephelus areolatus, E. bilobatus*	11104	33.5	33	
Rankin cod	*Epinephelus multinotatus*	8905	58.0	15	
Sea bream	*Gymnocranius* spp.	6612	6.7	99	
Longnose emperor	*Lethrinus olivaceus*	3936	17.1	23	
Eight bar cod	*Epinephelus octofasciatus*	3653	17.1	21	
Red snapper	*Lutjanus erythropterus*	2559	325.8	1	
Robinson's seabream	*Gymnocranius grandoculis*	1584	51.9	3	
Moses perch	*Lutjanus russelli*	1513	48.8	3	
Maori cod	*Epinephelus cyanopodus*	1276	1.3	98	
Coral trout	*Plectropomus maculatus #*	1270	22.5	6	
Maroon perch	*Lutjanus lemniscatus*	1229	11.8	10	
Duskytail grouper	*Epinephelus bleekeri*	1228	1.5	82	
Nor-west snapper	*Lethrinus* spp.	1100	256.0	0	
Sweetlip	Haemulidae	916	80.3	1	
Pearl perch	*Glaucosoma buergeri*	890	38.0	2	
Mangrove jack	*Lutjanus argentimaculatus*	823	15.9	5	
Sweetlip emperor	*Lethrinus miniatus*	735	97.4	1	
Foxfish	*Bodianus* spp.	564	1.1	50	
Red spot emperor	*Lethrinus lentjan*	487	75.1	1	
Flagfish	*Lutjanus vitta*	370	212.5	0	
Blue-spot emperor	*Lethrinus hutchinsi*	286	407.1	0	
Chinaman fish	*Symphorus nematophorus*	272	11.1	2	
Frypan snapper	*Argyrops spinifer*	103	42.1	0	
Trevally	Carangidae	99	193.8	0	
Cobia	*Rachycentron canadus*	87	35.3	0	
Parrotfish	*Scarus* spp., mainly *Scarus ghobban*	70	9.7	1	
Pink snapper	*Pagrus auratus*	69	850.4	0	
Amberjack	*Seriola dumerili*	67	3.3	2	
Golden trevally	*Gnathodon speciosus*	57	2.1	3	
Monocle bream	*Scolopsis* spp.	20	7.0	0	
Barracuda	Sphyraenidae	15	2.9	1	
Red mullet	Mullidae	12	108.8	0	
Seaperch	*Lutjanus* spp.	10	6.8	0	
Tang's snapper	*Lipocheilus carnolabrum*	9	0.1	9	
Javelinfish	*Pomadasys* spp.	5	21.6	0	
Northern mulloway	*Protonibea diacanthus*	5	78.6	0	
Ruby snapper	*Etelis spp.*	5	10.8	0	
Tuskfish	*Choerodon* spp.	5	11.8	0	
Catfish	Ariidae	4	18.8	0	
Other scalefish		11662	136.1	9	
Total		**433649**	**6656.6**	**7**	

(# only species caught by trap fishery shown, but total WA catch includes additional species) (T = target species)

5.2 NON-RETAINED SPECIES

COMPONENT TREE FOR THE NON-RETAINED SPECIES



A blue box indicates that the issue was considered a low risk, with no specific management required, and only a justification is presented.

5.2.1 PROTECTED/LISTED SPECIES

5.2.1.1 POTATO COD

Rationale for Inclusion:

Potato cod (*Epinephelus tukula*) are rarely caught in the tropical demersal finfish fisheries of Western Australia, and hence are rarely caught by fishers using fish traps or lines in the NDSMF. Potato cod have been a totally protected fish species in Western Australia since 1 July 1992 (FRMR).

ERA Risk Rating: Impact on breeding stock (C0 L6 NEGLIGIBLE)

Potato cod occur throughout the Indo-west Pacific, including the NDSMF, but are relatively uncommon and are not caught in sufficient quantities to be of commercial fisheries significance. However, large individuals may command high prices on the live food fish market in Hong Kong and China. Various biological characteristics (e.g. slow growth, late maturity, extended longevity, low natural mortality, inquisitive nature/ease of capture) make potato cod vulnerable to over-exploitation.

The level of incidental capture of Potato cod by fishers in the NDSMF is unknown. All potato cod caught by fish trapping are released as they are not allowed to be retained due their protection under the FRMR. Released fish are unlikely to survive if caught from depths greater than 40 m. However, catch levels are believed to be very low (incidental only), and so the NDSMF is **'likely'** to have a **'negligible'** impact on breeding populations of Potato cod. This results in a risk rating of **NEGLIGIBLE**.

Action: As part of the revised catch reporting system, compulsory reporting of any interactions with protected species will be required from all fishers. Catch levels (if any) will be subsequently reported in the annual status report for the NDSMF.

5.2.1.3 SEA SNAKES

Rationale for Inclusion:

Sea snakes are occasionally caught by the fishery and are released alive.

All species in the families Hydrophiidae and Laticaudidae are listed as protected species under Commonwealth legislation (EPBC). It is an offence to kill, injure, take, trade, keep or move a member of a listed species without a permit (EPBC).

ERA Risk Rating: Impact on breeding stock (C0 L6 NEGLIGIBLE)

Sea snakes are potentially vulnerable to overfishing because they grow and reproduce slowly. However, the impact of the NDSMF on sea snake populations is likely to be minimal because sea snakes are rarely caught and are released alive (S. Newman, pers. obs.). The composition of the sea snake catch is unknown, but is likely to include *Hydrophis elegans*. *H. elegans* is one of the most common species of sea snakes caught by the Pilbara Fish Trawl Fishery (Stephenson and Chidlow 2003) and prawn trawl fisheries in northern Australia. This species occurs across northern Australia and New Guinea (Heatwole 1999).

In general, the impact of the NDSMF on sea snake populations is likely to be minimal because the area of the fishery in which sea snakes are vulnerable to capture is small relative to the total distribution of each species. No estimates of population size are available for local sea snakes but many species are commonly observed across northern Australia and none are listed as vulnerable. Apart from the impact of fishing, there are probably few other threats to sea snake populations. The likelihood of survival is high for sea snakes that are released after capture. A study in the Gulf of Carpentaria found that 60% of sea snakes survive capture by prawn trawling (Wassenburg *et al.* 1994). Stobutzki *et al.* (2000) reported that in commercial prawn trawl shots of duration >180 min, the mortality of sea snakes ranged from 20-59%. Sea snakes caught by trawling are usually quite active when brought on deck, suggesting that they suffer limited harm during capture. The rate of survival after capture by trapping is expected to be higher than trawling.

Some NDSMF fishers have observed foreign fishing vessels with catches of dried sea snakes visible on deck. However, the magnitude of sea snake catches by traditional fishing operations is unknown.

Therefore, the NDSMF is **'likely'** to have a **'negligible'** impact on breeding populations of sea snakes. This results in a risk rating of **NEGLIGIBLE**.

Action: Although the impact on sea snakes stocks by the NDSMF is probably minimal, the performance of the fishery in regard to by-catch of sea snakes could be improved. Catches/discards by the fishery are not currently reported. However, as a protected species in Australia, all unintentional catches of sea snakes by the fishery

are required to be reported. Skippers will be encouraged to record details of the catch, release and mortality of protected species such as sea snakes. Incidental captures of protected species will be reported in the annual status report for the NDSMF.

5.2.2 OTHER NON-RETAINED SPECIES

5.2.2.1 UNMARKETABLE SCALEFISH

Rationale for Inclusion:

Several species of scalefish are caught in small quantities by the NDSMF and are discarded because they are unmarketable.

ERA Risk Rating: Impact on breeding stocks (C0 L6 NEGLIGIBLE)

Fishers in the NDSMF use trap fishing and line fishing methods to selectively target demersal scalefish species of significant commercial importance. Catches of non-target species, including unmarketable fish, are very low.

Data from surveys aboard industry vessels suggest that the annual discards by the NDSMF are equivalent to approximately 1.3% (by numbers) of the total retained catch (Newman *et al.* 2001). Therefore, assuming that the proportion of the non-retained catch by numbers is similar to the proportion of the non-retained catch by weight and is consistent through time, then the estimated weight of discards was approximately 6.4 t in 2001 and 5.6 t in 2002.

Starry triggerfish (*Abalistes stellaris*) is the most common non-retained species in the NDSMF and represents 85% of the non-retained catch (Newman *et al.* 2001) (Table 13). The level of catch and hence discards of starry triggerfish by the NDSMF fleet in 2001 and 2002 was estimated to be approximately 5.4 t and 4.8 t (85% of catch estimated above). Observations by trap fishers and Department of Fisheries staff suggest that some, possibly many, discarded starry triggerfish survive capture and release, although this has not been quantified.

Starry triggerfish have a widespread distribution throughout the Indo-west Pacific, including waters to the north and south of the NDSMF. They occur across a wide range of depths and habitat types in coastal and shelf waters (Allen 1997, Newman and Williams 2001). Given the small annual catch of starry triggerfish in the NDSMF and that at least a portion of these fish survive, the impact of the NDSMF on breeding populations of starry triggerfish is likely to be negligible.

Table 13 Species composition of the by-catch or discard component of the landed commercial catch sampled during surveys aboard NDSMF industry vessels and their relative contribution (% frequency) to the total catch (adapted from Newman *et al.* 2001).

Scientific Name	Common Name	% Frequency
Abalistes stellaris	Starry triggerfish	1.07
Sufflamen fraenatus	Brown triggerfish	0.08
Abalistes sp.	Long-finned starry triggerfish	0.03
Heniochus acuminatus	Longfin bannerfish	0.02
Myripristis murdjan	Crimson squirrelfish	0.02
Pterois volitans	Red lionfish/ firefish	0.02
Sargocentron rubrum	Red squirrelfish	0.02

The remainder of the non-retained catch (i.e. excluding starry triggerfish) was estimated to have been approximately 1.0 t in 2001 and 0.8 t in 2002. These total quantities include several species, and as a result catches of individual species are very low. Data from surveys aboard industry vessels suggest that the remainder of discards mainly comprise bannerfish (Chaetodontidae), squirrelfish (Holocentridae) and lionfish (Scorpaenidae).

The above species are discarded because they are unmarketable or unpalatable. These species are not retained by any commercial or recreational fishery in north-western Australia.

Therefore, it was considered that the impact of the NDSMF on breeding populations of starry triggerfish and other unmarketable scalefish species that are discarded is **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

Action: The level of bycatch of trap and line fishing vessels in the NDSMF fleet will be recorded as part of any future observer surveys of the NDSMF. The reporting requirements of the fishery are currently being modified with a planned move to reporting catches on a trip-by-trip basis. This will include an area for the collation of any bycatch data and also compulsory reporting of any interactions with protected species. As data becomes available from bycatch reporting on returns and by the proposed regular observer programs, the species composition and amount of bycatch being captured by the fishery will be assessed. Any significant change in the species and/or level of by-catch in the NDSMF will be reported in the annual status report for the NDSMF.

5.2.2.2 SHARKS

Rationale for Inclusion:

Fishers in the NDSMF occasionally land sharks.

ERA Risk Rating: Impact on breeding stocks of sharks (C0 L6 NEGLIGIBLE)

In 2001 and 2002, no elasmobranch species were reported on statutory monthly returns. The species composition of any retained or discarded elasmobranch catch in

the NDSMF is unknown. However, discussions with fishers indicate that sawfish are not part of the landed catch in this fishery (S. Newman, pers. comm.).

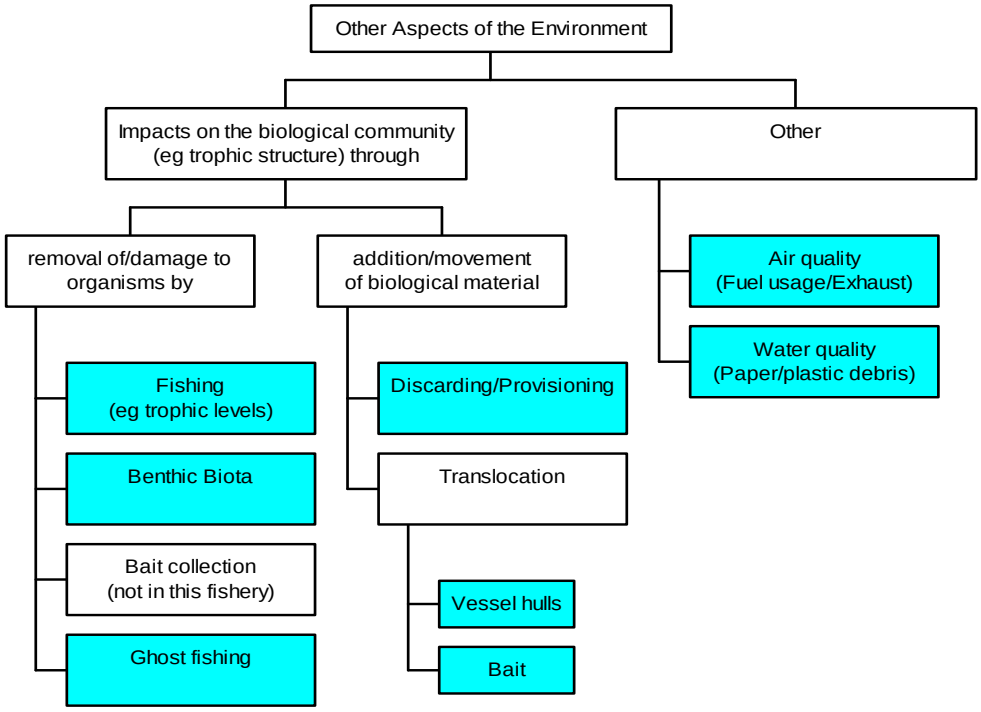
Elasmobranchs are vulnerable to overfishing because they have highly K-selected life history strategies (i.e. long-lived, slow to reproduce). However, the impact of the fishery on each elasmobranch species is likely to be negligible because very small quantities of any elasmobranch species are caught.

The impact of the NDSMF on each elasmobranch species is also likely to be negligible because the area of the fishery in which each species is vulnerable to capture by trapping is small relative to the total distribution of each species. Furthermore, the NDSMF management plan imposes a trip limit on the retained catch of shark. Under section 27 of the *Northern Demersal Scalefish Fishery Management Plan 2000*, a maximum of 2 whole sharks are permitted per trip.

Therefore, it was considered that the impact of the fishery on shark populations is **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

5.3 GENERAL ENVIRONMENT

COMPONENT TREE FOR THE GENERAL ENVIRONMENT



A blue box indicates that the issue was considered a low risk, with no specific management required, and only a justification is presented.

5.3.1 REMOVAL OF/DAMAGE TO ORGANISMS

5.3.1.1 FISHING (E.G. TROPHIC LEVELS)

Rationale for Inclusion:

The assessment of potential indirect ecosystem impacts that could result from the removal of target species by a fishery should always be assessed. Scalefish comprise almost the entire catch of the NDSMF. Most of the scalefish species are medium to large sized, generalist carnivores, feeding on smaller fish, crustaceans and molluscs. The deep-water snappers (*Pristipomoides* spp.) feed on pelagic urochordates, squid and small fish. There is no evidence that any of these species play a 'keystone' role in the ecosystem. Therefore, the majority of these species are similar in their trophic function and it is appropriate to consider the impact of total scalefish removals by the fishery.

ERA Risk Rating: Impact on the environment (C1 L5 LOW)

Scalefish comprise almost the entire catch of the NDSMF. The fishery retained a total of 434 t of demersal scalefish in 2002 (504 t in 2001). The contribution of non-

retained fish to total removals by the fishery is probably negligible because the total quantities of non-retained fish are low (see section 5.2.2.1). Also, triggerfish comprise the majority of non-retained fish and many returned triggerfish are expected to survive.

It is unlikely that total removals by the fishery would significantly disrupt trophic dynamics in the region. Most species in the catch are generalist carnivores and consume a wide range of fish and invertebrates prey across a diverse range of benthic habitats. Therefore, the impact of any reduction in scalefish predator abundance would be spread across many prey species. Moreover, the spawning biomass of many of the target and by-product species taken in the fishery is considered to be at relatively high levels (>50%). In addition, there are other species of medium-sized carnivores in the Kimberley region that are not caught in significant quantities by the fishery and contribute to the total biomass of carnivores in the region. These non-target species play a similar trophic role to targeted species and would compensate for the effect of removals by the fishery.

It is possible that scalefish removals by the fishery have small-scale, localised impacts in some areas of the fishery. However, overall catch rates of most fish species are stable across the fishery and this suggests that scalefish recruitment has not been affected by removals and that the total biomass of medium-sized, generalist carnivores in the region is probably being maintained at a level sufficient to maintain trophic function. There is no evidence that any lower order species are increasing in abundance as a result of this (or any other) fishery operating in the region.

In a review of scientific studies on the effects of fishing on marine ecosystems, Jennings and Kaiser (1998) concluded that "where the functional and species diversity of fishes is relatively high, the indirect effects of fishing on the abundance of unfished prey species appears to be minor". Tropical marine waters are characterised by communities of high species diversity. In such systems, the overall effect of piscivores on their prey is substantial but the removal of one species, or a small group of species, is minor (e.g. Hixon 1991). In the NDSMF, there is no evidence to suggest that the removal of scalefish by commercial fishing has directly resulted in a significant trophic effect (i.e. extinction and/or appearance of new species or other measurable shift in ecosystem function). Examples of such "trophic cascades", which occur because fishing interferes with predator-prey (or herbivore-plant) interactions, are quite rare. Evidence to suggest a shift in the community composition on the north-west shelf due to fishing (Sainsbury *et al.* 1997) is thought to be associated with direct habitat removal by trawl gear rather than removals of target species.

Therefore, it was considered that the trophic impact of total removals from the NDSMF was '**probably**' (likelihood level 5) **'minor'**, resulting in a risk rating of **LOW**.

Action: Although the trophic impact of total removals by the NDSMF was rated as LOW, the Department of Fisheries recognises that an assessment of trophic impacts by fisheries at a regional level, rather than at the individual fishery level, would be beneficial. Consequently, the Department will investigate the development of research to identify any detectable changes in the structure of coastal fish communities in this region over the last 40 years.

5.3.1.2 BENTHOS

Rationale for Inclusion:

Small numbers of attached epibenthos such as sea fans, seawhips, soft corals and coralline algae, may be damaged and removed by the actions of the fish traps.

ERA Risk Rating: Impact on benthos (C0 L6 NEGLIGIBLE)

Epibenthos may be damaged by traps when they are being retrieved, and by the movement of traps by tidal action during the soak period. Damage to epibenthos occurs when traps are dragged across the bottom, which mainly occurs during periods of strong currents. Under these conditions, traps may be dragged several metres. At other times, traps are expected to cause little damage to epibenthos.

The amount of epibenthos that is retrieved by traps (i.e. observed by fishers) is minimal. The amount of epibenthic material that is disturbed by traps, but is not retrieved (i.e. is not observed) is unknown. However, the level of disturbance is limited by the small number of vessels (6 vessels in 2001, 5 in 2002) that currently operate over a large fishing area (226,500 km^2) within the fishery.

Therefore, the impact of the NDSMF on epibenthic communities was considered **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

5.3.1.3 GHOST FISHING

Rationale for Inclusion:

Small numbers of fish traps are lost in the NDSMF each year. Traps are also left at sea, with doors open when returning to port.

ERA Risk Rating: Impact on ghost fishing (C0 L6 NEGLIGIBLE)

The number of traps lost at sea by the fishery each year is unknown, but discussions with fishers suggest that it is low (S. Newman, pers. comm.). Ghost fishing by lost traps is unlikely to result in significant mortality of any scalefish species, because similar fish species have been observed in video surveys to be able to enter and exit traps with relative ease (M. Cappo, pers. comm.). Traps that are deliberately left at sea could catch small quantities of fish, but the doors are left open and the traps are unbaited.

Therefore, the impact of 'ghost fishing' by fish traps on scalefish populations in the NDSMF is **'likely'** to be **'negligible'**, resulting in a risk rating of **NEGLIGIBLE**.

5.3.2 ADDITION/MOVEMENT OF BIOLOGICAL MATERIAL

5.3.2.1 DISCARDING/PROVISIONING

Rationale for Inclusion:

The discarding of fish, as non-retained catch, by the fishery results in a food source that would not normally be available to other organisms.

ERA Risk Rating: Impact on general environment (C0 L6 NEGLIGIBLE)

The quantity of scalefish that is discarded by the NDSMF is low. It is estimated that the fishery discarded approximately 6.4 t and 5.8 t of scalefish in 2001 and 2002, respectively. There is no processing of the retained catch onboard and so fish waste products (e.g. heads, fins and guts) are not discarded at sea. Discards occur over a large area of the fishery and discards are likely to disperse as they sink in the water column due to currents. Therefore, the impact of discarding will be diffused.

The total area of the offshore zone of the NDSMF is 408,400 km^2. Fishing is currently focused on the area from the inshore boundary to the 200 m depth contour, an area of 226,500 km^2. Therefore, the rate of provisioning from discards is very low and was estimated at 28.3 g per km^2 in 2001 and 25.6 g per km^2 in 2002. This amount is extremely low, relative to the biomass of food sources naturally available to carnivores and scavengers in the region. Also, 85% of discards consisted of triggerfish, many of which are expected to survive after discarding. Therefore, the actual rate of provisioning is likely to be lower than that suggested from total discards.

Therefore, it was considered that the impact of discarding of biological material by the fishery is **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

5.3.2.2 TRANSLOCATION – VESSEL HULLS

Rationale for Inclusion:

Vessels used in the fishery travel between regions and could potentially be a vector for exotic species and diseases.

ERA Risk Rating: Impact on the general environment (C4 L1 LOW)

Five vessels operated in the NDSMF in 2002 (6 in 2001). In addition to fishing in the Kimberley region, each vessel travels to Darwin approximately once per year for maintenance. The hulls of vessels moving between regions could provide an opportunity for translocation of organisms. However, hulls are regularly anti-fouled. Vessels operating in the fishery do not use ballast water.

Ocean currents on the north-west shelf are variable in direction and magnitude. However, the predominant flow is southward, under the influence of the Indonesian "throughflow" current and the Leeuwin Current (Cresswell 1991). Therefore, vessels

traveling between Darwin and the NDSMF are unlikely to translocate organisms beyond the range of dispersal that would occur through natural processes.

Therefore, although the impact of translocation of exotic pests or diseases via vessel hulls could be **'major'**, the likelihood of this event is **'remote'**. This results in a risk rating of **LOW**.

5.3.2.3 TRANSLOCATION - BAIT

Rationale for Inclusion:

The fishery uses bait that is imported from other regions and thus could potentially be a vector for exotic species and diseases.

ERA Risk Rating: Impact on the environment (C4 L1 LOW)

Pilchards are used as bait in the NDSMF. Pilchards are mostly caught in the southern region of Western Australia, but some pilchards are also imported from South Australia or elsewhere if necessary. There is a risk of translocation of exotic diseases via pilchards, mainly from the Australian south coast, to the Kimberley region.

Pilchards are known vectors of disease in Australian waters (Gaughan *et al.* 2000). However, the risk of translocation of disease to the Kimberley region via pilchards is minimized by the following factors:

1) Imported bait is frozen. Most large-size parasitic organisms (e.g. worms) do not survive freezing. Freezing thus limits potential translocations to small organisms, such as viruses, which survive the freezing process.
2) Pilchards are temperate species. Most pathogens imported from southern Australia and other temperate marine waters will be heat-sensitive and unlikely to survive in the tropical waters of the Kimberley region.
3) There are no local pilchard (*Sardinops sagax*) populations in the NDSMF to infect and it is unlikely that infection will cross species and affect tropical pilchard species.
4) The risk of introducing disease is dependant on the pattern of bait usage. Trap fishers in the NDSMF typically use approximately 60 kg of pilchard bait per standard fishing day (use of 20 fish traps). In 2002, a total of 808 standard fishing days were fished in the NDSMF, resulting in the use of an estimated 48.5 t of pilchard bait. This bait is used over an area of approximately 226,500 km^2. The amount of bait used per square kilometer is very small (214 g per km^2). Regular use of small, dispersed quantities of bait (e.g. this fishery) is less risky than occasional use of large quantities that are concentrated in space or time (e.g. use in aquaculture facilities) (Jones and Gibson 1997, Jones 2000).

Therefore, although the impact of translocation of exotic pests or diseases via bait could be **'major'**, the likelihood of this event is **'remote'**. This results in a risk rating of **LOW**.

5.3.3 OTHER ENVIRONMENTAL IMPACTS

5.3.3.1 AIR QUALITY (EXHAUST FUMES)

Rationale for Inclusion:

Trap vessels produce exhaust fumes.

ERA Risk Rating: Impact on general environment (C0 L6 NEGLIGIBLE)

There were 5 full time vessels operating in the fishery in 2002. The fishery extends from south of Broome to the Northern Territory border. The impact of exhaust fumes released by the fishery over this large area is **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

5.3.3.2 WATER QUALITY (DEBRIS)

Rationale for Inclusion:

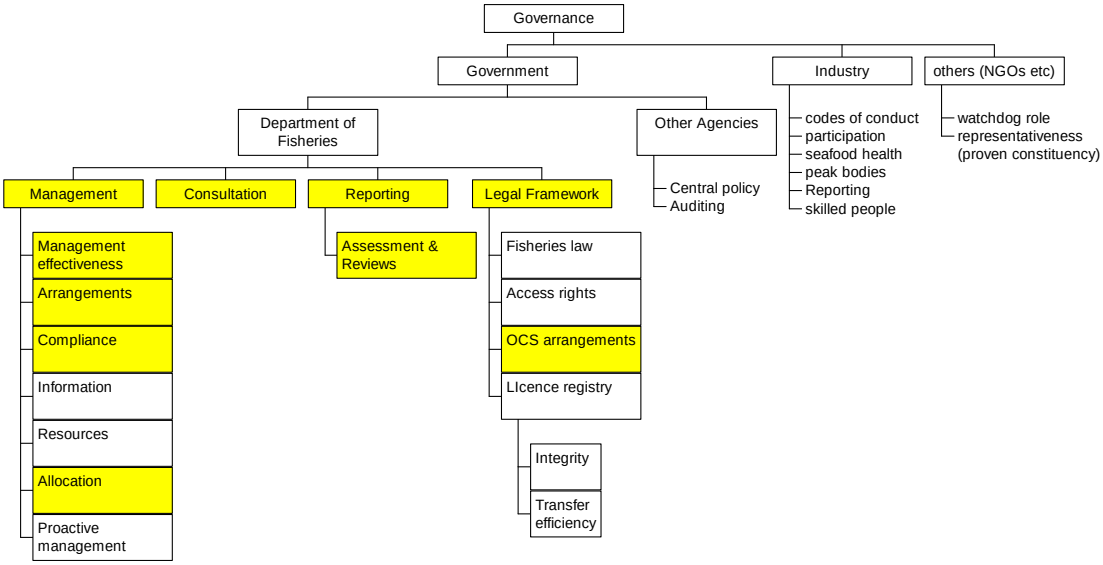
Fish trapping operations produce small quantities of plastic and paper debris that must be disposed of.

ERA Risk Rating: Impact on general environment (C0 L6 NEGLIGIBLE)

The fishery operates under an international code of practise (MARPOL) that specifies the appropriate disposal of debris at sea. The obligations of fishers under this code are clearly displayed on each vessel. Plastics are not discarded at sea by the fishery. Paper debris may be discarded at sea, but only when vessels are greater than 12 nm from shore. There were 5 vessels operating in the fishery in 2002. The NDSMF extends from south of Broome to the Northern Territory border. The impact of any paper debris, which is readily biodegradable, being released by the fishery over this large area is **'likely'** to be **'negligible'**. This results in a risk rating of **NEGLIGIBLE**.

5.4 GOVERNANCE

COMPONENT TREE FOR THE GOVERNANCE OF THE NDSMF



Nb- no generic components have been removed from the tree but only those boxes that are yellow will be reported in this application.

5.4.1 DEPARTMENT OF FISHERIES – MANAGEMENT

5.4.1.1 MANAGEMENT EFFECTIVENESS (OUTCOMES)

Rationale for Inclusion:

The effectiveness of management arrangements in the NDSMF are ultimately measured by assessing the outcomes of various strategies employed to manage this fishery. Effort has been controlled through input controls since the inception of the management plan in 2000. These include individually transferable effort allocations, gear restrictions and spatial (area) closures. In section 5.1.1.1 5.1.1.2 and 5.1.2.1, the catches for individual demersal scalefish species were discussed and analysed, therefore this section will look at the cumulative catch and assess whether current management arrangements are maintaining the total catch for all demersal scalefish species within an acceptable range.

If the annual acceptable catch range of demersal scalefish is maintained, then the community's expectation that variations in annual catch result only from annual changes in environmental conditions, or planned changes to the management of the level of commercial exploitation, and not from the depletion of the stock. Any large

unexplained variation in catch is likely to be a reflection of a reduction in management effectiveness and therefore reduce the community's confidence in the management of the resource and raise concerns about the on-going sustainability of the fishery.

Operational Objective

The commercial catch of the major species of demersal scalefish in the NDSMF are maintained within a determined acceptable range on an annual basis.

Justification:

If effective management arrangements are operational in the fishery (including the restrictions on effective effort levels, compliance with the regulations are being maintained effectively, combined with our understanding of the size of the exploitable stock), then the actual total catch for the major demersal scalefish species caught should be very close to the total acceptable catch. Any variation outside of the acceptable total catch range would elicit the need to explain the cause of this deviation and potentially result in changes to management arrangements.

Indicator

The total catch compared to the historical acceptable range for the six major demersal scalefish species in the NDSMF.

Performance Measure

Under the current fishing effort levels, the catch projections for the NDSMF are that the total catch of major demersal scalefish species should be less than 800 tonnes. However within this overall figure, consideration needs to be given to catches at the species level, particularly for red emperor and goldband snapper (see Section 5.1).

Justification:

The justification for the individual levels for each demersal scalefish species is located in Section 5.1

Data Requirements for indicator

The following data are required for this indicator:

Data Requirement	**Data Availability**
Commercial catch and effort	Yes – obtained annually.
Historical catch levels	Yes – records available and accessible.
Level of fishing effort and fishing power	Yes – number of vessels, days fished, number of traps used, areas of operations and activity and fishing power comparisons readily available.

Environmental indicators	Yes – key environmental indicators readily available.

Evaluation

Summary: Historical catch and effort information indicate that the catch levels for the fishery are below the target for the fishery and thus catch levels are being maintained. Therefore, the performance measure has not been triggered and current management strategies appear to be effective in achieving the overall objectives for the fishery.

The total landings for all species for the 2002 and 2001 season in the NDSMF were 434 and 504 tonnes (Table 14), which is below the target of 800 tonnes and within the range of 600 - 1000 tonnes (i.e. 800 tonnes ±20%). The 504 tonnes in 2001 included 95 tonnes of Red emperor, 38 tonnes of Scarlet perch, 204 tonnes of Goldband snapper, 83 tonnes of cod species, and 34 tonnes of Spangled emperor (Table 15). These figures represent both the trap and line catches.

Robustness
Medium / High

The data required for the indicators in most cases are readily available. However, the changes in fishing power and fleet efficiency through time need to be evaluated and considered in these analyses to ensure that the measures continue to be relevant.

Fisheries Management Response

The management measures imposed to achieve the objective for the total catch (see above) also serve to achieve the objective for the maintenance of spawning stock for the major demersal scalefish species caught at or above a level, which minimizes the risk of recruitment over fishing.

Historically, variations in catch outside of the acceptable range have been explained either in terms of increased fishing effort, increased fishing efficiency or seasonal environmental factors. The response to these issues has been to reduce fishing effort (e.g. spatial or temporal closures) with a focus on limiting the exploitation of breeding stocks and to develop a predictive model to take account of environmental factors such as sea surface temperature and ENSO, El Nino and La Nina events.

The Department of Fisheries is doing further work to improve the measurement of fishing efficiency and understanding of the relationship between stock recruitment and environmental factors and catch. The Department will continue to use input controls to adjust for variations in fishing efficiency. Furthermore, the introduction of the VMS has led to the ability of the Department of Fisheries to collect and analyze data on the area utilised by this fishery and individual fishing boat activity.

YEAR	Total Allowable Effort	Line catch (kg)	Line effort (days)	Trap Catch (kg)	Trap Effort (days)	Total Catch (kg)
1989		23,979	267	26,649	81	50,628
1990		4,638	91	202,783	395	207,421
1991		16,031	255	316,228	750	332,259
1992		29,607	433	695,954	1,776	725,561
1993		23,507	283	747,215	1,713	770,722
1994		71,763	453	656,937	1,349	728,700
1995		265,798	1,204	555,162	1,200	820,960
1996		242,590	1,319	706,063	1,412	948,653
1997		146,548	788	555,172	1,293	701,720
1998	1,684	44,863	78	497,154	916	542,017
1999	1,716	91,045	228	485,918	992	576,963
2000	1,562	68,543	155	401,487	890	470,080
2001	1,672	41,822	136	462,498	928	504,320

Table 14 Total catch (tonnes) by trap and line vessels of the demersal scalefish species for the NDSMF (landings from monthly CAES returns).

Species Group	Line Catch (tonnes)	Line Catch (%)	Trap Catch (tonnes)	Trap Catch (%)	Total Catch (tonnes)
Red emperor	1.3	0.3	93.7	18.6	95.0
Goldband snapper	33.5	6.6	170.8	33.9	204.3
Cod Species	2.0	0.4	81.8	16.2	83.8
Spangled emperor	-	-	34.4	6.8	34.4
Scarlet perch	2.3	0.4	36.0	7.1	38.3
Red snapper	0.5	0.1	2.2	0.4	2.7
Other species	2.3	0.5	43.7	8.7	45.9
All Demersal Finfish	41.8	8.3	462.5	91.7	504.0

Table 15 Percentage of total catch by trap and line vessels of the major demersal scalefish species (landings from monthly CAES returns).

Actions if Performance Limit is Exceeded: If the catch were outside the range of expected values then a review of the causes would be undertaken. This review would examine why the acceptable catch range was not met. If this variation is not explained by changes in effort or environmental variations or a peculiarity of fleet dynamics and behaviour then strategies that offer further protection to the breeding stock will be considered. These strategies that could be employed within the season or at the start of the next season include:

- Further reductions in the total effort expended in the fishery through a reduction in the length of the fishing season or within seasonal closures.
- Trigger points on the vulnerable species to trigger a review of the status of the fish stocks.
- Area closures.

Comments and Actions

While the Department has been able to maintain the catch of the major demersal scalefish species within acceptable levels, it continues to work on improving and refining the methods used to determine breeding stock estimates. The use of GIS systems for analysing data has also commenced.

External Driver Checklist

Environmental factors such as climatic changes, cyclonic activity impacting habitat, ocean currents and sea surface temperatures are known to impact upon recruitment and therefore are likely to impact the level and productivity of breeding stocks.

5.4.1.2 MANAGEMENT ARRANGEMENTS

Rationale for Inclusion:

In Western Australia, a number of instruments are used to articulate the management arrangements for fisheries. The FRMA has elements that affect all fisheries. The FRMA provides for the creation of Management Plans, Orders, Regulations, Ministerial Policy Guidelines and Policy Statements.

In cases where the current management arrangements were developed under the previous Act, whilst the terminology is slightly different, the powers from the previous Act have been transferred under various sections of the Transitional Provisions of the FRMA ((S 266) Savings and transitional provisions – Schedule 3 parts 8-12, 15-19).

The Act sets out the objects for the sustainable management of fish resources in Western Australia, and provides the framework for developing and implementing management plans for each of the State's fisheries (Table 16). The *Northern Demersal Scalefish Managed Fishery Management Plan 2000* effectively is a set of rules for the fishery and includes *inter alia* clauses concerning the spatial boundaries of the fishery, gear restrictions, and transferability arrangements.

Management arrangements for the commercial take of demersal scalefish in the Kimberley region off Western Australia are provided for through a managed fishery licence.

Table 16 Objects of the FRMA.

Objects
(1) The objects of this Act are to conserve, develop and share the fish resources of the State for the benefit of present and future generations. (2) In particular, this Act has the following objects- (a) to conserve fish and protect their environment; (b) to ensure that the exploitation of fish resources is carried out in a sustainable manner; (c) to enable the management of fishing, aquaculture and associated industries and aquatic eco-tourism; (d) to foster the development of commercial fishing and recreational fishing and aquaculture; (e) to achieve the optimum economic, social and other benefits from the use of fish resources; (f) to enable the allocation of fish resources between users of those resources; (g) to provide for the control of foreign interests in fishing, aquaculture and associated industries; (h) to enable the management of fish habitat protection areas and the Abrolhos islands reserve.

Operational Objective

In consultation with the industry members and other stakeholders, the Department periodically reviews the legislation, regulations and Ministerial policy guidelines to ensure the management framework remains relevant and aligned with the management objectives.

To have an effective and understandable plan for the management of this fishery with all of the 10 principles covered within the suite of arrangements developed for the fishery.

Justification:

Management arrangements ultimately enable the sustainable exploitation of a natural resource where the potential to harvest the resource could exceed the ability of the resource to replenish itself. The development of rules can restrict the potential to harvest (effort) to an appropriate level, and management arrangements can define processes within which access to the resource can be allocated to competing user groups (including natural ecosystems).

Indicator

The extent to which the FRMA, FRMR, Management Plans, Ministerial Policy Guidelines and other management arrangements allow for the timely setting of appropriate effort levels and resource allocation in the fishery.

The extent to which the management plan and supporting documentation addresses each of the issues and has appropriate objectives, indicators and performance measures, along with the planned management responses

Performance Measure

This should be 100%.

Evaluation

Formal evaluation of the management arrangements of the NDSMF has been completed. Preliminary investigations suggest that management arrangements for the fishery are adequate in that little potential exists for fishermen to activate inappropriately high levels of effort that could place the target demersal scalefish resource at risk.

The performance of current management arrangements can be evaluated on two levels – the micro level, i.e. the relevance of individual clauses/regulations and the role they play; and on the macro level, i.e. the relevance of the plans, endorsements or arrangements as a whole and the role that they play.

Current Performance against each of the areas required within the "plan"[1]:

1. **An explicit description of the management unit** – The management unit for NDSMF is explicitly described at Section 11 of the *Northern Demersal Scalefish Managed Fishery Management Plan 2000*. These management arrangements restrict the amount of fish traps allowed in the fishery.

2. **The issues addressed by the plan** –The issues that need to be addressed by the fishery management arrangements have been examined thoroughly and are documented within the 8 ESD component trees and their reports.

3. **Descriptions of the stocks, their habitat and the fishing activities** – the NDSMF demersal scalefish stocks are described in Section 2.1 and the fishing activities are described in Section 2.2.

4. **Clear operational (measurable) objectives and their associated performance measures and indicators** – These are now located in Section 5 for each of the major issues.

[1] "Plan" – includes all management arrangements

5. **Clearly defined rules, including what actions are to be taken if performance measures are triggered** – For each of these major issues, the management actions that are planned to be taken if performance limits are exceeded are now articulated in Section 5.

6. **Economic and social characteristics of the groups involved in the fishery** – A brief articulation of the economic and social characteristics of the fisheries is located in Section 3.3 and there is to be a greater level of detail accumulated during the process of completing the remainder of the ESD components.

7. **Management and regulatory details for the implementation of the actual management plan** – The regulations relating to the NDSMF are located in the *Northern Demersal Scalefish Management Plan*, and the FRMR.

8. **The reporting and assessment arrangements** – These arrangements are documented in Section 5.4.4.1 and include annual reporting against current agreed performance limits and targets and a five yearly review of these arrangements and assumptions.

9. **How and when reviews of the plan will occur (including consultation mechanisms).** – The FRMA clearly sets out how the process for the review of any management plan must occur. A review of the NDSMF plans and management arrangements is currently underway with a view to developing a more comprehensive set of management arrangements for all Pilbara fisheries.

10. **A synopsis of how each of the ESD issues are being addressed** – A synopsis of ESD issues has been compiled within the Overview Table of this report.

Robustness
High

The management plans and related legislation have provided a diverse but reasonably complete set of fisheries management legislation. The fact that the management arrangements are contained within legislation provides a high degree of stability with respect to how the fisheries are managed. The process for achieving management plan changes is well understood by the majority of stakeholders and the system is flexible enough for the management process to respond to change in stimuli.

Fisheries Management Response

The Department has successfully administered the management plans and related legislation to achieve and pursue the stated objectives for the NDSMF. Changes have occasionally occurred to address key concerns or issues. For example, the unit consumption monitoring mechanism was altered in 2001 to increase flexibility to the Area 2 licensees as well as provisions being inserted that allow Area 2 licensees the ability to pay their fees by instalments.

Comments and Actions

The NDSMF is managed via a consultative process and responds readily to changing circumstances within the fishery. However, fishers are often resistant to change. This means that before fishers accept substantial changes in the annual effort allocations, they may require substantial evidence of the need to implement changes. While most fishers have a very high level of confidence in the Department's research activities, some members of the industry demand a certain level of knowledge before accepting the need for change and can be skeptical of research findings no matter how valid they may be in a statistical sense. Individual fishers' views can understandably be greatly influenced by their own experiences and observations while fishing. Thus their personal views may sometimes be contrary to the Departments view in regard to the state of the fishery. Nonetheless, there is generally a very good relationship between fishers and the Departmental research scientists and most will accept the advice of the Research Division.

The commercial success of the fishery also appears to have encouraged many fishers to be somewhat risk averse and inclined to adopt a conservative approach to managing the fishery (particularly given their level of investment). While this encourages an attitude to avoiding risks to the sustainability of the fishery, it can also sometimes make some fishers resistant to changes in fishing rules that are designed to ensure sustainability. There is also sometimes a failure to recognize that the success of the fishery is in part due to a history of adaptive management. Proposed changes are often questioned on the basis that "as the fishery is operating successfully, why should any changes be necessary or contemplated?"

External Driver Check List

- Potential resistance of fishers to support Department initiated management arrangements.
- Potential reluctance of Minister to exercise power.

5.4.1.3 COMPLIANCE

Rationale for Inclusion:

Effective compliance is vital to achieve the management objectives of any fishery. This involves a mix of sea and land patrols and since the commencement of the Plan, the VMS. The ability to conduct at sea compliance patrols on the Kimberley coast is limited because of patrol boat size and availability. However, these fisheries are monitored by VMS, and therefore there is little need for compliance vessels to monitor spatial and temporal boundary infringements, as the vessels position is automatically communicated to the Department's compliance section at all times.

Operational Objective

To have sufficiently high levels of compliance with the FRMA, FRMR and various fish trap management plans, regulations, conditions [endorsements] and notices.

Justification:

The activities of the participants in the fishery need to be sufficiently consistent with the management framework and legislation in order to make it likely that the expected outcomes and objectives of the fishery will be achieved.

Indicators

The levels of compliance with the legislation, including the estimated level of boundary infringements, and compliance with conditions of licence.

Degree of understanding and acceptance of rules governing the operation of the NDSMF by licensees and the broader fishing community.

Performance Measure

That 100% of VMS polls record vessels within allocated temporal and spatial boundaries.

Data Collection Requirements and Processes

- Random inspections of vessels at sea and port.
- Ongoing collection of data on illegal activities.
- Comparative data on the relative effectiveness of certain compliance techniques.
- VMS and other vessel surveillance data.

Evaluation

For the NDSMF, 15 offences were detected in 2001 regarding the ALC not reporting, and one offence was detected for exceeding fishing units. In 2002, two offences were detected regarding the ALC not reporting, and no offences have been detected so far in 2003. The lack of ALC reporting was considered to be only a very minor offence. The majority of these reports resulted from the licensees learning how to use the ALC system, and many experienced battery problems. In addition, the management plan at the time resulted in licensees having to nominate every trip. This was often very confusing and time consuming, and as such the management plan has now been amended. No prosecutions were warranted regarding any of the above offences. Thus current compliance techniques used in this fishery are maintaining compliance by the fishers. Sea patrols and radar watches are also conducted on a random basis through the seasons. Compliance operations are mainly focussed on maintaining the integrity of the areas within the fisheries. The compliance staff also conducts annual licence and gear inspections both at sea and at port.

With the introduction of VMS into this fishery, it was expected that random patrol activities would decrease over time, while targeted patrols investigating specific incidences would become the major focus of patrol activities.

Robustness
Medium

The difficulties in identifying every illegal activity will remain. However, as the NDSMF is monitored continuously by VMS, there is little risk of temporal (seasonal) or spatial boundary infringements.

Fisheries Management Response

Despite the relatively low levels of compliance work being done in the NDSMF, the Regional Services division of the Department continues to gather intelligence on suspected breaches within this fishery.

Comments and Actions

The Department will continue to provide high standard compliance service within budgetary and resourcing constraints to the NDSMF. It is expected that the completion of a compliance risk assessment for the fishery will enable the Department to better direct resources to further increase the effectiveness of the limited compliance activities. In 2000 the VMS was introduced into the NDSMF, which enables the Department of Fisheries to monitor a vessel's location, direction and speed.

External Driver Check List

- Changes to technology that may facilitate an increase the level of non-compliance.
- Changes to non-Fisheries legislation and/or State/Commonwealth policy agreements (e.g. National Competition Policy) may impact upon the Department's ability to restrict activities in a way that assist management, which may impact on compliance (e.g. restrictions on processing licenses).

5.4.1.4 ALLOCATION AMONG USERS

Rationale for Inclusion:

Within the broad context of ESD, the issue of how fish resources can best be shared between competing users requires consideration. In Western Australia, the Integrated Fisheries Management Review Committee (IFMRC) was established to develop a strategy to integrate the management and sustainable use of fish resources. The report produced by the Committee in November 2002 proposes an alternative management framework and a set of guiding principles for allocating fish stocks to ensure optimal benefits are realised for the WA community (Department of Fisheries 2002).

The Department of Fisheries recognises that the integrated fisheries management approach applies to the demersal finfish fishery. In addition to the commercial fishery there is also a large recreational component for demersal scalefish in the Kimberley. There can also be non-extractive (i.e. Department of Conservation and Land Management, dive operations etc) interests in the resource and its related ecosystem, which also need to be considered in the management process.

In recent years, the north coast region has experienced significant growth in recreational fishing activity, with a booming fishing-based tour and ecotourism industry based around the region's reputation as remote and pristine.

Recreational fishing participation in marine waters between Onslow and the WA/NT border is estimated at about 12% of the State's recreation anglers, or 70,000 anglers per year generating 1 million fishing days. A recent creel survey conducted between December 1999 and November 2000 has confirmed that the Pilbara and Kimberley regions are a major focus of recreational fishing. Charter activity is also significant with 85 fishing tour and 5 ecotour licences issued for the north coast bioregion.

However, at present there is very little recreational fishing effort directed towards the deeper-water fish species in Zone 2, which are the key species targeted by commercial fishers in the NDSMF. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome Sector of Zone 1, which is closed to commercial fishing. The magnitude of this recreational fishing effort and the catch taken are expected to be small relative to the overall commercial catch.

Operational Objective

To ensure that allocation decisions aim to maximize the overall benefit to the Western Australian community from the use of fish stocks and take account of the economic, social, cultural and environmental factors.

Indicator

The level of resource sharing conflict between users and the level of participation of interested groups in any focused resource sharing process.

Data Requirements for Indicator

In order to ensure satisfactory allocation among user groups the following data is required:

Data Requirement	Data Availability
Breeding stock abundance estimates	Yes –not measured directly but data from catch rates and size/age structure are consistent with sufficient oceanic stock to maintain ongoing recruitment.
Estimate of recreational catch	Yes – measured in the creel Recreational Fishing Survey of the north coast (including east Kimberley) in December 1999 and November 2000 estimated at 300 tonnes.
Estimate of projected growth of recreational snapper fishing in Shark Bay	Yes – can be estimated based on existing growth trends in recreational fishing and overall population growth.

It should also be noted that cost is another major factor when considering various management options. For example, a TAC, which incorporated a recreational 'allocation' may satisfy sustainability issues, but would be prohibitively expensive in terms of the management/administration of the recreational 'quota'.

Furthermore, the Department is currently awaiting the outcomes of the integrate fisheries, management review process in terms of processes that need to be used for resource allocation mechanisms among user groups and timeframes etc.

Evaluation

Preliminary creel survey results of recreational fishing in the Pilbara and Kimberley region of Western Australia suggests a total recreational catch of all scalefish species at approximately 300 tonnes, excluding charter vessel catches. This equates to approximately 10% of the commercial demersal scalefish catch for the region during the same period. Spangled emperor, Red emperor, barramundi, threadfin salmon species and mackerel species were taken by both the recreational and commercial sectors. Recreational fishing records from charter boats were not included in the survey. However, a logbook has been developed to collect catch and fishing effort information from tour operators and these data will be provided in future years.

Robustness
Medium

At present, while there is no specific allocation made to the recreational sector, the current level of recreational take is considered sustainable. However, catch and release of unwanted demersal scalefish (including undersize) might be having an additional impact on stocks given the preliminary results of the post capture mortality rate study.

It should also be noted that a significantly increased recreational take would prompt a reassessment of current management arrangements for both recreational and commercial sectors.

Fisheries Management Response

Scientific information to support recreationally fished stock management in the north coast bioregion has come largely from previous Department of Fisheries studies focused on commercial fisheries. This research has provided good biological data on the major Lethrinid species (nor-west snappers), the red emperor and some related Lutjanid species (cods and coral trout), in the North West Shelf sector. A three year research project on mackerel species is now being written up and will provide detailed biological and fishery data on these important recreational species.

A major project, which commenced in July 2000, is collecting baseline data on the inshore finfish species targeted by recreational anglers across the north coast bioregion. In addition, a collaborative project is being undertaken with Murdoch University to provide biological data on the species subject to shore-based fishing by both recreational and commercial fishers.

To estimate the total catch for recreational stock management purposes, a 12 month creel survey of recreational boat and shore based fishing from Exmouth Gulf to Broome, was undertaken between December 1999 and November 2000. The results from this study will be complemented by data from the National Recreational Fishing Survey undertaken during 2000/2001. These data, integrated with the long run commercial CAES databases and the current fishery independent projects, will provide the basis for ongoing management of the most important recreational stocks in this region.

Comments and Actions

Through the processes already established, the Department will continue to promote the integration of fisheries management across all user groups. To this end, the Department has a number of initiatives related to improving the governance and allocation and reallocation. An Integrated Fisheries Management Policy was released in 2000.

This policy has been followed up by the formation of the IFMRC, which was required to report directly to the Minister on the most appropriate framework to try and achieve the integrated objectives of resource allocation in the state. In November 2002, the Committee released its report to the Minister. It is expected that the Minister will finalise his determinations on the new framework in 2003.

External Driver Checklist

Resource sharing issues being raised with the Minister independently of the IFMRC recommended process.

5.4.2 DEPARTMENT OF FISHERIES- CONSULTATION

5.4.2.1 CONSULTATION (INCLUDING COMMUNICATION)

Rationale for Inclusion:

The FRMA has certain requirements with regard to consultation that must be undertaken in the course of managing fisheries. The management of the NDSMF is based around a robust consultation and communication process.

There are sections in the FRMA that relate to the development of management plans (Section 64) and to the amendment of a management plan (Section 65). Given that the NDSMF already has a working management plan, Section 65 is the most relevant.

Section 65 of the FRMA states:

Section 65. Procedure before amending management plan

(1) A management plan must specify an advisory committee or advisory committees or a person or persons who are to be consulted before the plan is amended or revoked.

(2) Before amending or revoking a management plan the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan.

(3) Despite subsection (2), the Minister may amend a management plan without consulting in accordance with that subsection if, in the Ministers opinion, the amendment is –

(a) required urgently; or

(b) of a minor nature

(4) If –

(a) the Minister amends a management plan; and

(b) the amendment is made without consultation because it is, in the Minister's opinion , required urgently,

the Minister must consult with the advisory committee or advisory committees or the person or persons specified for that purpose in the plan as soon as practicable after the plan has been amended.

Each year in late October or early November, the Department holds meetings with the Northern Demersal Scalefish licence holders. These meetings typically involve discussions about management, research and compliance issues in the fishery, and provide a forum for industry to raise concerns and/or ask questions of the Department concerning management arrangements.

In addition, there is also a Northern Demersal Scalefish Management Advisory Committee (MAC) that meets at the same time as the Industry. The MAC has representatives from the Inshore and Offshore licensees, charter boat sector, recreational sector, indigenous sector and the Department. The MAC must be consulted when any alterations to the management plan are required or decisions are to be made within the fishery.

Operational Objective

To administer a consultation process that is in accordance with the requirements of the FRMA and allows for the best possible advice from all relevant stakeholders to be provided to the decision maker (Minister/ED) in a timely manner.

Indicators

- The Minister (or the Department on his behalf) conforms to the consultation requirements of the FRMA, the Management Plan and the MAC.
- The level to which licensees, the MAC and other stakeholders consider that they are adequately and appropriately consulted.

Performance Measures

Proper consultation procedures have been followed in any amendment of the management plan.

Industry meetings held annually.

MAC meetings held annually, or when required.

Data Requirements

The views of industry collected from stakeholders at each annual meeting.

When an amendment is proposed, documentation of the formal consultation procedures.

Evaluation

Consultation on management of the NDSMF is conducted in an open, accountable and inclusive environment where all sectors of the industry, the MAC and the Department's managers and researchers collectively identify and discuss appropriate courses of action.

Decision makers are provided with advice based on this consultation and reasons are provided for decisions that vary from consultation-based advice.

Robustness
High

The consultation process is very well understood with relatively high levels of participation from the various stakeholder groups.

Fisheries Management Response

The Department is attempting to improve communication links with industry in the NDSMF through regular correspondence and encouraging communications with the fishery manager. Given the remote location of many of the operators, it can be

logistically difficult and costly to undertake field trips and plan meeting dates more than once every year.

Comments and Actions

The Department will continue to provide a commercial fisheries management officer who coordinates and further develops the consultation process for the NDSMF.

External Driver Check List

Despite the aforementioned consultation processes that are in place, disaffected parties may still seek to use political avenues to further their cause.

5.4.3 DEPARTMENT OF FISHERIES - REPORTING

5.4.3.1 ASSESSMENT AND REVIEWS

Rationale for Inclusion:

It is important that the outcomes of the fisheries management processes administered by the Department for the NDSMF are available for review by external parties. It is also important that the community is sufficiently informed on the status of the fisheries, given that industry are utilising a community resource.

The reports that are currently developed include: the annual State of the Fisheries Report, the Annual report to the Auditor, the ESD report, and this application to DEH. There is also a longer-term plan to have the entire system of management audited by the WA Environmental Protection Agency (EPA).

Operational Objective

To continue to report on an annual basis to the Western Australian Parliament and the community on the state of all fisheries including the NDSMF. To prepare a framework for reporting on ESD requirements for all Western Australian fisheries.

Indicators

The extent to which external bodies with knowledge on the management of fisheries resources have access to relevant material and the level of acceptance within the community.

Performance Measure

General acceptance of the management system by the community.

Data Requirements

The majority of data required to generate reports are already collected in the course of pursuing resource management objectives. The Department conducts an annual survey of the community with respect to the community's opinion on the status of the State's fisheries and attitudes to the performance of the Department.

Evaluation

The Department has implemented more then one process to report on the performance of this fishery and in doing so has acted to ensure that the community has access to this information. In addition to this base level reporting, continual development of the management process will see the fishery undergo regular independent audits ensuring that the evaluation of the management arrangements in these fisheries is robust.

The Department has been the recipient of a number of awards for excellence for its standard of reporting - Premiers Awards in 1998, 1999 for Public Service excellence, Category Awards in Annual Reporting in 1998, 1999, 2000; Lonnie Awards in 2000, 2001.

Current Reporting Arrangements for this fishery include:

State of Fisheries

There is annual reporting on the performance of the fishery against the agreed objectives within the "State Of The Fishery Report". The document is available in hard copy format but is also available from the Department's web site in PDF format.

Annual Report

A summary of this report is presented within the Department's Annual Report and is used in some of the Performance Indicators that are reviewed annually by the OAG.

ESD

Following the completion of this application the Department will publish it as part of the ESD Report Series, which will be available from the web site.

Reports to Industry

Each year, the status of the resource and effectiveness of current management are presented to industry in a series of meetings in major population centres in the Pilbara Region and the Perth Metropolitan area.

Robustness
High

Fisheries Management Response

Current: For many years the Department has produced substantial and high quality documents that report on the operation of the Department and the status of its fisheries – these reports are the Annual Report and the State of the Fisheries.

Future: The Department is working with the EPA to prepare a framework for reporting on ESD for all Western Australian fisheries. It is proposed that this framework will be linked to a regular audit cycle involving the EPA and periodic reporting to the OAG. The Department is working to combine the processes for reporting to the States and the Australian Government and believes that this can best be achieved by using a Bilateral Agreement with DEH under the EPBC.

Comments and Actions

The assessment and review processes already established together with proposed external review processes should ensure that there would be many opportunities for the appropriateness of the management regime and the results it produces to be reviewed.

External Driver Check List

The assessments provided by independent review bodies and the community.

5.4.4 DEPARTMENT OF FISHERIES - LEGAL FRAMEWORK

5.4.4.1 OCS ARRANGMENTS

The functional fishing areas for the NDSMF are within the State waters boundary. Therefore there are no OCS arrangements to be considered.

6. REFERENCES

Allen GR 1997. Marine fishes of tropical Australia and south-east Asia. Western Australian Museum, Perth. 292 pp.

Allen GR 1985. FAO species catalogue. Vol. 6. Snappers of the world. An annotated and illustrated catalogue of lutjanid species known to date. FAO Fisheries Synopsis No. 125 Volume 6. Rome, FAO. 1985. 208 pp.

Brayford HG and Lyon GE 1995. Offshore Constitutional Settlement. Fisheries Management Paper, No. 77.

Cresswell GR 1991. The Leeuwin Current – observations and recent models. Journal of the Royal Society of Western Australia 74:1-14.

Department of Fisheries 2002. Report to the Minister for Agriculture, Forestry and Fisheries by the Integrated Fisheries Management Review Committee. Fisheries Management Report, No. 165.

Die DJ and Caddy JF 1997. Sustainable yield indicators from biomass: are there appropriate reference points for use in tropical fisheries? Fisheries Research 32:69-79.

Fishbase 2003. http://www.fishbase.org.

Fletcher WJ 2002. Policy for Implementation of Ecologically Sustainable Development for Fisheries and Aquaculture within Western Australia. Fisheries Management Paper, No. 157.

Fletcher W, Chesson J, Sainsbury K, Fisher M, Hundloe T, and Whitworth B 2002. Reporting on Ecologically Sustainable Development: A "How to Guide" for fisheries in Australia. FRDC project report 2000/145.

Gabriel WL and Mace PM 1999. A review of biological reference points in the context of the precautionary approach. (in) Restrepo V (ed) Proceedings of the 5th national stock assessment workshop. National Marine Fisheries Service, Office of Science and Technology, 1315 East-west Highway, Silver Spring, MD 20910.

Gaughan DJ, Mitchell RW and Blight SJ 2000. Impact of mortality, possibly due to herpesvirus, on pilchard *Sardinops sagax* stocks along the south coast of WA in 1998-1999. Marine Freshwater Resources 51:601-612.

Heatwole H 1999. Sea snakes. UNSW Press. University of NSW, Sydney.

Heemstra PC and Randall JE 1993. FAO species catalogue. Vol. 16. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail

species known to date. FAO Fisheries Synopsis No. 125, Vol. 16. Rome, FAO. 1993. 382 pp., 522 figs, 31 colour plates.

Hixon M. 1991. Predation as a process structuring coral reef fish communities. 105-118 pp. In Sale P (ed) 'The ecology of fishes on coral reefs.' San Diego, CA: Academic Press.

Jennings S and Kaiser M 1998. The effects of fishing on marine ecosystems. Advances in Marine Biology 34:201-352.

Johnson MS, Hebbert DR, and Moran MJ 1993. Genetic analysis of populations of north-western Australian fish species. Australian Journal of Marine Freshwater Resources 44:673-685.

Jones JB 2000. Baitfish and quantitative risk assessment issues. In: Rogers CJ (ed) Proceedings of the OIE International Conference on Risk Analysis in Aquatic Animal Health, Paris, France. Office International des Epizooties (OIE), 8-10 February, 2000.

Jones JB and Gibson AP 1997. Risk analysis for the practice of importing frozen fish as bait. Western Australian Fishing Industry Council (Inc.), Perth, Western Australia.

Kailola PJ, Williams MJ, Stewart PC, Reichelt RE, McNee A and Grieve C 1993. Australian fisheries resources. Bureau of Resource Sciences, Department of Primary Industries and Energy, and the Fisheries Research and Development Corporation. Canberra, Australia. 422 pp.

Last PR and Stevens JD 1994. Sharks and rays of Australia. CSIRO Australia, Hobart. 513 pp.

Leis JM and Carson-Ewart BM 2000. The larvae of Indo-Pacific coastal fishes. Brill, Leiden.

Mace PM 1994. Relationships between common biological reference points used as thresholds and targets of fisheries management strategies. Canadian Journal of Fisheries and Aquatic Sciences 51:110-122.

Mace PM and Sissenwine MP 1993. How much spawning per recruit is enough? In: Smith SJM Hunt JJ and Rivard D (eds) Risk evaluation and biological reference points for fisheries management. Canadian Special Publications in Fisheries and Aquatic Sciences 120:101-118.

McPherson GR, Squire L and O'Brien J 1992. Reproduction of three dominant *Lutjanus* species of the Great Barrier Reef inter-reef fishery. Asian Fisheries Science 5(1):15-24.

Moran M, Jenke J, Burton C and Clark D 1988. The Western Australian Trap and Line Fishery on the North West Shelf. FIRTA Report 86/28. WA Marine Research Laboratory 79 pp.

Moran M, Edmonds J, Jenke J, Cassells G and Burton C 1993. Fisheries biology of emperors (Lethrinidae) in north-west Australian coastal waters. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 89/20. 58 pp.

Moran MJ, Jenke J, Cassells G and Nowara G 1995. Research for allocation of North-west marine finfish resources among diverse user groups. Final report to the Fisheries Research and Development Corporation (FRDC) on Project No. 91/28.

Newman SJ 2002. Growth rate, age determination, natural mortality and production potential of the scarlet seaperch, *Lutjanus malabaricus* Schneider 1801, off the Pilbara coast of north-western Australia. Fisheries Research 58(2):215-225.

Newman SJ and Williams DMcB 2001. Spatial and temporal variation in assemblages of Lutjanidae, Lethrinidae and associated fish species among mid-continental shelf reefs in the central Great Barrier Reef. Marine and Freshwater Research 52 (6):843-851.

Newman SJ and Dunk IJ 2002. Growth, age validation, mortality, and other population characteristics of the red emperor snapper, *Lutjanus sebae* (Cuvier, 1828), off the Kimberley coast of North-Western Australia. Estuarine, Coastal and Shelf Science 55 (1):67-80.

Newman SJ and Dunk IJ 2003. Age validation, growth, mortality and additional population parameters of the goldband snapper, *Pristipomoides multidens*, off the Kimberley coast of northwestern Australia. Fishery Bulletin 101(1):116-128.

Newman SJ, Williams D McB and Russ GR 1996. Age validation, growth and mortality rates of the tropical snappers (Pisces: Lutjanidae), *Lutjanus adetii* (Castelnau, 1873) and *L. quinquelineatus* (Bloch, 1790) from the central Great Barrier Reef, Australia. Marine and Freshwater Research 47 (4):575-584.

Newman SJ, Evans D, and Ashworth R. 2000a. Assessment of the outer-shelf fishery resources off the Pilbara coast of tropical Western Australia. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 97/138.

Newman SJ, Cappo M and Williams DMcB 2000b. Age, growth, mortality rates and corresponding yield estimates using otoliths of the tropical red snappers, *Lutjanus erythropterus, L. malabaricus* and *L. sebae*, from the central Great Barrier Reef. Fisheries Research 48 (1):1-14.

Newman SJ, Steckis RA, Edmonds JS and Lloyd J 2000c. Stock structure of the goldband snapper, *Pristipomoides multidens* (Pisces: Lutjanidae) from the waters of northern and western Australia by stable isotope ratio analysis of sagittal otolith carbonate. Marine Ecology Progress Series 198:239-247.

Newman SJ, Moran MJ and Lenanton RCJ 2001. Stock assessment of the outer-shelf species in the Kimberley region of tropical Western Australia. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 97/136. 117 pp.

Ovenden JR, Lloyd J, Newman SJ, Keenan CP and Slater LS 2002. Spatial genetic subdivision between northern Australian and southeast Asian populations of *Pristipomoides multidens*: a tropical marine reef fish species. Fisheries Research 59 (1-2):57-69.

Paxton JR, Hoese DF, Allen GR and Hanley JE 1989. Pisces. Petromyzontidae to Carangidae.. Zoological Catalogue of Australia, Vol. 7. Australian Government Publishing Service, Canberra, 665 pp.

Pogonowski JJ, Pollard DA and Paxton JR 2002. Conservation overview and action plan for Australian threatened and potentially threatened marine and estuarine fishes. Environment Australia, Canberra.

Randall JE, Allen GR and Steene RC 1990. Fishes of the Great Barrier Reef and Coral Sea. Crawford House Press, Bathurst. 507 pp.

Sainsbury KJ, Campbell RA, Lindholm R and Whitelaw AW 1997. Experimental management of an Australian multispecies fishery: examining the possibility of trawl induced habitat modification. In: 'Global trends, Fisheries management. pp 107-112. (eds) Pikitch EK, Huppert DD, and Sissenwine MP. American Fisheries Society Seattle, WA, USA. 352 pp.

Sainsbury KJ, Kailola PJ, and Leyland GG 1985. Continental shelf fishes of north-western Australia. An illustrated guide. Canberra: Clouston and Hall and Peter Pownall Fisheries Information Service. 375 pp.

Stephenson PC and Chidlow J 2003. By-catch in the Pilbara Trawl Fishery. Final Report to National Heritage Trust. Department of Fisheries, Government of Western Australia, Perth. 77 pp.

Stephenson PC, Edmonds JS, Moran MJ and Caputi N. 2001. Analysis of stable isotopes to investigate stock structure of red emperor and Rankin cod in northern Western Australia. Journal of Fish Biology 58:126-144.

Stephenson P and Mant J 1999. Adaptive management of the Pilbara trawl fishery. Final Report to the Fisheries Research and Development Corporation (FRDC) on Project No. 96/133. Fisheries Western Australia, Perth, Australia. 73pp.

Stobutzki IC, Blaber S, Brewer D, Fry G, Heales D, Jones P, Miller M, Milton D, Salini J, Van der Velde T, Wang UG, Wassenberg T, Dredge M, Courtney A, Chilcott K and Eayrs S 2000. Ecological sustainability of bycatch and biodiversity in prawn trawl fisheries. Final Report to the Fisheries Research and Development Corporation FRDC Project No. 96/257. 512 pp.

Ward TM 2000. Factors affecting the catch rates and relative abundance of sea snakes in the by-catch of trawlers targeting tiger and endeavour prawns on the northern Australian continental shelf. Marine Freshwater Resources 51:155-164.

Ward TM 1996a. Sea snake by-catch of fish trawlers on the northern Australian continental shelf. Marine Freshwater Resources 47:625-630.

Ward TM 1996b. Sea snake by-catch of prawn trawlers on the northern Australian continental shelf. Marine Freshwater Resources 47:631-635.

Wassenburg T.J., Dews G. and Cook S.D. 2002. The impact of fish trawls on megabenthos (sponges) on the north-west shelf of Australia. Fisheries Research 58:141-151.

Wassenburg TJ, Salini JP, Heatwole H and Kerr JD 1994. Incidental capture of sea snakes (Hydrophidae) by prawn trawlers in the Gulf of Carpentaria. Australian Journal of Marine and Freshwater Research 45:429-443.

Williamson PC, Sumner NR and Malseed BE (In prep). A 12-month survey of coastal recreational fishing in the Pilbara region of Western Australia during 1999-2000.

APPENDIX 1 – ACRONYMS

ALC	Automatic Location Communicator
CAES	Catch and effort statistics
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific & Industrial Research Organisation
DEH	Department of Environment and Heritage
EPA	WA Environment Protection Agency
EPBC	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Development
FRMA	Fish Resources Management Act 1994
FRMR	Fish Resources Management Regulations 1995
IFMRC	Integrated Fisheries Management Review Committee
ITE	Individual transferable effort
MAC	Management Advisory Committee
MARPOL	International Convention for the Prevention of Pollution from Ships
NDSMF	Northern Demersal Scalefish Managed Fishery
OAG	Office of the Auditor General
OCS	Offshore Constitutional Settlement
SFDs	Standard Fishing Days
TACs	Total Allowable Catches
TSC	Total Sustainable Catch
VMS	Vessel Monitoring System
WAFIC	Western Australian Fishing Industry Council

APPENDIX 2 - DETAILS OF CONSEQUENCES TABLES

Level	Ecological
Negligible	General - Insignificant impacts to habitat or populations, Unlikely to be measurable against background variability **Target Stock/Non-retained:** undetectable for this population **Byproduct/Other Non-retained:** Area where fishing occurs is negligible compared to where the relevant stock of these species reside (< 1%) **Protected Species:** Relatively few are impacted. **Ecosystem:** Interactions may be occurring but it is unlikely that there would be any change outside of natural variation **Habitat:** Affecting < 1% of area of **original** habitat area *No Recovery Time Needed*
Minor	**Target/Non-retained:** Possibly detectable but little impact on population size but none on their dynamics. **By-product/Other Non-retained**: Take in this fishery is small (< 10% of total) compared to total take by all fisheries and these species are covered explicitly elsewhere. Take and area of capture by this fishery is small compared to known area of distribution (< 20%). **Protected Species:** Some are impacted but there is no impact on stock. **Ecosystem:** Captured species do not play a keystone role – only minor changes in relative abundance of other constituents. **Habitat**: Possibly localised affects < 5% of total habitat area *Rapid recovery would occur if stopped - measured in days to months.*
Moderate	**Target/Non-retained**: Full exploitation rate where long term recruitment/dynamics not adversely impacted **By-product:** Relative area of, or susceptibility to capture is suspected to be less than 50% and species do not have vulnerable life history traits **Protected Species:** Levels of impact are at the maximum acceptable level **Ecosystem:** measurable changes to the ecosystem components without there being a major change in function. (no loss of components) **Habitat:** 5-30 % of habitat area is affected. :or, if occurring over wider area, level of impact to habitat not major *Recovery probably measured in months – years if activity stopped*
Severe	**Target/Non Retained**: Affecting recruitment levels of stocks/ or their capacity to increase **By-product/Other Non-retained**: No information is available on the relative area or susceptibility to capture or on the vulnerability of life history traits of this type of species. Relative levels of capture/susceptibility greater than 50% and species should be examined explicitly. **Protected Species:** Same as target species **Ecosystem**: Ecosystem function altered measurably and some function or components are missing/declining/increasing outside of historical range &/or allowed/facilitated new species to appear. **Habitat:** 30- 60 % of habitat is affected/removed. *Recovery measured in years if stopped*

Major	**Target/Non retained:** Likely to cause local extinctions **By-product/Other Non-retained:** N/A **Protected Species:** same as target species **Ecosystem:** A major change to ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture) **Habitat:** 60 - 90% affected *Recovery period measured in years to decades if stopped.*
Catastrophic	**Target/Non-retained:** Local extinctions are imminent/immediate **By-product/Other Non-retained:** N/A **Protected Species:** Same as target **Ecosystem:** Total collapse of ecosystem processes. **Habitat:** > 90% affected in a major way/removed *Long-term recovery period will be greater than decades or never, even if stopped*