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Future mangement arrangements for Western Australia's temperate shark fisheries.

Jane Borg

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FUTURE MANAGEMENT ARRANGEMENTS FOR WESTERN AUSTRALIA'S TEMPERATE SHARK FISHERIES

by

Jane Borg and Rory McAuley

A DISCUSSION PAPER

FISHERIES MANAGEMENT PAPER NO. 180

Department of Fisheries
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Perth WA 6000

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for Western Australia's
Temperate Shark Fisheries
A Discussion Paper

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CUSTOMER FOCUS
WESTERN AUSTRALIA

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OPPORTUNITY TO COMMENT

This paper was prepared following discussions with commercial shark fishers, the WA Demersal Net and Hook Fisheries Management Advisory Committee and at the request of the Minister for Agriculture, Forestry and Fisheries. It is designed to encourage public involvement in any changes to management arrangements for the temperate shark fisheries within Western Australian waters.

The relevant fisheries are the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery, and the West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery.

Comments about this discussion paper are sought from all stakeholders, including commercial and recreational industry members, relevant community interest groups, government agencies and interested members of the public.

Once the public comments received on this discussion paper have been considered, the Minister will make a decision on the most appropriate measures to ensure sustainability of the temperate shark fishery resources.

To this end, there are some important elements you may wish to address in your submission.

1. This paper proposes measures aimed at the conservation of the shark species caught in the temperate shark fisheries, and therefore measures are directed at activities that may impact on these species outside these fisheries.

2. The sustainability of dusky shark is a major concern to the Department and there is unlikely to be compromise on proposed measures that are specific to the sustainability of this species.

3. The timing of closures for the whiskery shark is considered to be most appropriate and is the result of significant research. However, comment is welcome on the areas to be closed.

4. Comment is also sought on the implications of completely closing the fisheries, if that was considered necessary to guarantee sustainability of shark resources.

Although specific issues have been identified, your views are sought on any or all of the matters in the document of significance to you and/or your group.

To ensure your submission is as effective as possible, please:

- Make it clear and concise.
- List your points according to the topic sections and page numbers in this paper.
- Describe briefly each topic or issue you wish to discuss.
- State whether you agree or disagree with any or all of the information within each topic, or just what is of specific interest to you. Clearly state your reasons, particularly if you disagree, and give sources of information where possible.
- Suggest alternatives to address any issues that you disagree with.

Your comments would be appreciated by 24 September 2004, and should be marked to the attention of Fisheries Management Policy Officer, Shark Fisheries, Commercial Fisheries Program, and addressed to:

Executive Director
Fisheries Western Australia
3rd Floor, The Atrium
168 St George's Terrace
PERTH WA 6000

EXECUTIVE SUMMARY

The West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery and the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery are gear-based fisheries directed primarily at shark, but with a scalefish component in their catch.

From 1997 to 2001, a series of gear unit reductions was implemented in response to concerns over the sustainability of shark stocks, particularly dusky and whiskery sharks. Although the net length equivalent of gear units more than halved, the effective fishing effort did not. The activation of latent, or unused, fishing effort partially accounted for this result.

Significant levels of latent effort still exist within the fishing fleets of both fisheries, which could hamper the effectiveness of any future management attempts to reduce real fishing effort if it is not resolved.

Without management changes that have a real effect on fishing effort, the sustainability of the main shark species cannot be guaranteed.

At its meeting in October 2003, the Western Australian Demersal Net and Hook Fisheries Management Advisory Committee ('the MAC') acknowledged the results of the 2003 stock assessment for these fisheries, and the subsequent need to redefine the management objectives and modify existing management arrangements to meet them. A particular emphasis was given to the status of whiskery and dusky sharks in both fisheries.

This paper provides a summary of the attributes of these temperate shark fisheries, and sets out the proposed objectives and the measures available to achieve them.

In summary, primary measures are aimed at the sustainability of dusky and whiskery sharks, with dusky sharks being of greater concern as their status is more critical. The final decision on management of these fisheries cannot compromise sustainability, not only because of the Department's obligations under the *Fish Resources Management Act, 1994*, but also:

- national and international obligations associated with ecologically sustainable development;
- export accreditation under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- the National Plan of Action for shark.

The proposed management package and associated options aim to lower the risk to both whiskery and dusky shark by removing the take of these species outside the recognised shark fisheries south of North West Cape, and by limiting mortality of adult dusky shark Statewide.

Initially, research and management officers hoped the removal of these sources of mortality would ensure sustainability in the temperate shark fisheries when coupled with effort reductions within these fisheries. The latest research advice (Attachment 1) indicates this may not be sufficient to ensure the sustainability of dusky shark stocks; however, returning the temperate shark fisheries to target only juvenile stages of dusky shark could alleviate the immediate concerns.

The only realistic options within the temperate shark fisheries appear to be either to effect real effort cuts through removal of latent effort and the redefinition of gear units (supported by supplementary species-specific measures such as closures in significant areas and the targeting restrictions mentioned above), or to close down the fisheries for an extended period of time to allow dusky shark stocks to rebuild.

Although the Department will work with industry to find a solution that allows the fishery to continue, its concern is so deep that it will not hesitate to recommend to the Minister that the fisheries be closed if there is no other way to help achieve sustainability of the shark stocks.

SECTION 1 INTRODUCTION

1.1 The fisheries

The West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery and the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery are gear-based fisheries directed primarily at shark, but with a scalefish component in their catch. Given the primary target species are sharks, these multi-species fisheries are collectively referred to as the temperate shark fisheries in this paper.

Specifically, the fisheries target young dusky sharks (*Carcharhinus obscurus*), whiskery sharks (*Furgaleus macki*), gummy sharks (*Mustelus antarcticus*), and sandbar sharks (*Carcharhinus plumbeus*). In addition, a number of other elasmobranch species and scalefish species are caught.

North of these fisheries are two 'tropical' shark fisheries - the Western Australian North Coast Shark Fishery (WANCSF) operating off the Pilbara and south-west Kimberley coasts, and the Joint Authority Northern Shark Fishery (JANSF) operating off the north Kimberley coast. These smaller shark fisheries land mostly whaler shark species, including sandbar (*Carcharhinus plumbeus*), dusky (*Carcharhinus obscurus*), blacktip (*Carcharhinus spp*.), hammerhead (*Sphyrnidae*), tiger (*Galeocerdo cuvier*) and pigeye (*Carcharhinus ambionensis*) sharks.

Management arrangements for the take of shark north of North West Cape will be addressed elsewhere. However, it is important to acknowledge their existence in this paper, as there is some overlap of shark species and fishing activity that, if left unmanaged, would impact on the sustainability of the temperate shark fisheries.

1.2 Why the need for change?

The gear reduction strategy implemented through the current management arrangements was originally devised to reduce active effort levels. Analysis of fishing records and scientific data during a stock assessment in 2003 indicated the strategy has not had the desired effect.

The existing arrangements still contain some of the elements that have limited the effectiveness of earlier management strategies, and are not providing an appropriate management framework for the current issues within both temperate shark fisheries. Specific concerns include the high level of latent effort, the 'elasticity' of the unit of effort, and the accumulated fishing mortality that has resulted from the limited effectiveness of the previous effort reduction programs.

In addition to the impacts of fishing within the temperate shark fisheries, targeting of older and larger sharks outside these fisheries has increased fishing mortality of dusky shark to levels at which sustainability can no longer be guaranteed.

On completion of the 2003 stock assessment by the Department's Research Division, it was obvious that management objectives for the management of shark stocks off Western Australia needed to be refined and new strategies developed to meet them. Specific problem issues, such as an apparent depletion of the dusky shark breeding stocks, had been discussed in a series of industry meetings throughout 2002 and 2003.

A series of management proposals to address the total needs of the two fisheries was given to the MAC in October 2003. The MAC recommended to the Minister that the Department release this management paper to discuss the proposals and seek comment.

SECTION 2 INTERNATIONAL AND NATIONAL OBLIGATIONS

2.1 Ecologically Sustainable Development (ESD)

The definition of ESD adopted by Australia is set out in the National Strategy for Ecologically Sustainable Development (NSESD). It states that we should be '*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'* (Fletcher, 2002).

The core objectives for sustainable fisheries set out in NSESD are to:

- enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- provide for equity within and between generations, and;
- protect biological diversity and maintain essential ecological processes and life support systems.

Although the objects of the *Fish Resources Management Act 1994* do not specifically mention ESD, they are fully consistent with ESD objectives and guiding principles (Fletcher, 2002).

2.2 Environment Protection and Biodiversity Act, 1999

The *Environment Protection and Biodiversity Act, 1999* promotes the conservation of biodiversity by providing strong protection for listed species and communities in Commonwealth areas, Commonwealth waters and waters around our external Territories. Species and communities listed for protection include threatened species, marine species, migratory species and threatened ecological communities.

There are two Parts under the EPBC Act that require a fishery management regime to be assessed against the Australian Government *Guidelines for the Ecologically Sustainable Management of Fisheries* – Part 13 and Part 13A.

Under Part 13 of the EPBC Act, it is an offence to kill, injure, take or trade a member of a listed species in a Commonwealth area. The Act specifies that certain actions are not offences. These include actions undertaken in accordance with an accredited management regime or in accordance with a permit under which the action is approved.

As a result, any fishery that operates in Commonwealth waters, or has a licence area extending into Commonwealth waters must be accredited under Part 13. In order to be accredited under Part 13 of the EPBC Act, a fishery management regime must be assessed against the Guidelines.

If the Minister for Environment and Heritage is satisfied that the fishery's management regime requires fishers to take all reasonable steps to avoid killing or injuring protected species, and that the regime does not, or is not likely to, adversely affect the survival or recovery in nature of a protected species, the Minister may accredit the management regime, thus exempting operators from requiring permits or prosecution under the Act.

Part 13A requires a fishery management regime to be assessed against the Guidelines to allow the fishery to continue exporting its product. Accreditation under Part 13A results in the product from a fishery being added to the Section 303DB list of species to be exempt from export regulations. If accreditation is not received under Part 13A, a fishery may continue to operate but fishers would not be able to export catch.

Given that the temperate shark fisheries potentially impact on protected species and product from the fisheries is exported catch, they must be assessed against Part 13 and Part 13A and receive appropriate exemptions.

2.3 International and national action plans

The International Plan of Action for the Conservation and Management of Sharks (IPOA) was developed by the Food and Agriculture Organisation of the United Nations in response to worldwide concerns over increases in shark fishing, vulnerability of sharks to overfishing, and the lack of management by the majority of nations involved in this activity.

The IPOA suggests that those nations which target shark, or regularly catch shark, develop a National Plan of Action for sharks (NPOA). Only three nations have completed an NPOA for shark, including Australia, which ratified its NPOA nationally in April 2004.

Although Australian fisheries management is of a high standard and already incorporates management objectives based on ecological sustainable development, Australia recognises the need to improve shark management arrangements to address concerns over conservation and management of shark species.

The NPOA for sharks does not override or replace existing management arrangements, and does not add another layer of management. Rather, it provides advice and guidance on integrating conservation and management measures into management arrangements for target and non-target fisheries.

The objectives of the NPOA are:

I. "to ensure that shark catches from target and non-target fisheries are sustainable;
II. to assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use;
III. to identify and provide special attention, in particular, to vulnerable or threatened sharks;
IV. to improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between states;
V. to minimise unutilised incidental catches of sharks;
VI. to contribute to the protection of biodiversity and ecosystem structure and function;

VII. to minimise waste and discards from shark catches in accordance with article 7.2.2. (g)[1] of the Code of Conduct for Responsible Fishing (FAO 1995), for example, requiring the retention of sharks from which fins are removed;

VIII. to encourage full use of dead sharks;

IX. to facilitate improved species-specific catch and landings data and monitoring of shark catches;

X. to facilitate the identification and reporting of species-specific biological and trade data." (Dept of Agriculture, Fisheries and Forestry, in draft);

Further information on the NPOA for sharks is available from the Department of Agriculture, Fisheries and Forestry, or can be accessed from its website at http://affa/index.cfm.

[1] Article 7.2.2 of the Code of Conduct for Responsible Fishing requires management measures to provide that "pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species are minimised, through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques." The full text of the Code can be found at http://www.fao.org/fi/agreem/codecond/codecon.asp

SECTION 3 MANAGEMENT OF THE FISHERIES

3.1 The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery

3.1.1 Description of the fishery

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF), which covers waters between 33° 00' S and the WA/SA border, is managed under a joint authority arrangement with the Commonwealth Government, which delegates day-to-day management responsibility to the WA State Government.

The fishery has two management zones (Figure 1):

Zone 1 western zone, located south of 33° 00' S to 116° 30' E and

Zone 2 eastern zone, located east of 116° 30' E to the SA border (129° 00' E).

A third zone (Zone 3) incorporates all of Zone 1 and allows access into an area 30nm east of the boundary between zones 1 and 2. There is one licence holder in Zone 3. Rationalisation of these zones is necessary, and for the purposes of this paper, all Zone 3 statistics are incorporated into Zone 1.
The fishing year runs from 1 June to 31 May.

3.1.2 Management arrangements

The JASDGDLMF was declared a limited entry fishery in 1988. The current management plan for the JASDGDLMF is referred to as the *Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992*.

Management is based on effort controls in the form of time/gear units. Each unit allows the use of one net (or a fixed number of hooks) for one month. The original unit value of a net was 600m, but a series of effort reductions in 1992, 1994, 1997/98, and later between 1999 and 2001, resulted in the net length units being reduced to 270 metres, regardless of mesh specifications. This final year of phased net length reductions bought the two zones of the JASDGDLMF to 50 per cent of their 1992-93 level of effort. The hook unit was also reduced, and by 2001, was at 90 longline hooks.

There were 57 licenses in the JASDGDLMF in 2001/02, 24 in Zone 1 and 33 in Zone 2, although only 10 Zone 1 vessels and 20 Zone 2 vessels reported active fishing returns during that year.

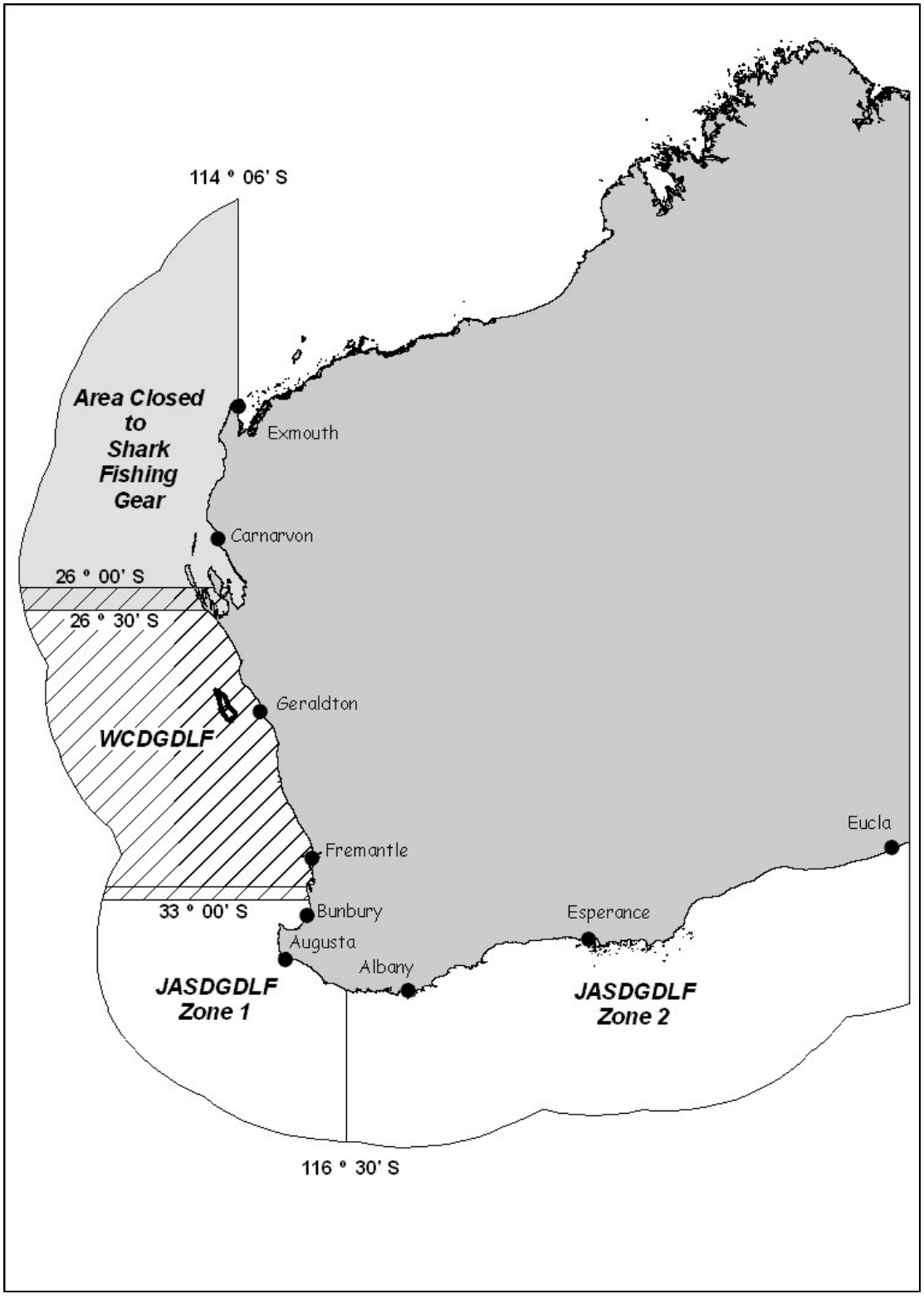
3.2 West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery

3.2.1 Description of the fishery

The West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery

(WCDGDLIMF) extends from the northern boundary of the JASDGDLMF (33° 00' south latitude) to 26° south latitude. The use of shark fishing gear north of Steep Point (26° 30' south latitude) and west of a line drawn due north along 114º 06' east longitude has been prohibited since 1993, primarily to protect breeding stocks of dusky whaler sharks. There is also a closure to gillnet and longline fishing within the waters of the Abrolhos Islands and within three nautical miles from the baselines of those islands (Figure 1).

Figure 1 The JASDGDLMF and WCDGDLIMF boundaries



3.2.2 Management arrangements

An interim managed fishery management plan was introduced for the WCDGDLIMF in 1997. Under this plan, the number of licences is limited and there are effort controls in the form of time/gear units, with each unit allowing a net length of 540 metres or 180 longline hooks. The interim plan was due to expire in June 2002 and be replaced by a managed fishery management plan. However, due to appeals against the proposed unit allocation, introduction of a managed fishery management plan continues to be delayed.

There were 26 licences in the WCDGDLIMF in 2001/02, although only 14 reported active fishing returns during that year.

3.3 Supplementary management measures

A prohibition on landing only shark fins was introduced in October 2000 to restrict the practice of at-sea finning in other sectors. Retention of trunks, especially, from large, higher fin-value sharks, is generally extremely difficult for non-shark fishing vessels, without adequate storage facilities. The practice of at-sea finning is widely perceived as both wasteful and cruel, and it encourages selective targeting of larger sharks with larger, higher value fins.

All Western Australian licensed fishers are now obliged, under the *Fish Resources Management Regulations 1995,* to land either whole sharks, with fins attached, or to land an equal number of shark trunks and sets of fins.

A prohibition on the use of hooks attached to rock lobster pot float-lines, which some West Coast rock lobster vessels have used to target sharks, was implemented in November 2002.

SECTION 4 BIOLOGICAL OVERVIEW

4.1 Dusky shark

4.1.1 Biology

The dusky shark (*Carcharhinus obscurus*) - also known as bronze or dusky whaler shark - was once common in temperate and tropical Continental Shelf and adjacent oceanic waters around the world.

In Western Australia, the focus of the dusky shark stock appears to be in the region between the Pilbara and about 120° E longitude on the South Coast. Although dusky sharks tagged in Western Australia have been recaptured in South Australia, the species is less common in southern waters, where a related and similar looking species of 'bronze whaler', the copper shark, *Carcharhinus brachyurus*, is more abundant.

The dusky shark is a large, slow-growing species that grows to more than 3.5 metres in Western Australian waters. They reach maturity between 17 and 23 years, and it is estimated that their maximum age may be as high as 50 years. In Western Australia, dusky sharks mate during winter in the waters of the North West shelf, and then migrate southwards, giving birth to their pups in the south-west of the State the following autumn.

4.1.2 Interaction with fisheries

The JASDGDLMF and WCDGDLIMF catch mainly juvenile dusky sharks due to the mesh selectivity of gillnets used and the areas fished. Catches of dusky sharks climbed steadily through the 1970s and early 1980s, before beginning to decline in the early 1990s. During the late 1990s, approximately 45 per cent (by weight) of dusky whalers caught in the two temperate fisheries were in their first or second year (0+ and 1+ fish).

Until 2001/02, when they were replaced by gummy sharks, dusky sharks were the single most important species, both by weight and by value, in the State's temperate demersal gillnet and longline fisheries. Annual dusky shark catch for the temperate shark fisheries has previously been about 500 tonnes, and in more recent years, around 300 tonnes.

While demersal gillnets catch almost exclusively young juvenile dusky sharks, the impact of this catch on the breeding stock is considered to be minimal due to the high natural mortality of the juveniles.

The fishery has therefore been considered sustainable based on its catch of young sharks. The damage to the breeding stock has largely occurred outside the managed fishery. It is believed the mortality of older year classes, primarily by the wetline[2] and pelagic longline fleets, has had a profound impact on this portion of the population.

[2] Wetline fishing includes those fishers licensed for State managed fisheries, such as the temperate shark and rock lobster managed fisheries, when fishing with wetline methods, such as hooks on nets and handlines.

4.2 Gummy shark

4.2.1 Biology

The gummy shark (*Mustelus antarcticus*) inhabits shallow southern Australian Continental Shelf waters between Geraldton and northern New South Wales (possibly into southern Queensland). Males mature at about four-years-old and females at five. Gummy sharks can live for up to 16 years.

A study by the CSIRO Division of Fisheries has found that the gummy sharks caught on the South Coast of WA are the same genetic population as those from south-eastern Australia. However, research suggests there is limited mixing between regions and both stocks need to be managed independently.

4.2.2. Interaction with fisheries

Fishing for gummy shark in Western Australia began with longlines in the Leschenault Inlet in the early 1940s. Today, the only significant catches in WA occur in Zone 2 of the JASDGDLMF. Western Australian catches peaked in the early 1990s at nearly 500 tonnes. *M. antarcticus* is also the primary component of the catch in the Commonwealth-managed Southern Shark Fishery, which operates in Victorian, Tasmanian and South Australian waters.

The selectivity of gillnets used in the State fisheries (6.5" - 7.0" stretched mesh) and Commonwealth fishery (6.0" - 6.5" stretched mesh), means that juveniles and the largest females are rarely caught. The catch largely comprises sub-adults and males, which are significantly smaller than females.

4.3 Whiskery shark

4.3.1 Biology

The whiskery shark (*Furgaleus macki*) is endemic to southern Australian Continental Shelf waters between North West Cape in Western Australia and Bass Strait, although it is most common in the southern half of WA. On average, males reach maturity at 4.5 years and females at 6.5 years, and both sexes are thought to live between 10 and 15 years. The diet of whiskery sharks is comprised almost entirely of cephalopods.

4.3.2 Interaction with fisheries

The exploitation of whiskery sharks was at its heaviest during the late 1970s and early 1980s with the catch peaking in 1980/81 at 525 tonnes. The mesh selectivity of commercial gillnets largely excludes whiskery sharks less than five-years-old. However, adults remain a significant part of the catch in both zones of the southern fishery and in the West Coast fishery.

Recently, a small number of tagged whiskery sharks have been caught in South Australia, suggesting that there may be some migration in and out of the WA fishery across the eastern border of the JASDGDLMF.

4.4 Sandbar shark

4.4.1 Biology

The sandbar shark (*Carcharhinus plumbeus*), known locally as the thickskin shark, is a medium-sized whaler shark. It is widespread around the world in temperate and tropical Continental Shelf and adjacent oceanic waters. In Australia, it is found in similar areas to that of the dusky shark, but not in the more southern latitudes between Coffs Harbour in New South Wales and Esperance in Western Australia.

In WA, *C. plumbeus* is mainly found between the Kimberley and Albany. The stock is largely segregated by size, with juveniles apparently preferring deeper Continental Shelf waters (>100m) south of Shark Bay, but moving into shallower waters (50m-100m) between summer and early winter. Adults are most commonly found in depths greater than 40m between the Eighty Mile Beach in the Pilbara and the Abrolhos Islands. Adults can also be found in deeper water (>100m) south of the Abrolhos Islands during summer and autumn.

Research undertaken in the USA and Canada indicates that this species does not reach sexual maturity until between 15 and 30 years.

4.4.2 Interaction with fisheries

As a long-lived, slow growing species with a low reproductive rate, sandbar sharks are susceptible to over-exploitation. Adult sandbar sharks are largely excluded from the catch in the JASDGDLMF and WCDGDLIMF due to gillnet selectivity, and because adults are not common in the near-shore fishing grounds.

Records of sandbar shark catches have been kept since 1985/86. However, fishers appear not to have routinely separated catches of this species until the mid 1990s, which means early records are considered to be under-reported, or at least not properly reported. Catches of *C. plumbeus* have increased steadily in the WCDGDLIMF and, to a lesser degree, in the JASDGDLMF since the mid 1990s.

4.5 Other elasmobranchs

A number of other sharks and rays are caught in these fisheries. McAuley and Simpfendorfer (2003) list 34 elasmobranch species (or groups) as being taken in the two temperate shark fisheries between 1994 and 1999. In addition to the primary shark species, which in 2001/02 made up 80 per cent of the catch by weight, commercial species include whaler sharks, hammerheads, wobbegongs, school shark and rays. The occurrence and numbers of each species or group of species is regionally significant, and further breakdown of these data can be found in McAuley and Simpfendorfer (2003).

The temperate shark fisheries also catch a number of species that are discarded, either because they are difficult to handle or they have no commercial significance. McAuley and Simpfendorfer (2003) list stingrays, eagle rays, carpet sharks, Port Jackson sharks, angel sharks, western wobbegongs, saw sharks, shovelnose rays, and broadnose sevengill sharks.

4.6 Scalefish

Observations show a total of 46 scalefish species were taken between 1994 and 1999 in the temperate shark fisheries (McAuley and Simpfendorfer, 2003). The most commercially important species were dhufish, queen snapper and blue groper. Other retained species included pink snapper, samsonfish, redfish, boarfish, mulloway, leatherjacket, mackerel, yellow tailed kingfish, and baldchin groper. As with the elasmobranch species, the importance of each fish species in the catch varied with region of the fishery.

Of the 46 species observed, only 10 species were discarded, although these accounted for 32.1 per cent of the total scalefish catch. The highest discard catches were of buffalo bream and dusky morwong. Other discarded scalefish include red-lipped morwong, North West blowfish, gurnards, gurnard perches, sea carp, boxfish, scorpionfish and stargazers.

SECTION 5 RESEARCH AND MONITORING

5.1 Stock assessment

5.1.1 Dusky sharks

There are difficulties with assessing the status of the dusky shark stock using traditional age-structured models as the target fishery only exploits a small number of juvenile age-classes. Consequently, there are no readily available indices of sub-adult or adult abundance. To overcome this problem, an assessment technique known as 'demographic analysis' has been used to provide an estimate of the annual rate of intrinsic population increase.

Demographic analysis is widely considered to be the most appropriate approach to assessment of long-lived shark species for which suitable time series of catch per unit effort (CPUE) data are not available for development of age structured models. The demographic technique adopted incorporates the best available information on the biology of *Carcharhinus obscurus*, including biological parameter values that were empirically calculated from studies of Western Australian sharks and age-specific exploitation rates, derived from an extensive tagging project.

It should be noted that this modelling was undertaken using 1994-95 exploitation rate data. In those years, the demersal gillnet fishery's catch of the youngest age classes was assessed as sustainable. The model also warned that any small mortality (up to one per cent[3]) of age classes over six years would cause the population to decline.

Therefore, even relatively small catches of larger dusky sharks were forecast to result in the collapse of the main stock exploited by the JASDGDLMF and the WCDGDLIMF, which were the only fisheries targeting this species at the time (although incidental catches were being taken in other fisheries). The research undertaken indicated that the fishery for dusky sharks should be sustainable, as long as targeting practices and effort levels remained constant at the levels being employed at the time of the research.

Since this research was undertaken, two factors have changed. Firstly, fishing practices within the two temperate shark fisheries have changed. Demersal gillnet fishers have also increasingly used wetline methods (i.e. hooks on net-floats and set lines) to target large sharks (including duskies) for the value of their fins and have geographically spread their fishing to cover more of the dusky shark's distribution.

Further, greater awareness of the seasonal abundance of adult dusky sharks in the south-west of WA, along with improved marketing and distribution networks for shark fin, have resulted in large increases in longline effort in the WCDGDLIMF. The nature of the fishing gear and the increased size of the vessels that have entered the fishery make these operations highly effective at targeting adult dusky sharks.

Secondly, the mortality of older dusky sharks taken outside this fishery (largely in the wetline and tuna fisheries) is now believed to have exceeded one per cent. Given that the domestic market value of shark fins is in excess of $100 per kilo for fins from larger sharks, there is

[3] Note that this figure of one per cent for age classes over six years old has replaced the previously used value of four per cent for all age classes following a review of the dusky model that was undertaken specifically at this time to ensure the information provided to stakeholders is up to date.

significant incentive for fishers to target the larger species, including dusky sharks. Ongoing anecdotal evidence indicates that both commercial and recreational fishers have been shooting large free-swimming sharks of all species to prevent 'bite-offs'.

It is likely that both these sources of adult dusky shark mortality have contributed to the apparent decline of newborn dusky sharks being indicated through catch rate data from the demersal gillnet fishery.

5.1.2 Gummy sharks

An age structured population model, similar to the one described for whiskery sharks, was developed in 1998 to examine the status and future trends in gummy shark stock abundance. It indicated biomass was at 42.7 per cent of virgin biomass, and estimates since then show an increase in abundance. However, subsequent formal assessment of the status of gummy sharks has not been possible due to other priority commitments.

5.1.3 Whiskery shark

To investigate the status and future trends in whiskery shark stock abundance, a model incorporating both biological information and fisheries data was developed. The model simulated the population since 1975.

In order to analyse the level of uncertainty in the modelling procedure, a technique known as 'bootstrapping' was used to calculate 500 equally likely new data sets. These were refitted to the model, providing 500 estimates of the biomass level. A 'risk assessment' technique was then used to examine the impact of future harvest strategies on stock abundance and to determine the probability that the biomass of the stock will be above a set level by a set date under different harvest regimes.

The assessment indicated that the stock was beginning to recover as a result of previous effort reductions. However, the biomass in 2003/03 was between 29.6 and 33.9 per cent of virgin biomass and at the effort levels for that time, there was only a 41.9 per cent chance of the biomass increasing. Current indications show whiskery stocks are continuing to recover slowly.

5.1.4 Sandbar shark

Age-specific exploitation rates and biological data from the current FRDC-funded research project have been incorporated into a *preliminary* demographic analysis, which will determine the likely response of the stock to current levels of exploitation. This is a similar approach to that used in assessing dusky sharks. However, the model incorporates fishing mortality of all age classes and not just juveniles. The results indicate the fishery is sustainable at 2001/02 catch levels.

5.2 Recent catch and effort trends in the fisheries

5.2.1 General trends

Catch and effort trends for the combined and individual fisheries are shown in Figures 2 and 3. Although the general trend through the 1990s was a gradual decline in catch and effort, the catch has increased in the past couple of years, and last year's figures indicated that effort is now rising.

Catch data from 2002/03 has not been fully assessed, so the implications of these increases for the fishery are not fully known. This being the case, Figures 2 and 3 are provided to show recent moves in catch and effort; however, the most recent stock assessment and the management recommendations are based on 2001/02 data. It is safe to say that increases in catch and, more recently in effort, only support the need to tighten existing management arrangements.

Catches in recent years have increasingly comprised higher proportions of larger sharks in both fisheries. This observation has accompanied reports of declining recruitment and has been acknowledged by the WA Demersal Net and Hook Fisheries MAC.

Research sampling of commercial catches from Zone 1 of the JASDGDLMF and from the WCDGDLIMF has found a statistically significant decline in the proportion of neonate dusky sharks caught in the fishery, from 51 per cent in 1994-96 to 38 per cent in 2001/02. This represents a 25 per cent decrease in the contribution of neonates, and provides corroborating evidence that the size structure of the catch has changed.

Researchers believe that this decrease has been masked in the catch per unit effort (CPUE) data of recent years by large sharks, probably taken by wetline methods, being reported as part of the gillnet catch. If this is the case, the gillnet catch has been artificially inflated, introducing a bias into the CPUE that results in an optimistic trend not indicative of the real situation.

The total elasmobranch catch by wetline methods outside the managed 'shark' fisheries has also increased sharply since 2000/01 (Figure 4). Much of this catch has been taken from coast waters in the southern half of the State, and would therefore include a large proportion of dusky whaler. Consequently, there is no doubt that the level of catch of adult dusky whalers has increased significantly since 1994-96, requiring a re-assessment of the stock status.

Figure 2: Temperate demersal gillnet and longline fisheries total shark catch

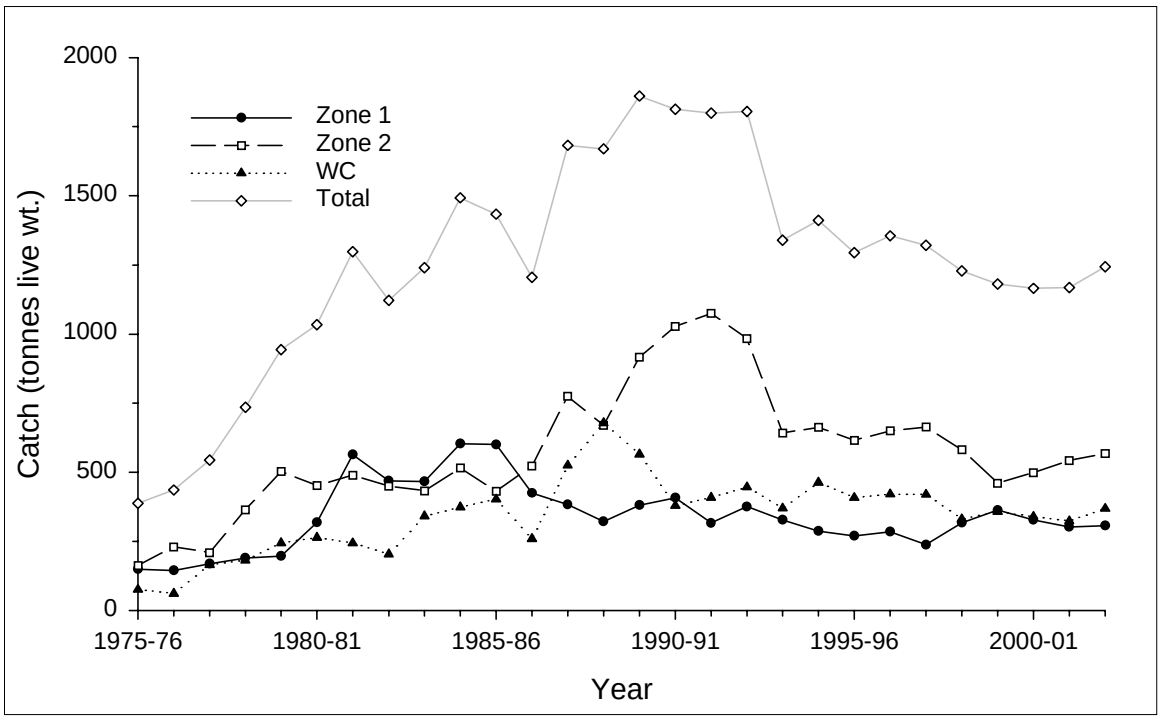


Figure 3: **Temperate demersal gillnet and longline fisheries corrected effort**

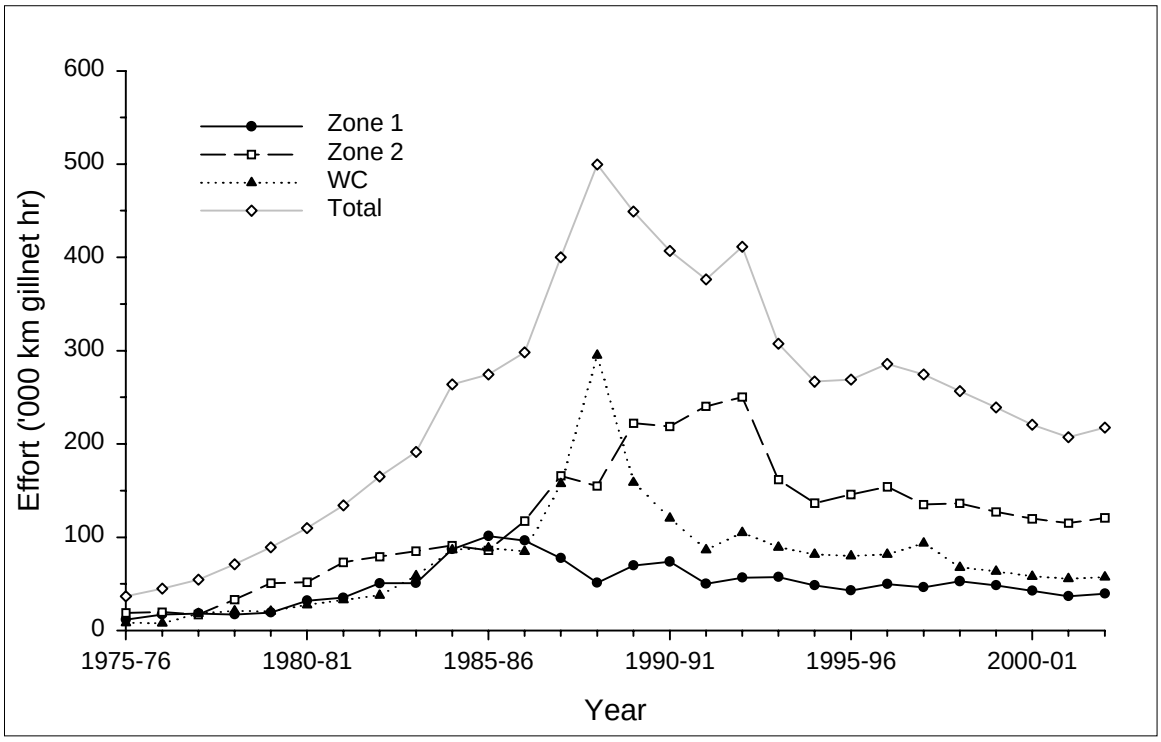
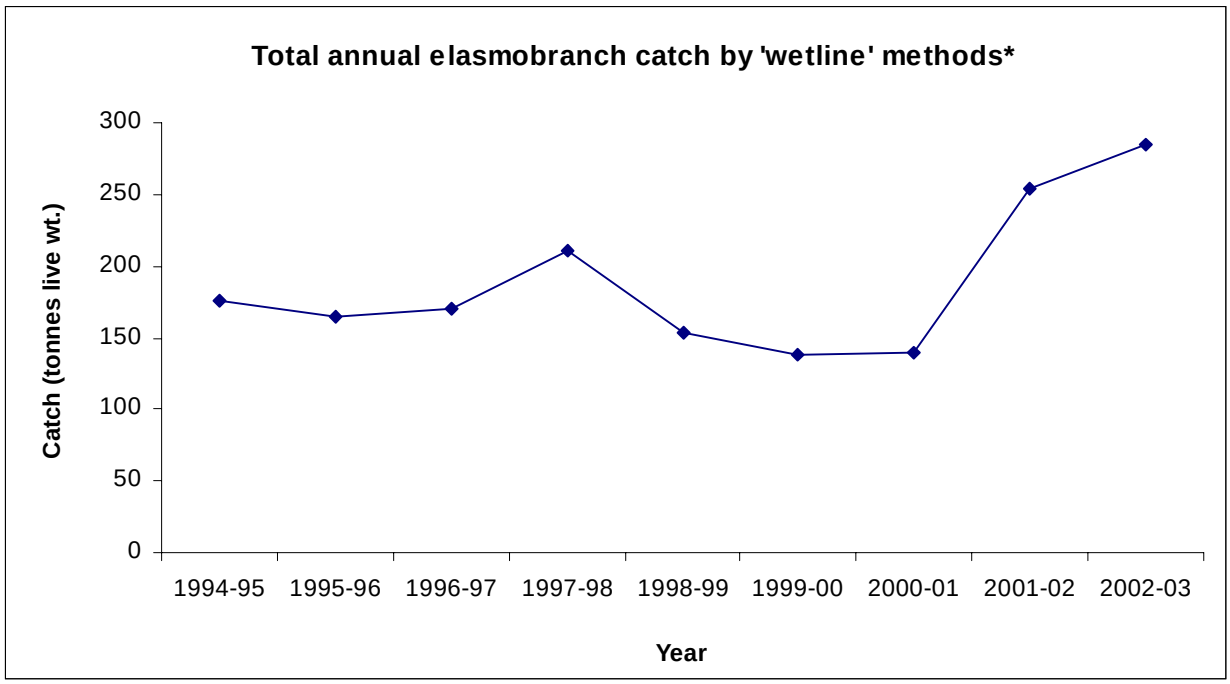


Figure 4: Total annual elasmobranch catch by wetline methods



5.2.2 JADGDLMF

In 2001/02, 842.2 tonnes of shark were caught in the southern fishery, which was an increase of 21.5 tonnes over 2000/01. Total shark landings decreased by 25.5 tonnes (7.8 per cent) in Zone 1 and increased by 46.9 tonnes (9.5 per cent) in Zone 2. Overall effort was six per cent lower than in 2000/01 at 151,232 km gillnet hr[4], decreasing by 13.9 per cent in Zone 1 and 3.2 per cent in Zone 2.

A total of 176.1 tonnes of dusky shark (*Carcharhinus obscurus*) were landed in the southern fishery in 2001/02, which was 54.9 tonnes (23.8 per cent) less than in 2000/01. Dusky shark catches decreased by 35.9 tonnes (25.6 per cent) in Zone 1 and 19 tonnes (21 per cent) in Zone 2. Gummy shark catches increased by 86.3 tonnes (36.3 per cent) in Zone 2 and by 13.1 tonnes (232.1 per cent) in Zone 1.

The Zone 1 catch of whiskery sharks (*Furgaleus macki*), was 9.6 tonnes (11.4 per cent) less than 2000/01 but the Zone 2 catch increased by 14.7 tonnes (28.1 per cent). Sandbar shark catches increased by 47.1 per cent in Zone 1, due partly to improved reporting and declined by 67.2 per cent in Zone 2. The composition of the 2001/02 JASDGDLMF shark catch is given in Table 1.

Table 1: Species composition of the 2001/2002 JASDGDLMF shark catch

Species	**Catch in tonnes, live weight (% of total catch)**		
	Zone 1	**Zone 2**	**Total**
Dusky	104.6 (34.7%)	71.5 (13.2%)	176.1 (20.9%)
Gummy	18.8 (6.2%)	323.9 (59.9%)	342.7 (40.7%)
Whiskery	74.3 (24.6%)	67.2 (12.4%)	141.5 (16.8%)

[4] A km gillnet hour is the kilometres that a gillnet would cover in an hour totalled across the fishery.

Sandbar	29.6 (9.8%)	0.7 (<1%)	30.3 (3.6%)
Hammerhead	7.3 (2.4%)	30.8 (5.7%)	38.1 (4.5%)
Wobbegong	10.8 (3.6%)	7 (1.3%)	17.8 (2.1%)
School	0.0 (0.0%)	14.9 (2.8%)	14.9 (1.8%)
Skates & rays	0.0 (0.0%)	6.4 (1.2%)	6.4 (<1%)
Pencil	0.1 (<1%)	1.8 (<1%)	1.9 (<1%)
'Blacktip'	1.1 (<1%)	0.2 (<1%)	1.3 (<1%)
Other sharks	55.0 (18.2%)	15.1 (2.8%)	70.0 (8.3%)

Scalefish catches have remained stable in Zone 2 and have increased steadily in Zone 1 since the mid 1990s, despite the trends of effort declining in Zone 2 and remaining steady in Zone 1. In 2001/02, scalefish catches decreased by 6.7 tonnes to 81.9 tonnes in Zone 1, and increased by 19.5 tonnes to 78.3 tonnes in Zone 2, an 8.7 per cent annual increase across the fishery. Scalefish accounted for 16 per cent of the fishery's total catch in 2001/02. The species composition of the 2001/02 catch is given in Table 2. Queen snapper (*Nemadactylus valenciennesi*) was the largest component of the catch at 30.5 tonnes, followed by blue groper, (*Achoerodus gouldii*) at 19.9 tonnes and dhufish (*Glaucosoma hebraicum*) at 8.5 tonnes.

Table 2: Species composition of the 2001/2002 JASDGDLMF scalefish catch

Species	**Catch in tonnes, live weight (% of total catch)**		
	Zone 1	**Zone 2**	**Total**
Queen snapper	8.6 (10.5%)	21.9 (33.5%)	30.5 (20.7%)
Blue groper	9.3 (11.3%)	10.6 (16.2%)	19.9 (13.5%)
Pink snapper	1.9 (2.3%)	6.6 (10.1%)	8.5 (5.8%)
Dhufish	6.4 (7.8%)	1.3 (2.0%)	7.7 (5.2%)
Samsonfish	5.5 (6.7%)	2.0 (3.0%)	7.4 (5.0%)
Salmon	5.8 (7.0%)	0.0 (0.0%)	5.8 (3.9%)
Redfish	0.0 (0.0%)	4.4 (6.8%)	4.5 (3.0%)
Boarfish	0.1 (<1%)	2.9 (4.5%)	3.1 (2.1%)
Leatherjacket	0.1 (<1%)	2.7 (4.2%)	2.8 (1.9%)
Trevally	0.0 (0.0%)	1.0 (1.5%)	1.0 (<1%)
Other scalefish	44.3 (54.1%)	11.9 (18.2%)	56.2 (38.2%)

5.2.3 WDGDLIMF

A total of 309.6 tonnes of shark was landed in the West Coast fishery in 2001/02, a decrease of 3.8 tonnes over the previous year. Effort was 52,981 km gillnet hour, 1.2 per cent less than in 2000/01. Sandbar shark landings in the West Coast fishery were steady, decreasing by only 800kg (0.6 per cent) and at 130.4 tonnes, remained the biggest component of the catch. Dusky shark catches fell by 9.4 tonnes (13.5 per cent) and whiskery shark catches by 10.9 tonnes (26.4 per cent). The species composition of the 2001/02 WCDGDLIMF shark catch is given in Table 3.

Table 3: Species composition of the 2001/2002 WCDGDLIMF shark catch

Species	Catch in tonnes, live weight (% of total catch)
Sandbar	130.4 (42.1%)
Dusky	60.0 (19.4%)
Whiskery	30.4 (9.8%)
Hammerhead	21.8 (7.0%)
Wobbegong	21.2 (6.8%)
'Blacktip'	20.9 (6.8%)
Gummy	15.5 (5.0%)
Shovelnose/fiddler rays	4.7 (1.5%)
Copper	4.6 (1.5%)
Other sharks	0.1 (<1%)

The species composition of the WCDGDLIMF scalefish catch is given in Table 4. The catch increased by 18.3 tonnes (26.6 per cent) in 2001/02 and accounted for 22 per cent, by weight, of the total catch. Dhufish (*Glaucosoma hebraicum*) remained the largest component of the West Coast scalefish catch (16.0 tonnes), followed by pink snapper (*Pagrus auratus*) (14.3 tonnes); samsonfish (*Seriola hippos*) (11.8 tonnes) and queen snapper (*Nemadactylus valenciennesi*) (6.6 tonnes).

Table 4: Species composition of the 2001/2002 WCDGDLIMF scalefish catch

Species	Catch in tonnes, live weight (% of total catch)
Dhufish	16.0 (18.3%)
Pink snapper	14.3 (16.5%)
Samsonfish	11.8 (13.5%)
Queen snapper	6.6 (7.6%)
Mulloway	5.9 (6.7%)
Emperor sweetlip	4.6 (5.3%)
Sweetlip	4.6 (5.2%)
Blue groper	4.0 (4.6%)
Baldchin groper	3.3 (3.8%)
Cobia	2.8 (3.3%)
Other scalefish	13.2 (15.2%)

5.3 Status of the stocks

The status of the key target stocks is summarised as follows.

- The breeding stock of dusky sharks is overexploited and recruitment of neonate dusky sharks has decreased in recent years. There is significant doubt over the continued sustainability of these stocks in both fisheries.
- Continuing mortality of larger dusky sharks from targeted fishing, bycatch, entanglement in plastic packing straps and possibly being shot is likely to further deplete the breeding stock.

- Whiskery shark biomass is higher than previously estimated, but is still well below the target biomass level.
- The biomass of mature female whiskery sharks increased marginally in 2001/02. It is anticipated that biomass will continue to increase towards the target level, but only slowly.
- Gummy shark biomass is apparently increasing.
- Current catches of sandbar sharks are sustainable, however increased targeting of adults for fins has the potential to cause a disproportionately adverse effect on sustainability, and requires careful management.

SECTION 6 FUTURE MANAGEMENT OPTIONS

6.1 Objectives of management

6.1.1 WA's fisheries management objectives

The State's shark fisheries are managed in accordance with the objectives of the *Fish Resources Management Act 1994*:

> *"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."*

Specifically, the *Fish Resources Management Act 1994* has the following objectives:

(a) to conserve fish and to 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 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.

6.1.2 Fishery specific objectives

Current management arrangements for the shark fisheries have been developed with a view to restoring and maintaining shark stocks. Under this broad objective, a number of more specific objectives are proposed for whiskery and gummy sharks, which appear to be more able to withstand exploitation than dusky sharks, as well as for dusky sharks, whose sustainability requires more careful management.

The following objectives have an outline of the management measures associated with them that are targeted at meeting that specific objective, should the prognosis for dusky sharks allow the fisheries to remain open. A detailed description of these proposed measures form the basis of the remainder of this paper.

6.1.2.1 All species

Objective: To facilitate the capping of fishing effort on all species of shark in the temperate shark fisheries at the level recorded in 2001/02.

Management measures:

a. Capping active effort at a level that is likely to result in a total shark catch from these fisheries of no greater than 2001/02 levels (842 tonnes in the JASDGDLMF and 310 tonnes in the WCDGDLIMF), but with a trigger catch for whiskery shark in each of the fisheries of 141 tonnes and 30 tonnes respectively. This will be assisted by removing latent effort and limiting the fisheries' capacity for 'effort creep' by moving to a day gear system.

b. Remove latent effort.

c. Redefine unit value from month-based to day-based units.

6.1.2.2 Dusky shark

Objective: To facilitate the breeding biomass of dusky sharks exceeding 40 per cent of virgin levels by 2040.

Management measures:

1. Within the temperate target shark fisheries:
    a. Imposition of a maximum size limit, equating to 1.5 metres fork length for dusky sharks.
    b. Restrict permissible hook sizes and prohibit the use of wire traces on longlines.
    c. Consider a trigger catch rate of neonates, measured in numbers[5]. Should the trigger catch of neonates be exceeded, further restrictions will need to be considered for following fishing years to ensure the catch of neonates is reduced to the target levels.
2. Outside the temperate target shark fisheries:
    a. Prohibit the take of all sharks outside the recognised temperate and tropical shark fisheries; and
    b. Restrict permissible hook sizes and prohibit the use of wire traces (except for the mackerel fishery).

6.1.2.3 Whiskery shark

Objective: To achieve an increase in biomass for whiskery sharks for three consecutive years prior to 2010, with the long-term objective of returning the breeding stock to 40 per cent of virgin biomass.

Management measures:

It is proposed this objective be addressed within the temperate shark fisheries by:

a. Instigating a whiskery shark pupping closure 15 August - 15 October.

[5] The trigger catch rate will be developed after further analysis of recent catch data.

b. Should the trigger catch of whiskery shark be exceeded, further restrictions will need to be considered for following fishing years to ensure the catch of whiskery shark is reduced to the target levels.

c. Implementing regular performance reviews to determine if the rate of shark recovery is consistent with the objectives.

d. Supporting (a) and (b) with the Vessel Monitoring System.

6.1.2.4 Gummy shark

Objective: To maintain the biomass of gummy shark at or above 40 per cent of virgin biomass.

Management measures:
These measures to be implemented for the sustainability of dusky and whiskery sharks should ensure gummy sharks remain sustainable. No additional management measures are proposed specifically for gummy sharks.

6.1.2.5 Sandbar shark

Objective: To maintain the annual State catch below 360 tonnes (approximately equal to the annual catches from the target shark fisheries in 2001/02), with the catch from the temperate shark fisheries to remain below 250 tonnes per year (68 per cent of the annual sandbar catch)[6].

Management measures
Specific management arrangements are not proposed for this objective. Should existing reductions in effort not be effective in meeting this objective, consideration will need to be given to further tightening of management in future years.

6.2 Positioning the temperate shark fisheries to achieve the performance targets

6.2.1 Stage One: Remove latent effort

The existence of latent effort in a fishery lessens the effectiveness of management arrangements. When changes to management are introduced, operators tend to compensate by activating previously inactive, or latent, units/licences.

This is one of the major management issues facing the temperate target shark fisheries - the existence of time/gear units that are currently inactive. To demonstrate the amount of unused, or 'latent' fishing capacity in each management zone, Table 5 shows the number of units that were required to achieve the actual effort for each management zone, assuming all fished the permitted net length for the average number of days, average hours per day and average number of shots per day. Latent effort (expressed as units) was calculated as the total unit allocation less the number of utilised units.

[6] The remaining portion of the catch (32 per cent, or 117 tonnes) is taken in the tropical shark fisheries (another paper).

In 2000/01, an estimated 34.6 per cent of time/gear units in the WCDGDLIMF were unused. In 2001/02, this figure was 44 per cent. A similar calculation for the JASDGDLMF indicated that 25 per cent of time/gear units in Zone 1 and 35.6 per cent of time/gear units in Zone 2 were unused. In 2001/02, these figures were 45 per cent and 21 per cent respectively. It should be noted that this is unused potential effort (both nominated and un-nominated units), not unused units which were nominated for fishing in those years.

Table 5: 2001/02 temperate demersal gillnet and demersal longline fisheries unit allocations, latent unit estimates and latent unit calculation parameters.

Fishery / zone	Total unit allocation	Actual effort (km gn hr)	Permitted net length (km)/unit	Mean days/ month	Mean hrs/ day	Mean shots/ day	Estimated units utilised	Latent units
Zone 1	1110.5	36,658	0.27	17	13	1	615	495
Zone 2	1404.5	114,574	0.27	16	15	1.6	1105	299
WC[7]	667	52,981	0.54	20	13	1	377	290
Total	3182	204, 213					1843	1339

To counter the effects of the 60 per cent gear reductions that have occurred over the past 10 years in the JASDGDLMF, unused units have been traded and/or activated, and the level of actual effort has not declined as much as planned. Nevertheless, despite the activation of some unused units to offset the earlier unit value reductions, there is still latent effort in both fisheries.

It is generally accepted that fishing effort within the temperate target shark fisheries needs to be capped at current levels at least, and possibly reduced, to ensure the sustainability of the target stocks. In the case of dusky shark stocks, the effort reduction would need to be considerable. The Department's view was that, apart from dusky shark issues, the catch of shark from the temperate fisheries during 2001/02 was sustainable, and hence the fishing capacity active in 2001/02 should be used as the starting point to calculate an effort cap.

In other words, either the number of units or unit values in the temperate target shark fisheries must be reduced accordingly to the level that would equate to the active fishing level in 2001/02. The capacity of both fisheries would also be set in each management plan.

Based on the level of unused capacity in the temperate target shark fisheries illustrated in Table 5, effort capacity would need to be reduced by around 32 to 45 per cent.

Once latent effort is removed, the fishery would be monitored to ascertain whether this total effort reduction has had any real impact on the achievement of management objectives. If not, further reductions would be required.

There are a number of options that could be used to implement the removal of latent effort, which are outlined.

6.2.1.1 Option 1: Revalue units

It is acknowledged that reductions in unit values will have both social and local economic impacts. Operators with lower unit holdings may need to trade out of the fishery, while remaining operators would need either to invest in more units to maintain viability or become more efficient with the units they hold.

Despite these impacts, the removal of latent effort is important if the management strategy is to be effective. Licensees would no longer have the opportunity to offset effort reductions by activating latent effort. Market forces would ensure the most efficient industry structure, and any attempt to address social issues are, in the long term, likely to be countered by these forces.

[7] *Final unit allocation still to be determined*

Example 1: Stage One removal of latent effort

There are 2,515 units in the JASDGDLMF. Each unit is worth 270 metres of net for one month.

In 2001/2002, it is estimated that 1,720 of those units were used, leaving 794 units latent. These figures are based on the number of units required to achieve the recorded level of effort in each zone, assuming all fished the permitted net length for the average number of days (see Table 5, from McAuley, 2003). These figures are then compared to the maximum effort that would be exerted if all units used maximum gear for the average number of days.

On these figures: $\frac{1,720}{\mathbf{2,515}} = 0.68$

Therefore to account for latent effort, the unit would need to be reduced to:
270 x 0.68 x 1 month = 184 m for 1 month.

A similar calculation for the WCDGDLIMF would yield the following:
$\frac{377}{\mathbf{667}} = 0.56$

Therefore, to account for latent effort, the unit would need to be reduced to:
540 x 0.56 x 1 month = 302.4 m for 1 month.

However, there are some potential consequences of management measures that encourage rationalisation:

1. The fishery is likely to become more 'industrial', which may have regional social and economic implications.
2. Clumping of effort on a few vessels may result in localised depletions as operators attempt to keep running costs to a minimum.
3. Increased targeting of the less sustainable, longer-lived species or older age classes for fins to increase income to cover the costs of the further investment required.

6.2.1.2 Option 2: Fisheries Adjustment Schemes (FAS)

There are a number of different options for implementing a FAS.

- *Buy back unused units under a voluntary FAS, at the current market price for units (fully Government Funded Adjustment)*

A study by the Department in 1995 indicated that it would cost in the region of $5 million to fully fund a buy back scheme that reduces the number of units in the JASDGDLMF to a point where long-term sustainability could be reasonably assured, and where future significant reductions would be unlikely to be necessary. While there has been some effort reduction since then, shark stocks continue to decline.

Current reported market prices for units in the WCDGDLIMF (regardless of zone) are between $5,000 and $5,500 per unit, and there are 667 units in the fishery. There are 2,515 units in the

JASDGDLMF (Zone 1, 1,110.5 units, including 62.5 Zone 3 units; and Zone 2, 1,404.5 units) with reported market prices varying between $2,300 to $2,600 for Zone 1 units and $2,800 to $3,200 for Zone 2 units.

Using these figures, the cost of making the required effort reduction through a fully funded FAS in both temperate shark fisheries varies between $2.6 million and $4 million, depending on the percentage reduction in each fishery and whether a premium is applied.

Given that the annual provision of funds for Fisheries Adjustment Schemes is only $500,000, and that the Government rarely approves special funding for such purposes, a fully-funded FAS is not a practical alternative. Even if half the annual allocation of FAS funds ($250,000) was used, it would only support about 8.5 per cent of the desired effort reduction or buy back of latent units or around a three per cent unit reduction over both temperate target shark fisheries.

The strongest argument against this option centres on the use of FAS. There are no government buybacks for the sustainability of fisheries where the reason for action is overfishing by licensees. Previous schemes in such circumstances have been fully funded by the licensees within the fishery (for example, Shark Bay Prawn Trawl Managed Fishery).

- *Compulsory buy back of units under a FAS, at less than the market price to effectively provide a Government contribution (jointly industry and Government funded adjustment).*

An alternative option involving partial funding of a FAS scheme would be a compulsory scheme in which a compulsory acquisition price is set based on the available funds. To get an effort reduction of 35 per cent in the WCDGDLIMF and 25 per cent in the JASDGDLMF with $250,000 would mean paying fishermen eight per cent of the market value of their units. Again, government funding would be required, which, as previously mentioned, is unlikely to be provided.

Generally, there seems little merit in pursuing a FAS based scheme to reduce effort unless substantial funding (at least $2 million) can be secured.

6.2.1.3 Option 3: Cancel unused managed fishery licences

Cancelling licences that have not been used in the previous two years is another option for removing some latent effort. Section 143 of the *Fish Resources Management Act 1994* provides for this type of licence cancellation.

6.2.1.4 Option 4: Set an annual effort ceiling and close the fishery when it is reached

Setting an effort ceiling in each fishery and in each zone of the fisheries and to close the fishery or zone once the effort reaches the ceiling is another alternative. This approach is working successfully in the Kimberley Prawn Fishery, due to the use of the Vessel Monitoring System (VMS). Successful implementation of revised management arrangements in the temperate shark fishery is likely to require VMS, so it would be available to support this option if necessary.

Other implications could be competition in the use of time/gear units and possible disruptions in market supply, but it would not require operators to invest significantly in buying further units.

6.2.2 Stage Two: Redefine unit value to limit increases in fishing efficiency

Fishing efficiency and technology, in conjunction with the flexibility built into existing management arrangements, has resulted in 'effort creep' in the temperate target shark fisheries. As the management arrangements are currently based on nomination of monthly time/gear units, it is possible for operators to increase the number of days per month they fish.

In 2001/02: JASDGDLMF Zone 2 operators fished an average of 16 days per month; Zone 1 operators fished an average of 17 days per month; and WCDGDLIMF operators fished an average of 20 days per month. Given there are 28-31 days per month, this is potentially a large source of latent effort. To address this latent effort, it is proposed to redefine the current monthly units in terms of days, with total capacity being set on the basis of 16-20 days/month. The implementation of a gear/day system would require the support of the Vessel Monitoring System (VMS) to monitor usage of fishing days. A worked example of how these reductions would be effected follows.

Example 2: Stage Two: Conversion from month-based to day-based units in JASDGDLMF

Based on mean fishing days in 2001/2002, a standard month across the whole JASDGDLMF is 16 fishing days.

The total month-based time units in 2001/02 were 2,515.

Converting month-based to day units would result in a total available gear unit days of 16 x 2,515 = 40,240 available day units.

In this scenario

- A fisherman with only 1 existing unit would have 16 gear unit days in a season.
- A fisherman with 100 existing units would have 1,600 gear unit days in a season.

If a fisherman chose to fish with more than one net unit (reduced to 184 metres under Stage 1), he would be using more than one day unit. For example, if a fisherman used 5-net units (920 metres), he would use 5-gear unit days each day that he fished.

The formula for calculating allowed fishing days is:

$$\frac{\text{(Units owned x 16)}}{\text{(Number of standard net length units fished each day).}}$$

For example, a fisherman with 90 existing month-based units planning to fish with 2208 metres of net (12 units) each day would have (90x16)/12 or 120 days available to fish within a fishing season.

Following the above premise that one month is converted to 16 fishing days, one 184-metre unit x 16 days would be 2.94 kilometre days.

100 units would be equivalent to 294 kilometre days.

Using the previous example, a fisherman with 90 units and 2.208km of net each day would have an allocation of 2.94 x 90 = 264.6 kilometre days. This in turn converts to 264.6/2.208 = 120 gear unit days.

Any reduction could be applied to the whole unit: e.g. 2.94 km days x 0.8 = 2.352 km days.

Reduction impact

Current Unit Value = 4.32 kilometre days

Less latent effort reduction of 32% as per Stage One: (0.68 x 4.32) = 2.94 km days.

Using day gear units, 16 days would reduce to 10.88 days after a 32% reduction.

Based on the previous example a 90-unit boat fishing 2.208 km of net each day would have 81.6 days.

Example 3: Stage Two: Conversion from month-based to day-based units in WCGNDLIMF

Based on mean fishing days in 2001/02, a standard month was 20 fishing days.

Existing Units 667 month based units where 1 unit is 540 metres for 1 month.

Total available gear unit days 20 x 667 = 13,340.

- A fisherman with only 1 existing unit would have 20 gear unit days in season.
- A fisherman with 100 existing units would have 2,000 gear unit days in a season.

As in the previous example, if a fishermen chose to fish with a net equivalent to the length of 5 units, he would use 5 gear unit days each day he fished.The formulae for calculating allowed fishing days is:

$$\frac{\text{(Units owned x 20)}}{\text{(Number of standard net length units fished each day)}}.$$

For example, a fisherman with 105 units planning to fish with 3,629 metres of net (12 units) each day would have (105x20)/12 or 175 days available to fish within a fishing season.

Any reduction could reduce available days or the length of gear units.In terms of kilometre days, one 302.4-metre unit x 20 days is 6.048 kilometre days.

100 units are 604.8 kilometre days.

Continuing the example, with 105 units and 3.629 km of net each day, the allocation becomes 6.048 x 105 = 635 kilometre days and 635/3.629= 175 days.

Reductions would be applied to the whole unit; e.g. 6.048 km days x 0.80 = 4.84 km days.*Reduction impact*

Current unit value = 10.8 kilometre days

Less latent effort reduction of 44% from Stage One: (0.56 x 10.8) = 6.048 km days.

Using day gear unit would reduce from 20 days to 11.2 days after a 44% reduction.

An alternative is to use the average of 16 days across the board, instead of using the average days for each fishery. The impact of this would be the greatest in the WCDGDLIMF, then Zone 1, and then Zone 2.

Although the time component of the unit would change under either option, the gear unit would not. The existing provisions relating to maximum net length would remain. Regardless of the time allocation method used, unit nomination would still be required prior to fishing in the fishery. This system allows fishers to engage in other fisheries when not shark fishing.

Adoption of an electronic nomination system, through VMS, would decrease the administrative costs associated with time/gear nominations. While implementation of VMS in the temperate shark fisheries would require Departmental resources to monitor fishing activity, these costs are likely to be offset by increased efficiency in administration and compliance. At this point, the Department does not recover VMS monitoring costs from licensees.

Collection of real time fishing activity data through VMS could also provide an opportunity in the future to achieve improved spatial management by setting effort limits within parts of a zone and/or giving effect to closed areas. VMS also offers significant improvements to the

spatial resolution of catch and effort data, which could greatly improve the quality of future stock assessments. The efficiency of at-sea and wharf compliance checks would also increase with the use of VMS, as Fisheries and Marine Officers would be empowered by the increased level of intelligence available.

6.2.3 An alternative approach: fixing the fishing season

Another approach that has been discussed with industry to address potential efficiency creep that usually accompanies tightening of management arrangements is to move to an annual fishing season, and to convert existing units to reduced 'annualised units' based on a fixed fishing season.

This proposal would work as follows:

- There would be a fixed nine month commercial fishing season ending Christmas Eve each year and with closed periods over the prime whiskery pupping months and the Christmas, New Year and Easter holiday periods (to reduce conflict with recreational fishers).
- Individual fisherman's existing units would be converted to a fixed length of net or number of hooks.
- To assist in compliance, a prohibition would then be placed on trading or transferring gear units within the fishing season. This would result in all operators fishing with a fixed net length or number of hooks throughout the fixed fishing season.

As a first step, individual units would simply be converted to a fixed number of units (annualised) by dividing the total units held by 12 (e.g. a licensee currently with 12 month-based gillnet units would have a maximum of one unit that could be used in each month for the fixed nine month season). Licensees with less than 12 units would have their unit net length or hook unit reduced accordingly.

Example 4: Gear conversion for a fixed season
Using the previous example of a JADGDLMF licensee with 90 net units, annualising these units would give the licensee 90/12 = 7.5 units or (7.5x 270)/12 = 168.75 metres of net each day fished during the fixed season.

For a licensee in the WCDGDLIMF, the previous example based on 105 units would yield the following reductions: 105/12 = 8.75 or (8.75x540)/12 = 393.75 metres of net per day fished during the fixed season.

Dividing by 12 rather than nine means that there would be an immediate 25 per cent reduction in total potential effort. Further reductions could be implemented by either shortening the length of the fishing season or simply proportionately reducing the length of net or number of hooks able to be used per unit.

One such reduction could be through basing the season or unit allowance on the current average fishing days – 16 for JADGDLMF and 20 for WCDGDLIMF. A further variation to prevent effort creep under this option is to limit line and net set and pulls to once per day (where currently nets are often set and pulled up to four times per day). This latter variation would require the adoption of VMS to monitor compliance.

Example 5: Fixed seasons based on average fishing days

JADGDLMF:16/30 = 0.53. THIS TRANSLATES TO 0.53X9 MONTHS = 4.77 MONTHS (ROUND TO 5).

WCDGDLIMF: 20/30 = 0.67. THIS TRANSLATES TO 0.67X12 MONTHS = 6.03 MONTHS (ROUND TO 6).

The suggested advantages of such an approach include:

a) Reducing potential for conflict with the recreational fishing sector.

b) Reducing the efficiency of fishing operations by spreading all the fishing effort evenly over a fixed season (preventing, as currently happens, fishers nominating to fish most units on the most productive days or months).

c) Enabling closure of the fishery at ecologically important times, such as the whiskery pupping season.

d) Simplifying management and compliance monitoring by having licensees with fixed unit (and net lengths and hook numbers which could be endorsed on licences) during any fishing season.

e) Limiting efficiency creep to gear related options (i.e. larger boats) rather than selection of fishing times (i.e. nominating to fish at the most productive times).

f) Maintaining and increasing the opportunity for fishing inefficiency and lost fishing days that results from such things as bad weather and boat breakdowns.

g) Reducing the need for VMS, although the Department would see the adoption of VMS as a preferred requirement under such a system.

h) Possible social advantages by providing those licensees with greater opportunity to be at home with their families during holiday period.

Possible disadvantages of such an approach include:

a) Unless the variation of using average fishing days to further reduce the fishing season or annualised units is used, it does not prevent all effort creep or totally freeze potential effort at target levels.

b) It gives fishermen less flexibility about when they fish.

c) It may unfairly disadvantage those who have a boat breakdown during the season and cannot arrange prompt repairs or a boat replacement.

6.3 Implementation of a size restriction on sharks taken by operators in the recognised shark fisheries

In addition to the measures outlined in section 6.2, a maximum size limit based on an interdorsal fin measurement and equating to 1.5 metres fork length is proposed for dusky sharks landed in the managed shark fisheries. In order to effectively monitor the size of shark trunks, both dorsal fins will need to be left attached to the trunk. Alternatively, fishers may be required to leave a minimal fin ‘stump’ that would allow measurement with the fins removed.

It should be remembered that most sharks of 1.5 metres fork length weigh in excess of the current Health Department recommendations, which discourage the sale of sharks over 16

kilograms dressed weight for human consumption because of unacceptable mercury levels in their flesh. Further, Standard 1.4.1 of the *Australian Food Standards Code* sets out a maximum (mean) level of mercury of 0.5mg/kg.

6.4 Supplementary measures for whiskery sharks

As discussed in section 6.1, there is a need to cap effort in the temperate shark fisheries at the 2001/02 levels and to reduce latent effort. However, it is considered that further reductions in whiskery shark catches might be necessary to achieve increases in the biomass before 2010 and to position the stock for a return to 40 per cent of virgin biomass. Despite indications that the stock is beginning to recover as a result of previous effort reductions at 2001/02 effort levels, there is estimated to be only a 41.9 per cent chance of the biomass increasing. Further management measures are required to increase the likelihood of the whiskery stock reaching its target biomass.

Although whiskery sharks are caught in the temperate shark fisheries throughout the year, they are most abundant (or 'catchable') during Spring, with catch rates peaking in September. This corresponds to the pupping season of the species, and a large proportion of the catch is comprised of near-term pregnant females.

Gear reductions may reduce latent effort and address sustainability concerns to some extent, however, changes in fisher behaviour or technical improvements may enable the fishing fleet to take advantage of local and temporal abundances. For example, operators would still be able to target their effort at whiskery sharks during the Spring pupping season, when adult females are most catchable. Fishing behaviour such as this would undermine the benefits of further unit reductions and a high catch of near-term pregnant whiskery sharks during Spring is thought to have contributed to the delayed recovery of this stock.

Closure of large portions of the whiskery shark's pupping grounds, i.e. the waters of the temperate target shark fisheries for about two months during August, September and October, is expected to have the twofold effect of reducing the overall catch of adult whiskery sharks and increasing recruitment of neonate sharks. To achieve this, the current 12-month fishing season would have to be reduced to 10 months, in addition to the time gear unit system being converted from months to days. The 'kick start' achieved from this two pronged action should increase the chance of three consecutive biomass increases prior to 2010.

With the implementation of VMS, specific spatial closures could be considered ahead of any total closure of the fisheries, should that be necessary (see section 6.5.1). While suitable closure areas are open to discussion, it is recognised that the highest catch rates of whiskery sharks occur between Mandurah and Albany in waters of approximately 50-90 metres deep.

Some suggested areas for consideration include:

- JASDGDLMF Zone 2: Albany westwards to the Zone 1 border (Chatham Island) and selected areas to the east.
- JASDGDLMF Zone 1: All waters of between 50m and 90m depth.
- WCDGDLIMF: From the town of Seabird ($31^{o}17'$ S) south to 33^{o} S latitude.
- Whole fishery: All waters between 50m and 90m deep.

These areas have been suggested not only for their benefits for conserving pregnant females and pups, but also to avoid concentrating effort in areas where increased fishing pressure could lead to conflict with other user groups, such as the recreational sector. Such closures would also warrant increased compliance and monitoring, and it may therefore be more efficient to have a blanket two-month seasonal closure to address the whiskery shark issue.

Whiskery sharks reach sexual maturity earlier than whaler species, taking approximately seven years to first pupping. Researchers believe that a temporal closure between August and September should exist for five years followed by a review of stocks to determine whether the closure is still warranted.

6.5 Other options

There are a number of other management tools and options that could be considered. However, for the reasons mentioned, they are not as likely to meet the needs of the total fishery as the management options previously proposed.

6.5.1 Fishery closures

An alternative to reducing net allocations and redefining time units is to simply implement large-scale closures, either in time or in area. The advantage of this is that it is easy to implement and enforce – fishing is either allowed or not allowed, and it can be easily enforced through VMS. The great disadvantage is the disruption both to fishers' income flow and to market supply or, if the closure is not fishery-wide, displacement of effort into the remaining open areas.

At the extreme end of this spectrum is the total closure of either or both fisheries. This is always the last resort in managing a fishery. However, if available information indicated that no other measure would place the fisheries in a sustainable position, they should be closed.

The lack of gear selectivity in these temperate shark fisheries means that it is difficult to tailor management arrangements to protecting one or two species of shark. There is significant concern over the status of the dusky shark stocks, and unless management can be tailored to remove that fishing pressure sufficiently, there is no guarantee that the dusky stocks will not collapse. No government managing fisheries under the precautionary principle can allow a fishery to continue when all evidence points towards the collapse of part of the fishery.

Should such a decision need to be made, the fisheries would need to remain closed for time sufficient to allow the stock to rebuild to acceptable levels. Given the time that it takes for dusky sharks to reach maturity, the period necessary for the recovery of this species might be in the order of 25 years.

6.5.2 Total allowable catches

Total allowable catches or quotas could be set for the major shark species, either as individual or competitive allocations. This would be administratively cumbersome and expensive, as it would require a complete change to the management of these fisheries. Quota systems also do

not take into account the sustainability of non-quota species and are a less effective management tool in mixed species fisheries such as these.

Competitive quotas often lead to uneven supply as fishers compete against each other to maximise their own catch before the ceiling limit is reached and the fishery closed. Individual transferable quotas remove this problem to some extent, but unless accompanied by gear restrictions and closures, fishing is likely to be targeted at times and in areas that will maximise catch. This may not result in the level of stock protection necessary to ensure sustainability – especially that of whiskery and dusky sharks.

Further potential problems include any move to targeting of non-quota scalefish and the dumping of over-quota or protected species of sharks.
Such a system would lead to angst, both within the commercial sector and between sectors, without providing any benefit to shark mortality – the primary motivation for management.

6.5.3 Gear changes

6.5.3.1 Redefine to hook only

One option is to redefine the permissible gear for the fishery to ban the use of nets so that the fishery is transferred to a hook only fishery. An additional necessary measure would be to require the line to be pulled within 12 hours of being set and the release of all dusky sharks caught. However, given the proposal to limit hook size and ban wire traces, it is unlikely much shark would be caught in such a fishery.

There are several reasons why this would not be an appropriate move:

- Total shark production from these fisheries would most likely cease, which would impact on the market for shark in Western Australia.
- It would be expensive for fishers to change their method from net fishing to line fishing.
- It would increase the number of scalefish caught and move the fishery operationally from a target shark fishery to a scalefish longline fishery, which may increase potential conflict between (and the extent of the resource sharing debate between) the commercial and recreational fishing sectors.

6.5.3.2 Redefine to net only fishery

The opposite of the last option would be to remove line fishing as a permissible method, making the fishery a total demersal gillnet fishery. The fishery has naturally progressed to a stage where this is already nearly the case, although increasing interest in fin-based fishing may reverse this trend.

This would take the pressure off larger sharks and focus the fishery on smaller species and juvenile and neonates of larger species. Without pressure on the shark species from outside this fishery, as proposed in this paper, departmental research scientists consider such a fishery would likely be sustainable.

The disadvantage of converting the fishery to net only is that the fishermen who operate in this fishery by longline would need to either leave the fishery or convert to net fishing.

6.5.3.3 Decrease mesh size

Mesh size could be decreased to reduce the number of large sharks taken by the nets, although this would increase the number scalefish caught. Given the nature of this fishery as a target shark fishery, it is not desirable to transfer effort to the scalefish fishery.

Another reason for not supporting this option would be the undesirable effects on size composition of whiskery and gummy shark catches.

6.5.4 Banning sale of fins

Some fishers target shark with the primary product being the shark fin instead of the flesh. On 6 October 2000, regulations were gazetted to prevent commercial and recreational fishers finning sharks without retention of the shark trunks. However, finning and the sale of fins is not banned and therefore still a legal practice.

An option to reduce the take of larger sharks is to ban the sale of shark fins. This would impact on the operations of all fishers to some degree, but would particularly affect fishers in the two tropical shark fisheries.

Rather than ban the sale of shark fins, a less drastic measure would be that all sharks be brought in with fins on.

SECTION 7 OTHER COMMERCIAL FISHERIES THAT TAKE SHARK

7.1 What are they?

As previously stated, data suggests that the size of the dusky shark breeding population has been depleted by the catch of older sharks outside the target fisheries and recruitment has declined.

All the available evidence indicates that they continue to be caught by directed 'wetline' fishing methods (hooks set on net-floats of demersal gillnets, droplines, etc), as bycatch in the Commonwealth-managed Southern and Western Tuna and Billfish Fishery (SWTBF), and in the tropical shark fisheries. This issue needs to be addressed in the immediate future, as it is believed that a significant quantity of dusky shark continues to be caught outside the target fisheries. It is also thought that much of this catch remains unreported, as it is either discarded or landed illegally.

The catch of dusky sharks by other sectors of the State-managed fisheries is difficult to ascertain, due to identification problems and possible under-reporting. In 2000/01, fishers outside the temperate shark fisheries took 35 tonnes of 'bronze whaler' shark (a name commonly used for dusky sharks). Of this, nine tonnes were caught in the tropical shark fisheries, three tonnes were caught in other managed fisheries and 23 tonnes were caught by 'wetline' vessels, that is those fishers operating without specific access to other managed fisheries.

Some of the additional 136 tonnes of unidentified sharks caught by fishers outside the temperate shark fisheries may also have been dusky sharks.

The catch of dusky/bronze whaler sharks by permit holders operating in the SWTBF in 2001 was reported in numbers only. A total catch of 40,508 sharks was landed, including 1,165 'bronze whalers'. Japanese pelagic longline vessels operating in the Australian Economic Exclusion Zone between 1992 and 1996 reported that dusky sharks and bronze whaler sharks made up 0.7 per cent and 0.5 per cent of landings respectively. It should be noted, however, that Japanese vessels were restricted to operating more than 50nm offshore but no such restrictions apply to the domestic SWTBF fleet.

7.2 Prohibition on the take of sharks and rays by commercial non-target fishers

The Department's view is that a prohibition on the take of sharks and rays by commercial non-target fishers south of North West Cape is required in order to reduce fishing mortality of sharks outside the recognised shark fisheries.

Non-target fisheries include all other State-managed commercial fisheries and Commonwealth managed fisheries operating off the Western Australian coast. These fisheries are managed by species or use trap, trawl, line and net (other than gillnet) gear and do not always target sharks and rays, but often take sharks and rays as bycatch.

While the SWTBF (20 sharks per trip) and the Northern Demersal Scalefish Managed Fishery (NDSMF) (two sharks per trip) are subject to possession limits, the take of sharks by other commercial non-target fisheries is currently not restricted. It is becoming increasingly evident that, in an attempt to ensure ongoing sustainability of sharks, the take by the non-target commercial fisheries also needs to be addressed.

Catch records indicate that an average of 260 tonnes of sharks and rays have been landed by commercial fishers not licensed to fish in the recognised shark fisheries per year over the five years 1998-2002, with 367 tonnes of sharks and rays landed in 2002. The wetline sector took the majority of this catch, landing an average of 174 tonnes per year, with 278 tonnes landed in 2002. Other non-target shark managed fisheries (apart from wetline) landed an average of 86 tonnes of shark and rays over the same five years, with a recorded landing of 88 tonnes in 2002.

The general trend shows an increase in catches of sharks and rays by the commercial fisheries other than the managed shark fisheries.

The Department is planning to pursue a zero take of inshore shark species (primarily whaler and other target species) to apply to Commonwealth fisheries, particularly in respect to the SWTBF.

Recent catch data indicates that, in addition to the recognised northern shark fisheries operators, three Commonwealth-licensed vessels operated longlines off the north-west coast in 2002 and 2003. Anecdotal evidence also suggests that some Commonwealth tuna fishery operators with a State FBL may be sinking pelagic longline gear and using demersal longline gear (without metal traces) to target demersal scalefish and shark species in the Pilbara.

The Department's preferred position is that the take of all shark and ray species is prohibited in the State-managed non-target commercial fisheries. It recognises that north of North West Cape, there are a small number of 'non-shark' fisheries that take shark as part of their operations - the Kimberley Gillnet and Barramundi Managed Fishery (KGBMF), the NDSMF (up to its bycatch limit), shore-based set net exemption holders and the Pilbara Fish Trawl Interim Managed Fishery (PFTIMF). The continued position of fishers in these fisheries will be addressed in a future paper dealing with fisheries in the north of the State.

Operators within the Aquarium Fish Managed Fishery also take a relatively small number of small sharks, and consideration needs to be given as to whether this activity should continue, given the nature of the species they take.

In addition, in an effort to reduce the capacity of non-target commercial fishing gear to catch sharks, which exposes them to a fishing mortality risk, it is proposed that a maximum hook size be imposed and the use of wire traces be prohibited, except for those fisheries that use wire traces to target species such as mackerel and recreational fishers targeting tailor. Consideration should also be given to prohibiting unattended droplining by the wetline sector. This will ensure that operators monitor their gear, providing the best opportunity for any shark caught accidentally to be released alive.

SECTION 8 RECREATIONAL FISHERIES

Unpublished recreational survey data estimate that 20,149 sharks were caught and retained by recreational fishers in WA during 2000/2001 (Table 6). It is difficult to estimate the weight of this catch from the available data, but it is considered likely to be less than 10 tonnes.

Table 6: Estimated 2001 WA recreational shark catch from unpublished survey data (N Sumner, pers. comm.).

Category	Species	Catch (no.)
Unspecified	Various	6709
Bronzey	Family *Carcharhinidae*	4235
Blacktip	Family *Carcharhinidae*	2472
Wobbegong	Family *Orectolobidae*	1978
School	Various	1639
Gummy	Family *Triakidae*	960
Tiger	*Galeocerdo cuvier*	827
Hammerhead	Family *Sphyrnidae*	409
Sawshark	Family *Pristiophoridae*	195
Other	Various	725
Total		20149

Currently, recreational fishermen are entitled to retain two per day of any shark or ray (combined) within the West Coast and Gascoyne regions. In the Kimberley, Pilbara and South Coast regions, there is currently a daily bag limit of four sharks and 40 rays per day, although the draft review documents for these regions were recently released and propose the same limit of two per day of any shark or ray (combined).

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ATTACHMENT 1

BACKGROUND

Information supplied by Rod Lenanton, Dan Gaughan and Rory McAuley

Biological synopsis

The dusky (whaler) shark (*Carcharhinus obscurus*) is a large, slow-growing species, which attains over 350cm in Western Australian waters. The young are born at about 74cm fork length and grow slowly, at around 10cm per year, until reaching maturity at approximately 20 years. Mature females generally produce fewer than 10 young every second or third year.

Mature dusky sharks appear to migrate from the north-west coast, where they spend winter and spring, to the south-west coast in late summer and autumn where they give birth. Juveniles inhabit the waters off the southern half of the State, often moving long distances, including movements into South Australia, and possibly Victoria, before joining the mature stock on the western and northern WA coastline.

History of fishery and research until the mid 1990s

Fishery

Shark fishing began in WA during the 1940s and expanded rapidly during the early 1980s with demersal gillnet fishers targeting dusky sharks in their first (neonates) and second year after birth, along with gummy sharks and whiskery sharks, all in nearshore waters.

Following consistent increases in shark catches during the late 1980s, the Joint Authority Southern Demersal Gillnet and Demersal Longline Limited Entry Fishery (JASDGDLMF) was declared a limited entry fishery in 1988 and the formal stock assessment process began in 1993. The dusky shark has been the most important single species in both the JASDGDLMF and the West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLIMF). The combined annual catch of dusky whalers peaked at approximately 500 tonnes, but has subsequently declined to 250 – 350 tonnes.

Dusky catches by demersal gillnets, during the peak period, consisted almost exclusively of sharks less than six-years-old, but with two- to five-year-olds much less important than the zero to one-year-olds. Thus, age-specific exploitation rates were traditionally highest as neonates, decreasing sharply by the second year after birth due to gear selectivity and location of fishing, i.e. in nearshore waters.

Research

The Department of Fisheries' Research Division has carried out biological research and monitored the status of Western Australia's main commercial shark species since 1993. Due to their commercial importance and vulnerable life history characteristics, a significant amount of this research has been targeted at dusky shark. Research on the dusky shark centred around the collection of biological data and a tagging study to aid in the assessment of their status.

The life history of the dusky whaler (e.g. long-lived, high age at maturity, low intrinsic rate of population growth) and the fact that they have traditionally been caught at only the youngest

ages in the JASDGDLMF and WCDGDLIMF mean that standard age-structured modelling was not possible with the available time series of CPUE data. Neither is such an approach possible without a long time-series of annual age-structure data. Age-structured models therefore have limited application for long-lived sharks anywhere in the world.

Instead, a sophisticated demographic analysis technique, which incorporated empirical age-specific exploitation rates from tagging, was undertaken for dusky shark (Simpfendorfer, 1999[8]). The tagging data, input to the mid-1990s model, indicated that the exploitation rate of neonates was around 30 per cent per annum. Exploitation rates for 1 to 5-year-olds decreased from nine per cent to one per cent per annum respectively.

Based on the 1994-1996 exploitation rates and patterns of fishing effort at that time, the results from this model indicated that:

1. the exploitation rate of dusky sharks less than six years old (predominantly zero and one year olds) by the demersal gillnet sector was sustainable; and
2. this fishing strategy of focussing on dusky sharks less than six-years-old was sustainable because only a **small proportion** of the younger age classes were targeted; but
3. an overall exploitation rate greater than 4.3 per cent, i.e. applied to all ages, would not be sustainable.
4. An exploitation rate of greater than one per cent applied to ages greater than six years would result in a continuous decline in the breeding stock of dusky whalers.

In summary, expansion of exploitation to include even very small catches of larger dusky sharks was forecast to result in the collapse of the main stock exploited by the JASDGDLMF and the WCDGDLIMF, which were the only fisheries at the time targeting dusky shark. The research undertaken indicated that the long-term sustainability of dusky shark would be maintained only as long as the fishery remained stable in its targeting practices.

Post-1996

Increased bycatch and targeting of adults

Since 1996, the domestic market value of shark fins has increased and now exceeds $100/kg for fins from large sharks, such as duskies. Therefore, the mortality of adult dusky whalers has increased as a consequence of increased targeting for the fin market.

The development of the Commonwealth Southern and Western Tuna and Billfish Fishery (SWTBF) during the mid-late 1990s has also resulted in increased mortality of these older year classes of dusky whalers, particularly during the late-1990s and the early 2000s. The available evidence for this assertion includes tuna hooks recovered from sharks taken in State-managed fisheries, reported catches in Australian Fisheries Management Authority (AFMA) logbooks, observed captures during the SWTBF pilot observer project, anecdotal reports of large numbers of fins being landed from SWTBF vessels and pelagic longline gear being encountered in Continental Shelf waters.

In recent years, while much of the effort in the SWTBF has migrated further offshore in pursuit of economical catch rates of target species (i.e. swordfish and tuna), a significant proportion of

[8] Simpfendorfer, C.A. (1999) Demographic analysis of the dusky shark fishery in south-western Australia. *American Fisheries Society Symposium* **23**: 149-160.

this fishery's effort still remains focussed along the edge of the Continental Shelf. This is evidenced by recent data received from AFMA and by industry lobbying to retain access to the shelf edge.

The shelf edge is a habitat used by dusky shark during their annual natal migration. Furthermore, efforts by the SWTBF to increase their shark bycatch trip-limit clearly indicates that sharks remain an important economic component of their catch. Discussions in late 2003 and early 2004 between representatives of the SWTBF and the Department provided evidence that the SWTBF would undoubtedly increase its exploitation of shark if allowed.

The increased demand for fins and the declining availability of neonates (see *Fishery Performance*, below) to the temperate demersal gillnet fisheries has also led to increased targeting of large dusky sharks by State-managed (gillnet and non-gillnet) fishers using wetline methods. Possible misreporting of dusky whalers caught by WA licensed vessels using wetline methods as 'gillnet' catch, is also believed to have complicated analysis of catch rate data from the demersal gillnet fishery (see below).

The total elasmobranch catch by wetline methods outside the managed 'shark' fisheries has also increased sharply since 2000/01 (Figure 1). Much of this catch has been taken from coastal waters in the southern half of the State and would therefore include a large proportion of dusky whaler.

Consequently, there is no doubt that the level of catch of adult dusky whalers has increased significantly since 1994-96, requiring a re-assessment of the stock status.

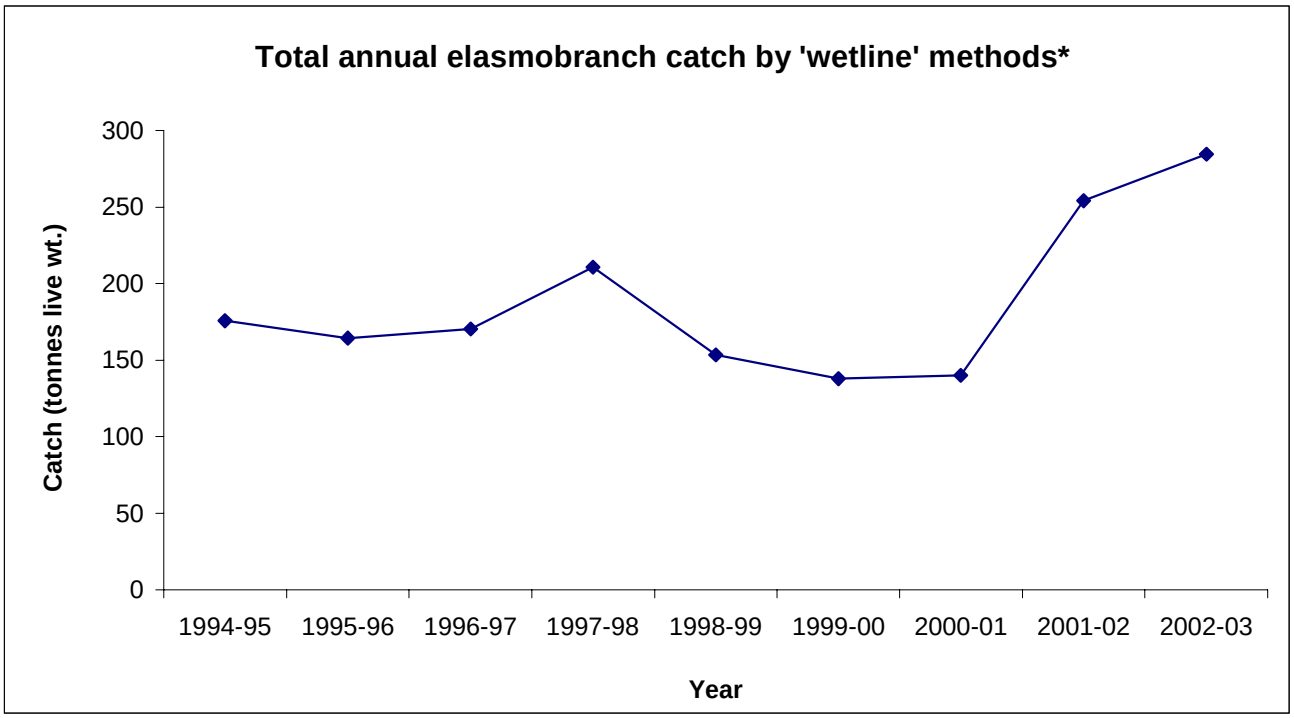


Figure 1: Total annual elasmobranch catch by 'wetline' methods

Current status

Ongoing increase in exploitation of adults

Within the JASDGDLMF and WCDGDLIMF: targeting of adult dusky whalers continues and has geographically spread to cover more of their distribution. Greater awareness of the seasonal abundance of adult dusky sharks in the south-west of WA, along with improved marketing and distribution networks for shark fin, have resulted in very large increases in longline effort in the WCDGDLIMF. The nature of the fishing gear and the increased size of the vessels entering these fisheries make these operations highly effective at targeting adult dusky sharks.

Demersal gillnet fishers have also increasingly used wetline methods (ie. hooks on net-floats) to target large sharks (including duskies) for the value of their fins, and **it is believed that a significant proportion of the large sharks caught in this way are reported by these fishers within their normal gillnet catch**. This artificial inflation of the gillnet catch seriously biases the historical gillnet fishery's CPUE data, and provides an overly optimistic trend in the CPUEs for recent years (see *Fishery Performance*, below).

Increased targeting of large sharks has also occurred in the northern shark fishery. Although this fishery has not directly focussed on dusky shark, it has become an additional source of mortality that needs to be taken into account.

Outside the target shark fisheries: operators in other State-managed commercial sectors have also caught large dusky sharks by various methods for many years. In particular, Western Rock Lobster Fishery vessels are known to have previously used hooks attached to pot-floats to take sharks. Although this practice has been prohibited since November 2002 (Reg 56A.), fishers are still legally able to use hooks to target sharks, as long as they are not attached to pot floats. As dusky sharks are well known to follow western rock lobster fishing vessels to scavenge discarded bait, they are also vulnerable to line fishing directly from boats.

As previously mentioned, bycatch of dusky sharks in the Commonwealth SWTBF has been cause for increasing considerable concern over many years. AFMA logbook records, which are considered to grossly under-report the true level of shark bycatch, show that this fishery had a reasonably large catch of this species, at least until recent times.

Given the financial incentive to retain shark fins, as evidenced by prosecutions of SWTBF operators for landing quantities of fins in excess of their bycatch limit, it is believed that the mortality rate continues to be unacceptably high. Although the level of dusky bycatch has probably decreased in the SWTBF as effort has shifted offshore in recent years, any relaxation of existing shark bycatch arrangements will encourage the fishery's development as a pelagic shark fishery and refocus effort to near-Continental Shelf waters, resulting in higher levels of dusky whaler bycatch.

Other sources of mortality: There is little doubt that there are sources of mortality of dusky whalers besides those described here (e.g. recreational catch, entanglement in plastic bait-packaging straps). While it is likely that the impact of any one of these is at low levels cumulatively, these poorly understood interactions are important, given the stock's low resilience to exploitation of adults and given the high exploitation rate of juveniles.

Fishery performance – catch rates and decline in abundance of neonates

By 2001/02, the CPUE (by weight) of dusky sharks in the demersal gillnet sector had decreased to its lowest ever level. This has occurred despite the probable inclusion of adult shark in the catch and effort data.

Research sampling of commercial catches has found a statistically significant decline in the proportion of neonate dusky sharks caught in the fishery, from 51 per cent in 1994-96 to 38 per cent in 2001/02. This represents a 25 per cent decrease in the contribution of neonates and provides corroborating evidence that the abundance of neonates has declined.

Furthermore, because catches in recent years have increasingly comprised higher proportions of larger sharks, CPUE data in terms of weight have masked the true extent of the decline in the number of sharks available to the fishery. It is therefore important to recognize that the calculated CPUE can only be biased upwards, i.e. are certainly higher than the true levels. That is, despite the 'new' practises that result in the inclusion of larger dusky whalers in the catch data, there has been a steady downward trend in dusky whaler catch rates since 1994 (Figure 2).

Appendix 1 is provided to illustrate a conceptual model of the link between decreased abundance of adults, declining recruitment levels and the change in size structure of the gillnet catch of dusky sharks that has been reported anecdotally. This increase in size of dusky shark caught by the gillnet sector is supported by advice from fishers and has been acknowledged by the WA Demersal Net and Hook Fisheries MAC.

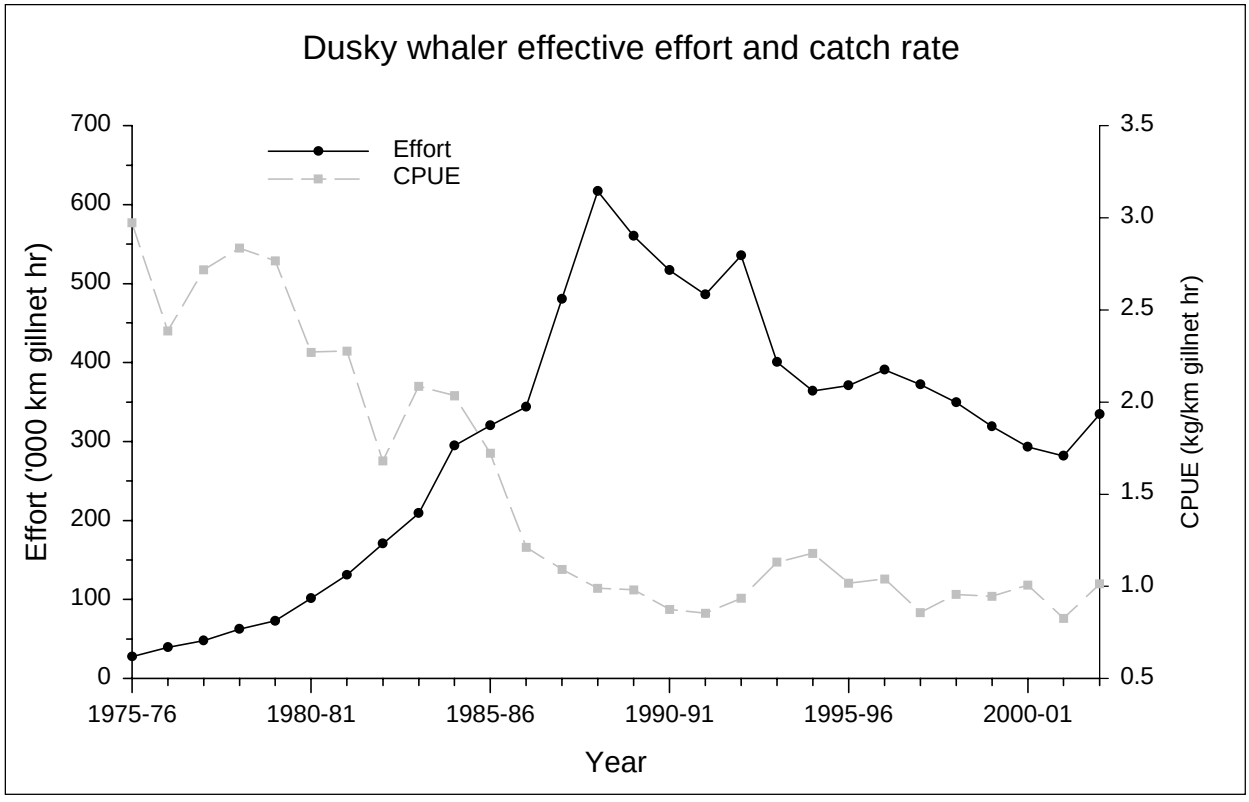


Figure 2: Dusky whaler effective effort and catch rate
(Note that the CPUE data since the mid-1990s has not been adjusted downward to reflect the inclusion of larger sharks in recent years.)

Ongoing monitoring for making management decisions

While demographic modelling has shown that significant exploitation of all age classes of dusky shark (i.e. neonates, older juveniles, sub-adults and adults) is not sustainable, the lack of explicit biomass estimates reduces our ability to ascertain whether or not the depletion of adults is already sufficient to cause an ongoing decline in recruitment. Consequently, there is a risk that even in the absence of further mortality of adults, the fishery targeting neonates and juveniles may not be sustainable at current levels.

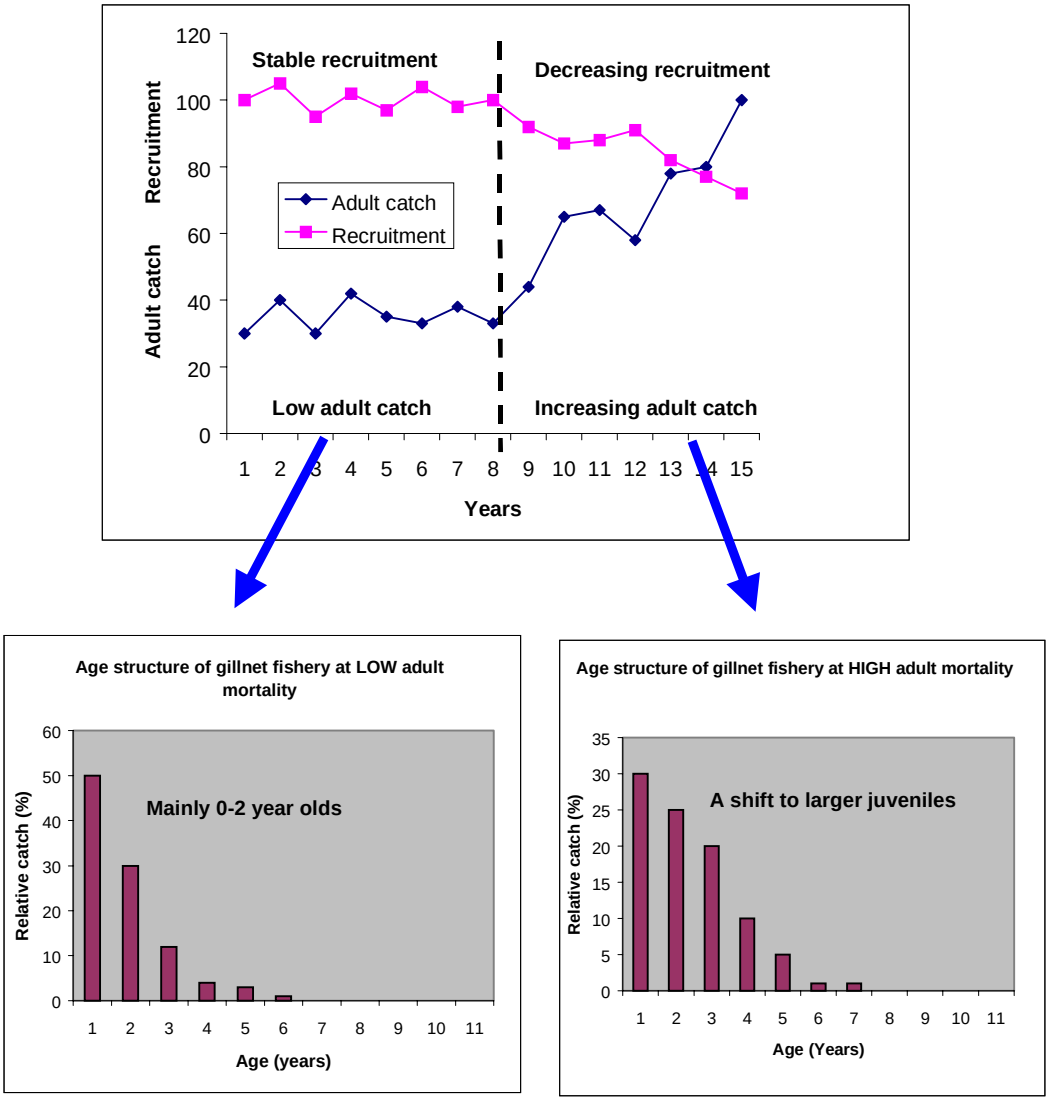
Data from gillnet fishery do offer, however, the only effective means of monitoring the recovery of this stock, and therefore the efficacy of management. Yet with the price of shark fins likely to remain high, it is unrealistic to believe that all mortality will cease as a result of implementing new management measures.

Ongoing assessment of the performance (i.e. catch rates) of the gillnet fishery may provide the only means of assessing whether or not management actions, such as imposing an upper size limit on dusky shark, were effective. In addition to the catch rate data, monitoring of the catch to assess size composition, and a tagging study to re-assess exploitation rates, is required to provide data that would permit the Department to determine if the continuing exploitation of neonates is sustainable.

Focussed monitoring of the fishery and the dusky catch would allow the traditional fishery to continue by improving the quality of assessments and lowering the risk of not detecting evidence of overexploitation.

APPENDIX 1

Appendix 1
Conceptual model of the link between adult mortality and recruitment for dusky whalers.



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