GOVERNMENT OF WESTERN AUSTRALIA

Department of
Fisheries

State of the Fisheries Report 2006/07

Fish for the future

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Acknowledgments

Cover photographs
Upper photograph: South Coast
Lower photograph: Baldchin groper (*Choerodon rubescens*)

Contents

Overview from the Chief Executive Officer

The *State of the Fisheries Report* is published annually to provide a detailed level of reporting on the management of fish stocks and their environment undertaken by the Department of Fisheries. A summary report from this document is included in the Department's *Annual Report* to Parliament, which includes the Department's non-financial (fishery) performance indicators. The *Annual Report* is no longer printed but is available through the Department's website (www.fish.wa.gov.au).

The *State of the Fisheries Report* summarises the outcomes of many departmental activities including management changes, compliance work and research to assess stock levels, monitor breeding stocks and undertake environmental assessments. This document provides a valuable reference point for the Western Australian fisheries of major importance to the commercial and recreational sectors, and also for the aquaculture industry.

This year's report continues to support the Department's Ecologically Sustainable Development (ESD) approach to the management of the State's fisheries and their associated aquatic environments. The structure of the report deals with fisheries and fishing-related activities on a bioregional basis, enabling Ecosystem-Based Fisheries Management (EBFM) to be more efficiently considered. Furthermore, reports on the activities and systems undertaken by the Department to manage the broader impacts of fishing on the aquatic environment, such as habitats, precede the fishery reports in each bioregion.

These bioregional reports indicate that the majority of Western Australia's significant fisheries stocks continue to be in a healthy condition and that fishing presents few risks to the stocks or the aquatic ecosystems underpinning them. However, the stocks of west coast demersal finfish (including dhufish and snapper) have been found to be overfished and a suite of new management measures has been initiated to reduce the effort on these stocks by 50%.

Whilst management actions to reduce the catch quota and restore the spawning biomass of snapper in the Gascoyne region to appropriate levels had already been implemented, a review resulted in further quota cuts to increase the speed of recovery. On the south coast, while management has enabled stock of the whiskery shark stock to improve, the dusky whaler and sandbar stocks continue to decline due to the impacts of previous fishing activities, not from current fishing levels.

The concerns expressed in last year's *State of the Fisheries Report* about the status of crustacean fisheries within Cockburn Sound were confirmed and this fishery was subsequently closed for the 2007 season. Extensive research on the status of crab stocks is now underway within Cockburn Sound and, for precautionary reasons, also within the Peel-Harvey estuary.

There was a decline in level of landings for the key crustacean fisheries (rock lobsters and prawns) plus a large drop in the production and value of the scallop fisheries. The decline in the catch of rock lobsters had been predicted for a number of years and large variations in scallop fisheries are mainly due to environmental effects on their recruitment.

In addition to discussing the status of our aquatic resources, the individual reports in the *State of the Fisheries Report* also outline any new management initiatives. Adjustments to fisheries management arrangements are frequently required to accommodate natural fluctuations in stock abundance and continuing improvements to fishing efficiency through the application of new technology by both the commercial and recreational sectors.

For example, the WA Demersal Gillnet and Longline Fishery will now shift its management controls from monthly gear units to daily gear units to more effectively control effort and keep catch at the desired levels. This highlights the increasing complexity and challenges facing those involved in fisheries and marine management, and especially the need for ongoing scientific monitoring and stakeholder support.

I would like to take this opportunity to express my appreciation to all departmental staff who contributed to this important, annual performance review of our fish stocks. Similarly, the commercial and recreational fishers throughout the State are to be commended for their positive support for the Department's research and management programs, without which such a high level of sustainability would not be achieved.

Peter J. Millington
Chief Executive Officer

Editor's introduction

The *State of the Fisheries Report 2006/07* follows the fully bioregional format reflecting the Department of Fisheries' ongoing commitment to ecosystem-based management of the State's aquatic resources. Furthermore, each of the fishery reports in this volume now contains both the commercial and recreational activities within the one report to ensure that the aggregate catch harvested from each stock is clear and to show how it is being shared between the fishing sectors. This structure should enable readers to more easily assess the interrelationships between fisheries and their cumulative effect within each bioregion of the State. In this context, individual fish stocks can be regarded as general indicators of the health of the aquatic environment.

Each of the individual fishery status reports is currently based upon the well-established Ecologically Sustainable Development (ESD) reporting approach that has enabled all of the State's significant commercial fisheries to undergo assessment and achieve environmental certification under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

To generate parts of this report, the long-standing involvement of commercial skippers in specific research projects now extends into the recreational sector, including a significant number who participate in the new Research Angler Program. Thus, both commercial and recreational fishers have continued to support the Department's research and management effort through a variety of voluntary log book and Voluntary Fisheries Liaison Officer programs. The active collaboration between aquaculturists and the Department's research teams has also enhanced the research and development projects necessary to expand production from these small but important regional industries.

The Naturaliste Marine Discovery Centre within the Hillarys research and education complex is now operational. This provides the public and school groups with a unique opportunity to understand and appreciate the State's marine resources and the science that underpins their sustainable management.

The Department of Fisheries' Research Division's Biodiversity Branch is now the focus for research on ecological and protected species interactions arising from fishing activities within the research division. The group is pivotal in the additional research about to begin through the Government's WA Marine Science Institution (WAMSI) initiative. It is planned that this will enable comprehensive monitoring of the State's marine systems at a bioregional level.

While the *State of the Fisheries Report* provides the general public and interested fishers with a ready reference source, it is also designed to support the Department's various reporting requirements, including those to the Commonwealth Government under the EPBC Act. The report is directly accessible on the Department's website (www.fish.wa.gov.au/docs/sof), where users are free to download relevant sections for personal use. If quoting from the document, please give appropriate acknowledgment using the citation provided at the front of the report.

Finally, I would like to thank all of my departmental colleagues who have assisted in the production of this volume and its many status reports. Particular thanks are due to Ms Karen Santoro who had the unenviable job of coordinating the submission of the text from the various authors, Steve Ireland who ensured that the standard of text throughout this complex document is at an exceptionally high level and Matthew Terwey for contributing his significant publishing expertise to convert the text into this high-quality printed volume.

Dr Rick Fletcher
Director – Fisheries Research

How to use this volume

To obtain full benefit from the information provided, readers need to understand various terms and headings used in the text and summarised in Appendix 1 (which appears as Appendix 5 in the Department of Fisheries' *Annual Report* 2006/07 to Parliament).

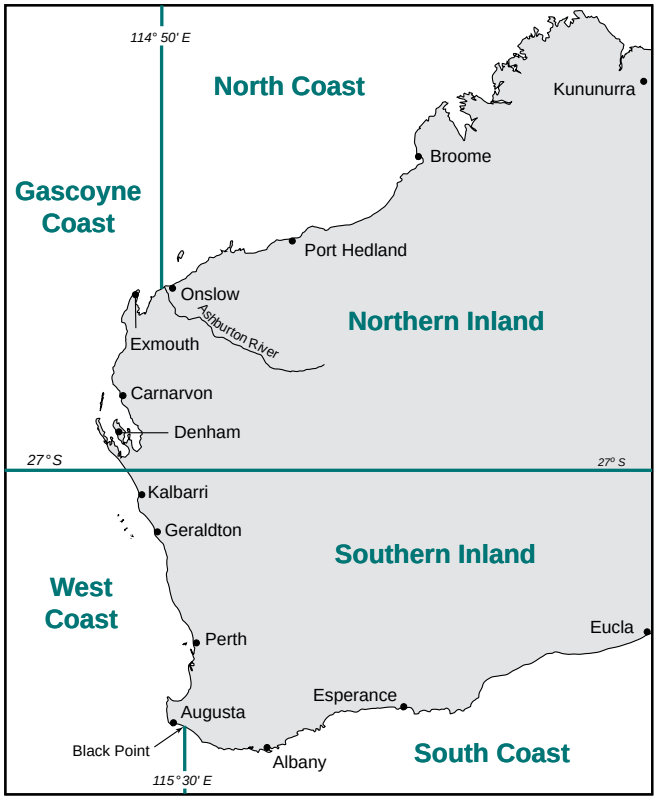
Many of these terms and headings follow the national Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002). In addition to the explanations provided below, acronyms are expanded at their first occurrence in a section of the text and are also listed in a glossary at the end of the volume.

Bioregions

As noted above, readers need to note the fully bioregional structure of this report (see Introduction Figure 1). A 'bioregion' refers to a region defined by common oceanographic characteristics in its marine environment and by climate/rainfall characteristics in its inland river systems.

The marine bioregional boundaries used here are broadly consistent with those of the *Interim Marine and Coastal Regionalisation for Australia* report (IMCRA Technical Group 1997), except for the inclusion of the Gascoyne coast as a separate region, reflecting its nature as a permanent transition zone between tropical and temperate waters.

The precise boundaries of the bioregions reflect specific grid reference points used in fisheries management plans and data recording systems. Each individual bioregion has been provided with a general introduction outlining its aquatic environment, major commercial and recreational fisheries and aquaculture industries.



INTRODUCTION FIGURE 1
Map of Western Australia showing the general boundaries of the bioregions referred to throughout this document.

Breeding stock status

Adequate: reflects levels of parental biomass where annual variability in recruitment of new individuals (recruits) to the stock is a function only of unrelated environmental effects or recruit survival.

Increasing: reflects situations where the parental biomass has previously been depleted to unacceptable levels by fishing or some other event (e.g. the virus attacks on pilchards in the 1990s) but is now recovering due to management action and/or natural processes.

Inadequate/declining: reflects situations where excessive fishing pressure (catch) or some external event has caused parental biomass to fall to levels where recruitment over fishing is possible.

Non-retained species

This refers to any species caught during a fishing operation which are not the target of, or retained by, the fishing operation, and can include both potential impact on unwanted 'bycatch' species and any interaction with protected species. In each case, an explanation is provided of the situation and the level of risk to the stock from fishing operations.

Ecosystem effects

This refers to the indirect impacts of removing fish from the ecosystem, and physical interactions of fishing gear with the sea floor. Each fishery is considered in terms of its effects on the food chain and the habitat, and an assessment of current ecological risk ('negligible', 'low', 'medium' or 'high') is provided.

Target catch (or effort) range

Target catch range: the range of annual catches, taking into account natural variations in recruitment to the fished stock, which can be expected under a fishing-effort-based management plan.

Target effort range: the range of annual fishing effort, assuming natural variability in stock abundance, required to achieve a total allowable catch under a catch quota management plan.

Where the annual catch or effort falls outside of this range and the rise or fall cannot be simply explained, a management review or additional research to assess the cause is generally required.

External factors

This refers to known factors outside of the direct control of the fishery legislation which impact on fish stocks or fishing. An understanding of these factors, which are typically environmental (cyclones, ocean currents) but might also include, for example, market factors or coastal development, is necessary to fully assess the performance of the fishery.

Season reported

Readers should also be aware that the individual fishery and aquaculture production figures relate to the latest full year or season for which data are available, noting the inevitable time-lags involved in collection and analysis. Therefore, the statistics in this volume refer either to the financial year 2005/06 or the calendar year 2006, whichever is more appropriate.

Similarly, the statistics on compliance and educational activities are also for 2005/06, following the analysis of data submitted by Fisheries and Marine Officers.

In contrast, the sections on departmental activities in the areas of fishery management and new compliance activities are for the current year, and may include information up to June 2007.

Performance measures

As noted above, almost all the State's significant export fisheries have now undergone assessment and achieved environmental certification under the Commonwealth Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Consequently, the *State of the Fisheries Report* also reports the performance of the relevant fisheries against the specific performance measures developed during the EPBC Act assessment process.

Within the individual fishery status reports, each of these performance measures is shown in a highlighted box to assist the reader. The results are also summarised in Appendix 6.

Common fish names

It should be noted that the common names of a small number of fish species have changed in this volume from its predecessor. Where this has occurred, a reference is included to the common name formerly used for the same species. This situation reflects an initiative of the seafood sector to standardise marketing names across Australia, and it is likely that further changes will occur in future volumes.

West Coast Bioregion

Beach fishing in Kalbarri. Photo: Andrew Cribb

West Coast Bioregion

ABOUT THE BIOREGION

The marine environment of the West Coast bioregion between Kalbarri and Augusta is predominantly a temperate oceanic zone, and is heavily influenced by the Leeuwin Current, which transports warm tropical water down the continental shelf.

Under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) scheme, published in 1998 by the Australian and New Zealand Environment and Conservation Council, the bioregion has been divided into 3 meso-scale regions: the Abrolhos Islands, the Central West Coast and Leeuwin–Naturaliste.

The fish stocks of the region are typically temperate, in keeping with the coastal water temperatures that range from 18°C to about 24°C. The current is also responsible for the existence of the unusual Abrolhos Islands coral reefs at latitude 29° S and the extended southward distribution of many tropical species along the west and south coasts.

The Leeuwin Current system, up to several hundred kilometres-wide along the west coast, flows most strongly in autumn/winter (April to September) and has its origins in ocean flows from the Pacific through the Indonesian archipelago. The current is variable in strength from year-to-year, flowing at speeds typically around one knot, but has been recorded at 3 knots on occasions. The annual variability in current strength is reflected in variations in Fremantle sea levels, and is related to El Niño or Southern Oscillation events in the Pacific Ocean.

Weaker counter-currents on the continental shelf, such as the Capes Current that flows northward from Cape Leeuwin as far as Shark Bay, occur during summer and influence the distribution of many of the coastal finfish species.

The most significant impact of the clear, warm, low-nutrient waters of the Leeuwin Current is on the growth and distribution of the temperate seagrasses. These form extensive meadows in all protected coastal waters of the west coast bioregion, in depths of up to 30 m, and act as major nursery areas for many fish species and particularly for the large western rock lobster stock.

The west coast is characterised by exposed sandy beaches and a limestone reef system that creates surface reef lines, often about 5 kilometres off the coast. Sea floors further offshore on the continental shelf are typically composed of coarse sand interspersed with low limestone reef associated with old shorelines.

There are few areas of protected water along the west coast, the exceptions being in the Abrolhos Islands, in the lee of some small islands off the mid-west coast, and behind Rottnest and Garden Islands off the Perth metropolitan area. The major significant marine embayments of the west coast are Cockburn Sound and Geographe Bay.

Beyond Cape Naturaliste, the coastline changes from limestone to predominantly granite and becomes more exposed to the influences of the Southern Ocean. Along the west coast, there are 4 significant estuarine systems – the Swan/Canning, Peel/Harvey and Leschenault estuaries and Hardy Inlet (Blackwood estuary). All of these are permanently open to the sea and form an extension of the marine environment except when freshwater run-off displaces the oceanic water for a short period in winter and spring.

The principal commercial fishery in this region targets the western rock lobster. The West Coast Rock Lobster Fishery is Australia's most valuable single-species fishery, producing an average catch of 11,000 t valued at around $300 million annually. There are also significant fisheries for scallops, abalone, blue swimmer crabs, sharks, pilchards, and coastal and estuarine finfish. Many of these inshore fish resources are shared with the recreational sector.

The West Coast bioregion is also home to an active wetline fishery, for which specific management arrangements are currently being developed. Demersal line fishers take a range of species including dhufish, snapper, baldchin groper and emperors from boats operating purely as 'wetliners' (i.e. no form of access other than the fishing boat licence) as well as from boats operating in other managed fisheries. There is also an important take of fish by beach seining and near-shore gillnetting using hand-hauled nets, for species including whitebait, mullet and whiting.

In the West Coast bioregion more than any other in the State, population growth poses specific challenges for fisheries management. Increased recreational fishing pressure, and the setting of catch shares for commercial and recreational users, is a major focus of the Department of Fisheries' management activity.

The West Coast bioregion is the most heavily used one for recreational fishing, owing to its accessibility to the main population centres. The bioregion provides a range of recreational fishing opportunities – from estuarine fishing to beach fishing and boat angling in embayments. Offshore boat angling includes both demersal and pelagic/game fishing opportunities around islands and on the edge of the continental shelf.

Species targeted in estuaries include black bream, flatfish and blue swimmer crabs, whilst herring, whiting (including King George whiting), tailor, mulloway and abalone are targeted from beaches. Boat-based fishers target herring, whiting, rock lobsters, pink snapper, dhufish, baldchin groper and a number of larger pelagic and game species.

The principal aquaculture development activities in the West Coast bioregion are the production of blue mussels *(Mytilus edulis)* and marine algae *(Dunaliella salina)* for beta-carotene production, and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands.

The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates. Owing to the generally low productivity of the Western Australian coastline under the influence of the Leeuwin Current, areas outside embayments (where nutrient levels are enhanced) are unsuitable for bivalve aquaculture.

Western buffalo bream (*Kyphorsus corneli*).
Photo: Henrique Kwong

The Department of Fisheries' Research Division's newly established Biodiversity Branch has embarked on a number of important research initiatives. Ecological risk assessments undertaken on the western rock lobster fishery have identified lobster fishing pressure in the deep water as being a moderate risk to communities in those depths.

As a result, basic ecological information has been collected to determine if changes in lobster density and size structure due to fishing has caused significant changes in habitat structure and benthic community composition in deep water. The project has focused on sites at Jurien Bay, Dongara and Lancelin and is due for completion in December 2007.

Researchers from the Biodiversity Branch have also been involved in 'Marine Futures', a National Heritage Trust (NHT)-funded collaborative project managed by the University of Western Australia, which aims to collect baseline scientific data to develop marine resource indicators for marine habitats, biodiversity and human use patterns in south-western Australia. The focus of the project is on mapping the dominant marine habitats, and conducting biodiversity surveys in order to build spatial habitat models of the marine environment.

Outputs from habitat mapping and biodiversity surveys will assist in the identification of key marine indicators, and will support regional natural resource management groups in establishing marine ecosystem monitoring targets. The habitat maps produced will provide information on the distribution and extent of various substrates (e.g., reef versus sediment), relief, dominant vegetation types, and different classes of sessile invertebrates.

In the West Coast bioregion, sampling is focused at the Abrolhos Islands, Jurien Bay, Rottnest and Cape Naturaliste. Bathymetric and towed video surveys have been completed at all of these sites, as well as biodiversity sampling including research trawls using the *RV Naturaliste* and Baited Remote Underwater Video Stations (BRUVS).

Concern about over-collecting of molluscs, particularly the abalone *Haliotis roei*, on inter-tidal platforms in the Perth metropolitan area, led the Department of Fisheries to ban collecting in early 1982. Detailed surveys of molluscs were conducted from 1983 to 1986 at Cottesloe, Trigg and Waterman – platforms with different fishing histories for abalone. Echinoderms were examined in 1986.

Since then, the platforms at Trigg and Waterman have been incorporated into the Marmion Marine Park. In 2001, the Cottesloe platform was included in the Cottesloe Fish Habitat Protection Area. All the above platforms were recently resurveyed and, overall, the conclusion reached has been that the diversity, density, biomass and composition of molluscs and echinoderms on the 3 inter-tidal platforms parallel the results obtained in the 1980s. While there have been variations in individual characteristics, they have been within the ranges expected.

Over the past fishing season, sea lion exclusion devices (SLEDs) were implemented in the commercial and recreational west coast rock lobster fisheries in an effort to eliminate the incidental mortality of the threatened Australian sea lion pups in lobster pots. Research has been undertaken monitoring the success of the SLEDs, in their ability to exclude further sea lion mortalities while at the same time not impacting on lobster catches in any way.

In concert with this research, the monitoring of the seasonal pup production at the 4 Australian sea lion breeding colonies on the west coast has continued this year – and recent data suggest that the population on the west coast is currently stable. Fishery-dependent data on interactions between commercial fisheries and all protected species is monitored for its use as an indicator in risk assessments.

Finally, a project has recently commenced aimed at evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions. One of the objectives of the project is to determine the risk of different vessel types in introducing marine species to WA waters, based on shipping patterns and the species that are likely to be translocated through those movements.

Other objectives are the establishment of a centralised introduced marine species monitoring framework that:

- uses the national monitoring approach;
- determines locations where monitoring should occur, recognising both ports and high value areas; and
- provides information for the developing national database.

The project will also analyse potential future changes to threats due to increased shipping movements and changes in vessel origins.

ENVIRONMENTAL MANAGEMENT

Regional Overview (West Coast)

On the west coast of Western Australia, marine habitats are largely protected from any physical impact of commercial fishing by extensive closures to trawling. These closures were introduced in the 1970s and 1980s, and protect all seagrass and reef habitat (West Coast Habitat Protection, Figure 1).

In addition, habitat and biodiversity protection is provided within State waters by individual marine protected areas including:

- Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes (anticipated to be declared in late 2007);
- Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under s.43 of the *Fish Resources Management Act 1994* at Yallingup Reef, Cowaramup Bay, the Busselton Underwater Observatory, and around the wrecks of the Saxon Ranger (Shoalwater Bay) and Swan (Geographe Bay); and
- marine conservation areas proclaimed under the *Conservation and Land Management Act 1984* at Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and the proposed Capes Marine Park between Cape Leeuwin and Cape Naturaliste (West Coast Habitat Protection, Figure 2).

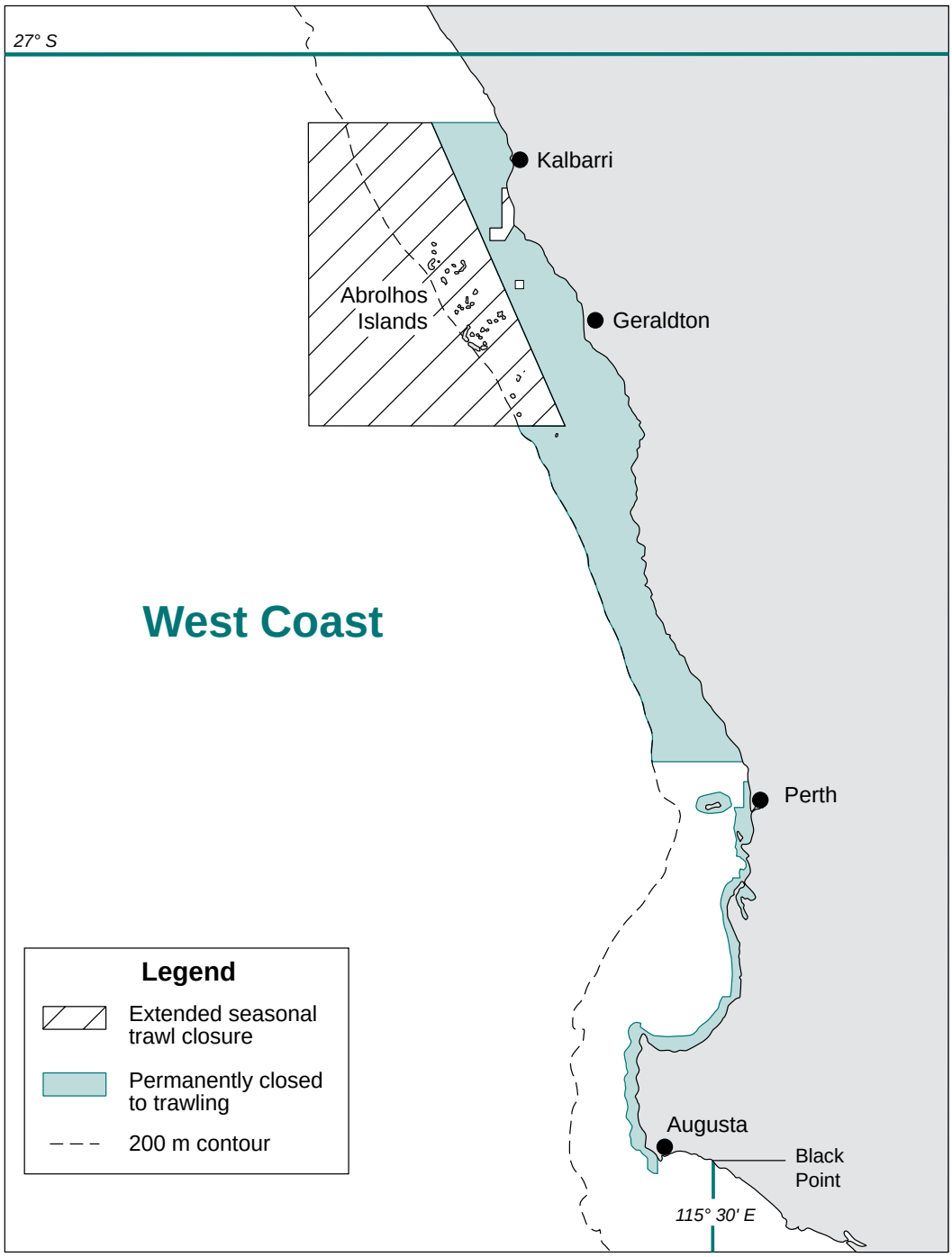
The Commonwealth Government's Department of Environment and Water Resources is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay, with a view to finalizing a South West Marine Bioregional Plan (MBP) which will contain individual marine protected areas.

These protective management measures have contributed to maintaining the marine habitat and biodiversity in generally good condition. However, biodiversity and fish habitats in the West Coast Bioregion now face major threats from coastal development and environmental degradation through terrestrial run-off impacting estuaries and some protected near-shore waters.

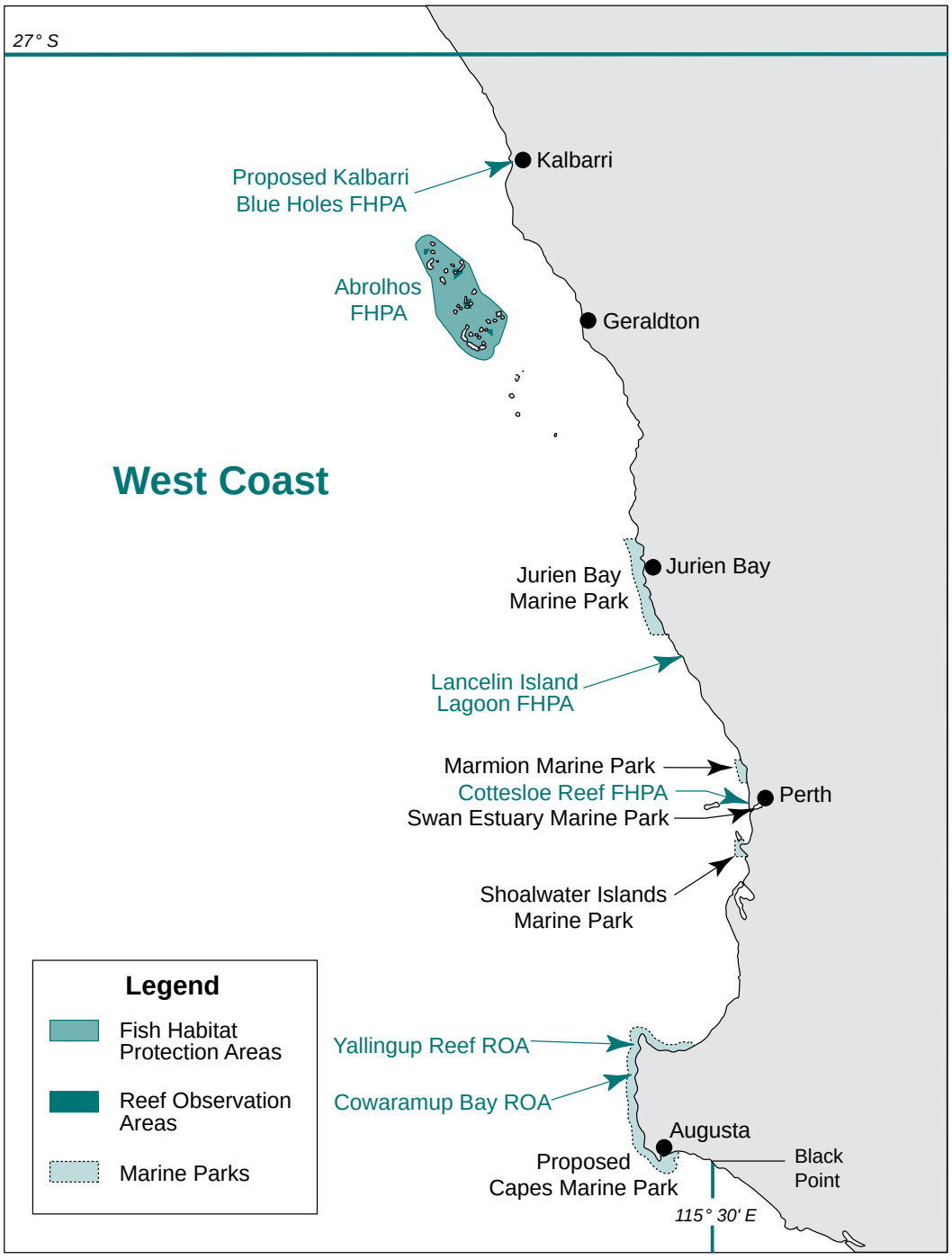
In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has initiated Ecosystem Based Fisheries Management (EBFM), which involves a more holistic approach to traditional fisheries management and will guide fisheries management arrangements at a regional level in the future. EBFM will encompass Integrated Fisheries Management and also embrace broader ecosystem issues, as information becomes available, so that both exploited fish stocks and the ecosystems that support them will be more sustainably managed in the future. The West Coast and Gascoyne Bioregions have been selected to trial this process.

The Department continues to provide advice to the Environmental Protection Authority on development proposals which have the potential to impact on the aquatic environment, and continues to actively in engage with the natural resource management groups for the west coast to promote sustainable use of the aquatic environment.

Kalbarri coastline. Photo: Andrew Cribb



WEST COAST HABITAT PROTECTION FIGURE 1
Map showing areas of permanent and extended seasonal closures to trawl fishing in the West Coast bioregion.



WEST COAST HABITAT PROTECTION FIGURE 2
Map showing current and proposed marine protected areas in the West Coast bioregion.

FISHERIES

West Coast Rock Lobster Fishery Status Report

S. de Lestang, R. Melville-Smith, A. Thomson and M. Rossbach.
Management input from K. Donohue (commercial) and P. Readhead (recreational)

Fishery Description

Commercial

The West Coast Rock Lobster Managed Fishery (WCRLF) targets the western rock lobster, *Panulirus cygnus*, on the west coast of Western Australia between Shark Bay and Cape Leeuwin, using baited traps (pots). With an annual production that averages in excess of 11,000 t, this is Australia's most valuable single-species fishery.

Recreational

The recreational rock lobster fishery primarily targets western rock lobsters in the Perth metropolitan area and Geraldton, using baited pots and by diving.

Governing legislation/fishing authority

Commercial

West Coast Rock Lobster Management Plan 1993; West Coast Rock Lobster Managed Fishery Licence; Various Notices and Orders under the *Fish Resources Management Act 1994;* Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994 and subsidiary legislation; Recreational Fishing Licence

Consultation processes

Commercial

Rock Lobster Industry Advisory Committee (RLIAC) and subcommittees; annual RLIAC coastal tour; meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee

Boundaries

Commercial

The boundaries of this fishery are 'the waters situated on the west coast of the State bounded by a line commencing at the intersection of the high water mark and 21°44′ south latitude drawn due west to the intersection of 21°44′ south latitude and the boundary of the Australian Fishing Zone; thence southwards along the boundary to its intersection with 34°24′ south latitude; thence due east along 34°24′ south latitude to the intersection of 115°08′ east longitude; thence due north along 115°08′ east longitude to the high water mark; thence along the high water mark to the commencing point and divided into zones'. The fishery is managed in 3 zones: south of latitude 30° S (C Zone), north of latitude 30° S (B Zone) and, within this northern area, a third offshore zone (A Zone) around the Abrolhos Islands.

Recreational

The recreational rock lobster fishery operates on a state-wide basis and encompasses the take of all rock lobster species. Fishing is concentrated on western rock lobsters in inshore regions in depths of less than 20 metres between North West Cape and Augusta.

Management arrangements

Commercial

This fishery is managed using a total allowable effort (TAE) system and associated input controls. The primary control mechanism is the number of pots licensed for the fishery, together with a proportional usage rate, which creates the TAE in pot days. Unitisation in the fishery and transferability provisions allow market forces to determine what is the most efficient use of licences and pot entitlements. This is known as an individually transferable effort (ITE) management system. The number of pots allowed in the fishery was set at 68,961 in the early 1990s. Since 1993/94 a usage rate of 82% has operated to keep the TAE at a sustainable level. Further effort reductions were introduced during 2005/06.

The fishery is divided into 3 zones, which distributes effort across the entire fishery, reducing concentration of effort and the potential for higher exploitation rates. This also permits the implementation of management controls aimed at addressing zone-specific issues, including different maximum size restrictions in the northern and southern regions of the fishery.

The management arrangements also include the protection of females in breeding condition – a minimum size limit of 77 mm carapace length applies from 15 November to 31 January, and a minimum of 76 mm from 1 February to 30 June. A maximum size limit for female lobsters was re-imposed in 2002/03 that prohibits the take of female lobsters larger than 105 mm from waters between 21º44′ S and 30º S and those larger than 115 mm between 30º S and 34º24′ S, excluding waters east of 115º08′.

Gear controls, including escape gaps and a limit on the size of pots, also play a significant role in controlling exploitation rates. The season is open annually from 15 November to 30 June, with the Abrolhos Islands zone operating from 15 March to 30 June.

In 1999/2000, the West Coast Rock Lobster Managed Fishery became the world's first fishery to receive Marine Stewardship Council (MSC) certification. The ongoing requirements of maintaining this certification continue to require a high level of research and management input.

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were lobster breeding stock levels, by-products (octopus) and interactions with protected species. Boxed text in this status report provides an annual assessment of performance on these issues.

Recreational

The recreational component of the western rock lobster fishery is managed under fisheries regulations, which impose a mix of input and output controls on individual recreational fishers. These arrangements are designed to complement the management plan for the commercial fishery.

Input controls include the requirement for a recreational fishing licence (either a specific rock lobster licence or an 'umbrella' licence covering all licensed recreational fisheries). Fishers are restricted to 2 pots per licence holder, although the total number of licences is not restricted. The pots must meet specific size requirements and have gaps to allow under-size rock lobsters to escape. Divers are also restricted to catching by hand, snare or blunt crook in order that the lobsters are not damaged. Fishing for rock lobsters at the Abrolhos Islands is restricted to potting.

An open season runs from 15 November to 30 June each year, with a shorter season (15 March to 30 June) at the Abrolhos Islands. Night-time fishing for lobsters by either diving or potting is prohibited.

Management regulations on minimum size limits, protection of breeding females and the maximum size of females that can be taken are the same as those for commercial fishers.

A daily bag limit of 8 lobsters per fisher per day is used to control individual catches, and limits the ability of recreational fishers to accumulate quasi-commercial quantities of lobsters. A daily boat limit of 16 provides further control on high individual catches where there are 2 or more people fishing from the same boat. There is also a requirement for recreationally-caught lobsters to be tail-clipped in order to stop these animals from being sold illegally as part of 'shamateur' activity.

The Intergrated Fisheries Advisory Committee's (IFAAC's) Western Rock Lobster Draft Allocation Report was released for public comment in November 2005. The associated public submission period closed at the end of March 2006. The IFAAC's allocation report was released with the Minister's preliminary responses in early 2007 for a further period of comment, which closed at the end of April 2007. The Minister is expected to announce his decisions regarding allocation of the western rock lobster resource in 2007.

Research summary

Research activities continue to focus on the core business of assessing stock sustainability and forecasting future catch levels. This involves fishery-independent monitoring of puerulus settlement and breeding stock levels. Industry performance is monitored through compulsory catch and effort records from both fishers and processors and comprehensive data from the voluntary log book scheme, all of which are used for modelling and stock assessment.

An environmental management strategy was developed for use in the assessment of the broader ecosystem impacts of rock lobster fishing in the context of ESD and MSC certification. This strategy includes research into the ecosystem effects of rock lobster fishing in deep water.

A Fisheries Research and Development Corporation (FRDC) funded project to examine the effects of western rock lobster fishing on the deep-water ecosystem off the west coast of Western Australia began in 2004/05. In 2006/07, analysis of video transects and dietary samples continued. Extensive habitat mapping of the same locations using multi-beam side scan sonar, video transects and sediment grabs was also conducted as part of the Marine Futures project. These detailed maps are currently being developed and will be available during 2007/08.

A second FRDC project, which is to be completed in 2007/08, is investigating reproductive biology issues relevant to managing the western rock lobster broodstock. Results from this project have been published in peer reviewed journals.

A project focusing on the impact that 'no-take' zones have on lobster populations has been funded by the Swan Catchment Council. This project began in mid-2007 at Marmion, Shoalwater Bay and Rottnest Island.

For the recreational component of this fishery, an annual mail-based survey of participants has been used to estimate the annual catch and effort for the past 19 years. These trends, together with data on puerulus settlement, are used to predict the recreational catch and effort in following seasons.

Telephone diary surveys of recreational rock lobster fishers have been undertaken in 2000/01, 2001/02 and 2004/05. Estimates of recreational catch from this method are considered to be more accurate than those from mail surveys, as the phone diary eliminates the recall bias in the mail survey and there is a higher participation rate in the random sample selected. However, there is a need to increase the sample sizes for the phone diary surveys and this has been implemented for the 2006/07 survey.

Retained Species

Commercial landings (season 2005/06): 10,326 tonnes

Trends in the annual catches from the WCRLF are shown in West Coast Rock Lobster Figure 1. The 2005/06 catch in the WCRLF was forecast from puerulus settlement 3 to 4 years previously to be 10,050 – 10,450 t. The actual catch from the WCRLF for the 2005/06 season was 10,326 t – which was 6.5% lower than the long-term average catch (1980/81 to 2003/04) of 11,046 t and 14.9% lower than the previous season's 12,139 t.

In 2005/06, the catches in A Zone, B Zone and C Zone were 2,076, 2,954 and 5,296 t respectively, with A Zone 5.2% lower, B Zone 8.9% lower and C Zone 21.0% lower than the previous season.

Octopus may also be caught in rock lobster pots, generally in shallow water (0 – 20 fathoms or 0 – 37 m), and a catch rate of 0.023 octopus per pot lift was recorded in the 2005/06 voluntary research log book data. This was 4.2% below the average of 0.024 per pot lift over the historical range (1985/86 to 2003/04).

This catch rate translates to an estimated 131,574 octopus caught in the shallow waters of the fishery during 2005/06. Octopus catches were estimated for A, B and C Zones as 8,543, 75,733, and 47,297, respectively.

The catch rate of octopus (incidental landings) is a performance indicator for this fishery, and at 0.023 octopus per pot lift achieved the performance measure of being within 10% of the historical range. The historical range (± 10%) is 0.0129–0.033 octopus per pot lift.

Recreational catch estimate (season 2005/06): 214 tonnes

Based on the first 2 phone diary surveys (2000/01 and 2001/02), catch estimates from previous mail surveys going back to the 1986/87 season were adjusted downwards by the average ratio of 1.9. A fourth phone diary survey undertaken in the 2005/06 season produced a different ratio between the mail and phone diary recreational catch estimates. In the interests of maintaining consistency from year to year, the 1.9 conversion factor has been maintained as the current best estimate until a series of comparative data are available and a more reliable conversion factor can be determined.

The recreational catch of western rock lobster for 2005/06 was estimated at 214 t based on the adjusted mail survey, with 157 t taken by potting and 57 t by diving. Comparative catch estimates for 2004/05 were 285 t by potting and 94 t by diving. The estimated recreational catch in 2005/06 was 29.4% below the 2004/05 catch. The 2005/06 season catch estimate was below the catch prediction confidence limits (i.e. 250 – 420 t) produced by the model constructed using adjusted mail survey catch estimates.

Fishing effort/access level

Commercial

Management initiatives aimed at reducing effort have had the secondary effect of a reduction in fleet size, as vessels purchased additional pot entitlements to improve their economic efficiency. In 2005/06 the numbers of vessels fishing for lobster were 131 in A Zone, 114 in B Zone and 255 in C Zone. Thus, in comparison to the 536 active boats in 2004/05, a fleet of 500 vessels fished in 2005/06, which was a reduction of 6.7%.

The nominal fishing effort was 8.8 million pot lifts – 10.2% lower than the 9.7 million pot lifts for 2004/05 and the lowest level since the 1970s (West Coast Rock Lobster Figure 1). This decline in nominal pot lifts is due in part to the sustainability package adopted by the fishery for this and the following 2 seasons.

The 2005/06 nominal effort for A, B and C Zones was 1.3, 2.8 and 4.7 million pot lifts respectively, which was 3.9% more, 22.5% less and 8.1% less than the previous season's pot lifts. The effort distribution was also affected by a movement of boats between Zones A and B.

Recreational

A total of 42,053 licences were sold that permitted fishing for lobsters during some part of the 2005/06 season (made up of rock lobster licences plus umbrella licences), with an estimated 21,000 (50%) utilised for lobster fishing. The number of licences used for rock lobster fishing in 2005/06 was substantially less (19%) than the number of fishers (25,900) for the 2004/05 season.

The average rates of usage by active pot and diving fishers (excluding all those who held a licence but failed to use it) were 16 and 5 days respectively during the 2005/06 fishing season. These rates were 18 and 5 for potters and divers respectively in the 2004/05 fishing season.

Licence usage was forecasted to be 25,700 but came in below that prediction at around 21,000. The percentage of fishers that used their licences decreased to 50%, which is the lowest level on record since the surveys began in 1986. Finally, the average number of lobsters caught for the season by pot and dive fishers was amongst the lowest on record for both groups.

In addition to long-term trends in licence usage, the annual recreational catch in Zone C has also been shown to be correlated with puerulus settlement indices recorded on the Alkimos collectors 3 to 4 years earlier.

Recruitment of lobsters to the fishery is dependent on puerulus settlement with a 3- to 4-year time lag. As might be expected, sales of licences and associated usage figures are substantially higher in years of good recruitment into the fishery, which in turn results in those years producing a relatively higher overall recreational rock lobster catch due to a combination of increased lobster abundance and higher fishing effort.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected commercial catch next season (2006/07): 9,450 tonnes

Projected recreational catch next season (2006/07): 205 tonnes

Stock assessment in this fishery utilises the broad range of fishery data and fishery-independent monitoring outlined in the research summary above.

The stock remains close to maximum sustainable yield. Under the current management arrangements introduced in 1993/94 and 2005/06, which included a reduction in pot usage rate, the protection of setose and maximum size females, and a number of temporal closures, the overall breeding stock also remains at, or above, the target levels of the late 1970s and early 1980s (West Coast Rock Lobster Figures 3 and 4).

Indices of breeding stock are the main measure for assessing the health of this fishery. A 3-year moving average (smoothing) is used to show the underlying trends in the trajectory of the breeding stock indices, rather than highlighting individual data points which can vary significantly due to environmental effects on the catchability of lobsters.

The north and south coastal fishery-dependent breeding stock indices, based on commercial monitoring data, together with the related coastal fishery-independent breeding stock survey (IBSS) index, are presented in West Coast Rock Lobster Figures 3 and 4. The Abrolhos Islands index from the IBSS is presented in West Coast Rock Lobster Figure 5.

A performance measure for the fishery is that the breeding stock index remains above that estimated to be the 1980 level (22% of virgin biomass). The breeding stock levels in 2005/06 for A and C Zones were clearly above this threshold value, although B Zone is close to this value (see West Coast Rock Lobster Figures 3 and 4). The fishery has therefore met its performance measure.

Depletion Analysis

Another measure used to assess stock condition is depletion-based estimates of the harvest rate, as this is a measure of the proportion of the legal biomass that is removed by fishing each season. Over the past 11 years the harvest rate in A Zone has decreased slightly, while a significant increase has occurred in the coastal fishery, particularly in B Zone (West Coast Rock Lobster Figure 7). This analysis also highlighted an increasing trend in catchability (reflecting increasing efficiency) in B Zone and a declining trend in the residual biomass of legal-sized lobsters at the end of the year.

Catch per Unit Effort (CPUE)

A third stock assessment measure is the catch per unit of effort (CPUE) achieved annually by the fishery (West Coast Rock Lobster Figure 2). This provides a broad indicator of variations in the abundance of the legally catchable stock.

The downward trend from the 1950s to the 1980s reflects the increasing effort during this period (West Coast Rock Lobster Figure 1), which automatically leads to lower CPUE. This trend was reversed in the early 1990s through a substantial management-induced reduction in effort (i.e. pot usage was reduced to 82% of the unit holding).

Shorter-term fluctuations in abundance represent the cyclical nature of puerulus settlement, which is reflected in the legal-sized abundance (CPUE) 3 to 4 years later. The decrease in CPUE to 1.19 kg/pot lift in 2005/06 (around 5.6% less than the previous year) relates directly to the levels of puerulus settlement recorded previously. It should be noted that the catch rate does not directly reflect the overall abundance of lobsters, as legal catches are generally only a proportion of the overall biomass due to the large biomass of under-size animals and breeding females, which are fully protected.

The average recreational pot and diving catch rates were 1.4 and 1.9 lobsters per person per fishing day in the 2005/06 fishing season. These catch rates are slightly lower compared to those in the 2004/05 fishing season, where potters and divers also caught 1.8 and 2.9 lobsters per person per fishing day respectively.

Puerulus

Post-larval (puerulus) recruitment to the fishery is monitored monthly and relates to fluctuations in environmental conditions such as strength of the Leeuwin Current and the frequency and intensity of low-pressure systems generating westerly winds. Annual indices of puerulus settlement for 2005/06 were below average at all sampling sites (West Coast Rock Lobster Figure 7).

These results reflect the neutral Southern Oscillation Index (an indicator of El Niño conditions which affects the strength of the Leeuwin Current), which commenced in 2005 and has continued well into 2006. These low 2005/06 settlements will first impact on catches during the 'reds' of 2008/09 and the 'whites' throughout the fishery in 2009/10.

Total catch predictions for the WCRLF are made by summing the regional catch predictions from puerulus settlement at the Abrolhos Islands (A Zone), Seven Mile Beach (B Zone) and Jurien Bay, Lancelin, Alkimos and Warnbro Sound combined (C Zone) (West Coast Rock Lobster Figure 7).

Seasons 2006/07 and 2007/08 are expected to produce commercial catches of around 9,350 t and 9,650 t respectively, resulting from below-average puerulus settlement in 2002/03 and average puerulus settlement in 2003/04 (West Coast Rock Lobster Figure 7). Catches during the 2008/09 season are expected to remain similar to those in 2007/08 (9,900 t).

Based on weaker puerulus settlements in the last few years, it is forecast that the recreational rock lobster catch for the whole fishery will be around 205 t in 2006/07 (West Coast Rock Lobster Figure 8), before increasing to 253 t in 2006/07, and 287 t in 2008/09. Therefore, licence sales and usage in 2005/06 are expected to remain at similar levels; the prediction is that sales will be approximately 40,950 and usage 20,800, in the 2006/07 season.

Non-Retained Species

Bycatch species impact: **Low**

Fishery-independent monitoring on commercial vessels records the catch rates of fish and invertebrate bycatch species caught during normal rock lobster fishing operations. Approximately 62,700 fish and invertebrates other than rock lobster and octopus were captured during the 2005/06 fishing season, of which more than 90% were released (Table 1). This equates to less than 1 fish captured per day fished (based on an average daily pot usage rate of 110 pots).

In future seasons, more quantitative data on actual return rates and the condition of released bycatch will be recorded by species.

WEST COAST ROCK LOBSTER TABLE 1.
Catch rate of bycatch in lobster pots recorded during observer monitoring programs in 2005/06. The total number caught is an estimate based on the catch rate and the total number of pot lifts in 2005/06 fishing season.

Bycatch observed	Catch/1,000 potlifts	Total number caught (whole fishery)
Port Jackson shark (*Heterodontus portusjacksoni*)	1.55	13,543
Wobbegong shark (*Orectolobus* spp.)	1.38	12,117
Breaksea cod (*Epinephelides armatus*)	0.73	6,415
Eel (Muraenidae)	0.41	3,564
Baldchin groper (*Choerodon rubescens*)	0.65	5,702
Western wirrah (*Acanthistius serratus*)	0.08	713
Scorpion fish (Scorpaenidae)	0.16	1,426
Bullseye (*Pempheris* sp.)	0.08	713
Gurnard (*Chelidonichthys* sp.)	0.08	713
Wrasse (Labridae)	0.16	1,426
Boxfish (Ostraciidae)	0.08	713
Chinaman cod (*Epinephelus rivulatus*)	0.08	713
Leopard perch (*Acanthistius pardalotus*)	0.08	713
Charlie Court cod (*Epinephelus fasciatus*)	0.08	713
Unknown finfish	1.22	10,692
Cuttlefish (*Sepia* sp.)	0.33	2,851
Total	**7.15**	**62,727**

Protected species interaction: Low – moderate

Historically, the WCRLF has interacted with the Australian sea lion, *Neophoca cinerea*, resulting in the accidental drowning of an estimated small number of sea lion pups in rock lobster pots, as the pups attempted to retrieve from the traps the bait or rock lobsters contained in them. Incidents were restricted to shallow waters (< 20 m) and to areas within 30 km of the mainland sea lion breeding colonies on the mid-west coast.

In order to eliminate these accidental drownings, from November 15 2006 all pots fished in waters less than 20 m within approximately 30 km of the 3 breeding colonies, i.e. just north of Freshwater Point to just south of Wedge Island, must be fitted with a Sea Lion Exclusion Device. A number of SLED designs were tested in 2005/06.

Approved SLED designs include an internal rigid structure, directly under the pot neck and an external design across the top of the pot, both of which ensure that the diagonal distance from the SLED to the neck of the pot is not greater than 132mm. Further information on the SLED management package is available at: www.fish.wa.gov.au/docs/pub/SeaLionExclusionDevices/index.php

A performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2005/06 western rock lobster season, no sea lion captures were reported, whereas the historical level is just over 3 sea lions per season. The fishery has therefore met this performance measure.

Turtle deaths as a direct result of interaction with the lobster fishery are very rare. Of the 6 turtle species that occur in the waters of the western rock lobster fishery, only the entanglement of leatherback turtles (*Dermochelys coriacea*) was identified as a moderate risk in the risk assessment.

A performance measure for the fishery is that there is no increase in interactions with turtles. In 2005/06, 3 leatherback turtles were reported to have been entangled in lobster fishing gear. This incident rate is within the historical range of between 2 and 5 entanglements per season over the preceding 4 seasons. The fishery has therefore met this performance measure.

There are occasional reports of a whale becoming entangled with pot ropes. The humpback whale is the predominant species that interacts with the WCRLF, during its northward migration to the North West Shelf breeding grounds in June to August. Owing to the fishery's closed season, there is a limited period for interaction; however, with the increasing population of whales, more interactions are likely to occur in the future.

Interactions are reported by industry to the Department of Environment and Conservation (DEC) and a specialist team is used to disentangle the animal, with a very high success rate. The western rock lobster fishing industry has developed a code of practice to minimise the interaction with whales in conjunction with DEC and SeaNet. The environmental management strategy adopted for the WCRLF requires monitoring of, and attempts to, minimise accidental interaction with these species wherever practicable.

A performance measure for the fishery is that there is no increase in the rate of interactions with whales and dolphins (entanglements). Over the recorded history (1989–2004), commercial lobster fishing has resulted in zero to 4 whale/dolphin interactions per season. 6 whale entanglements were recorded during the 2005/06 lobster season, of which 5 whales were disentangled, therefore the fishery did not meet this performance measure.

Ecosystem Effects

Food chain effects: **Moderate**

The fishery is unlikely to cause significant trophic ('food web') cascade effects, as the protected sub-legal-sized lobsters and breeding stock components form a relatively constant significant proportion of the biomass which remains from year-to-year, and the catch, particularly in inshore areas, is less than the annual variability in biomass due to natural recruitment cycles. However, a recent rock lobster-specific ecological risk assessment considered that the removal of lobster in deep-water regions might impact on their surrounding ecosystem. This forum subsequently classed this as a moderate risk. As such this has become a focus of research, with preliminary work, funded by FRDC, almost completed and a second project being submitted to the FRDC to expand on these preliminary findings.

Habitat effects: **Low**

The legislated design of rock lobster pots, the materials they are made from and the strict control of replacement pots prevents 'ghost fishing' problems arising. A study of human impacts on the marine environments of the Abrolhos Islands estimated that potting might impact on less than 0.3% of the surface area of fragile habitat (corals) at the Abrolhos, where fishing is only allowed for 3 and a half months of the year.

Generally, throughout the coastal fishery, rock lobster fishing occurs on sand areas around robust limestone reef habitats, covered with coralline and macro-algae such as kelp (*Ecklonia* spp.). This type of high-energy coastal habitat is regularly subjected to swell and winter storms and so is considered highly resistant to damage from rock lobster potting.

Social Effects

Commercial

The western rock lobster fishery is an important sector of Western Australia's economy, with the commercial catch from the current reporting season valued ex-vessel at $289 million. Employment is seasonal, the fishing season covering 7 and a half months from 15 November to 30 June.

A total of 500 vessels and 1,385 people were engaged directly in fishing for rock lobsters in 2005/06. This equates to 1 skipper

Measuring a western rock lobster for legal size. Photo: Andrew Cribb

and an average of about 1.77 deckhands per vessel, which is very similar to that recorded during the 2004/05 season. During the year, 7 processing establishments, located in the Perth metropolitan area (3), Dongara (1) and Geraldton (3), serviced practically every location where fishing occurred.

Recreational

With around 21,000 people taking just over half a million individual lobsters annually, this fishery represents a major recreational activity and provides a significant social benefit to the Western Australian community.

Economic Effects

Estimated annual commercial value (to fishers) for year 2005/06: $289 million

The price that commercial fishers received for the western rock lobster in 2005/06 was an estimated average of $28.00/kg in all zones of the fishery. This was a 30.2% increase on the $21.50/kg paid in 2004/05, and is mainly attributable to the smaller catch in 2005/06 and the low standing value of the Australian Dollar. Thus, despite the increase in price per kilogram, the overall value of the fishery did not change significantly from the previous season's value of $259 million.

The bulk of the product was exported to Japan, Taiwan, Hong Kong/China and the United States.

Fishery Governance

Commercial

Current Fishing (or Effort) Level: Acceptable

Target commercial catch range: 8,166 – 14,523 tonnes

Between 1975/76 and 2005/06 commercial catches have averaged 10,951 ± 565 t (95% confidence intervals of the mean) and ranged from 8,166 t in 1985/86 to 14,523 t in 1999/2000. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions experienced by western rock lobster larvae and post-larvae, and levels of fishing effort. With fishing effort having been reduced, catches are still expected to fall within the above range.

New management initiatives (2006/07)

The new management system, which came into effect at the commencement of the 2005/06, continued into the current season (2006/07). This new system consists of 2 separate sustainability packages, 1 for Zones A and B (northern) and 1 for Zone C (southern), as the sustainability risks in these areas differed.

Specifically, the Department of Fisheries advised industry that the equivalent of a 15% effort reduction was required in the northern region of the fishery, while in the south a 5% effort reduction would be sufficient. The final composition of the 2 management packages was determined by industry on the basis of advice provided by the Department. The packages introduced are expected to reduce effort by the desired amounts and provide economic savings within the industry.

In the northern coastal region the management package comprised:

- 10% pot reduction (15 November – 14 March);
- Zone A – 10% pot reduction (15 March – 15 April);
- 15 January – 9 February closure;
- no fishing on Sundays in Zone B (15 March – 30 June); and
- time off – fishery closed for Christmas Day and New Year's Day.

In the southern region the management package comprised:

- 10-day November closure (15 November – 24 November);
- 3-day moon closures from 1 February to 30 June (1 day prior to the full moon, the day of the full moon and the day after the full moon); and
- time off – fishery closed for Christmas Day and New Year's Day.

A 3-year review of the fishery's long-term management options was completed in February 2007. The review compared the current fishing effort management system (input controls) to the introduction of a catch quota management system (output controls) An industry poll, conducted as part of the consultation process, revealed that over 80% of licensees preferred a retention of the effort management system.

Following consideration of advice from the industry and the Rock Lobster Industry Advisory Committee (RLIAC), the Minister approved a continuation of the current effort management system.

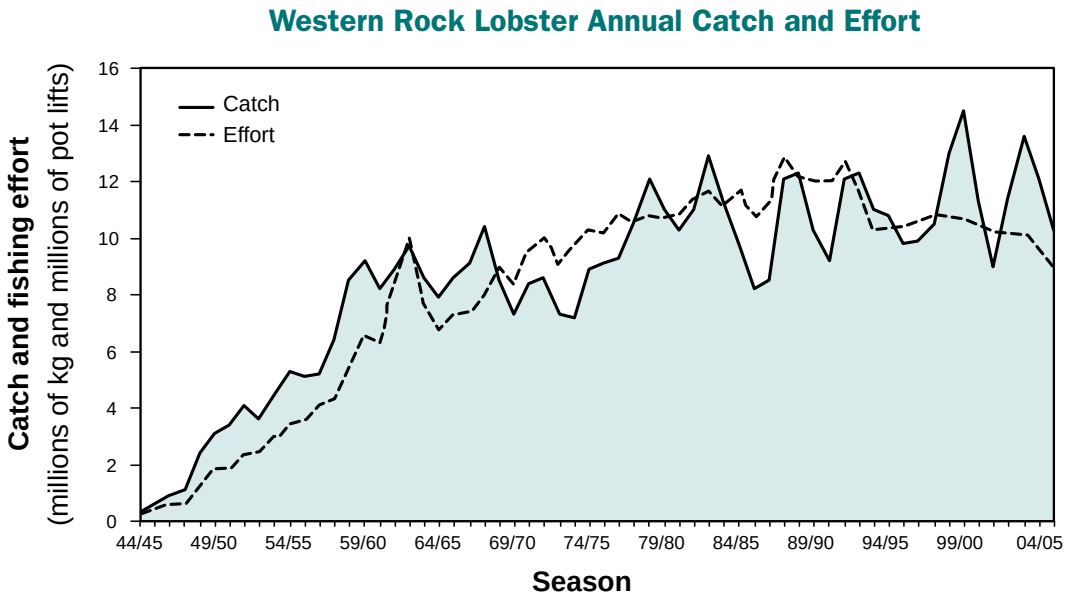
The introduction of Sea Lion Exclusion Devices to the fishery took effect in the 2006/07 season (see also the section headed 'Protected species interactions').

Daylight saving was introduced for a 3-year trial in October 2006. The period over which daylight saving occurs is from the last Sunday in October to the last Sunday in March. As a consequence, the hauling times for pots was changed from 4:30am until 7:30pm to 5:30am until 8:30pm over the period of daylight saving.

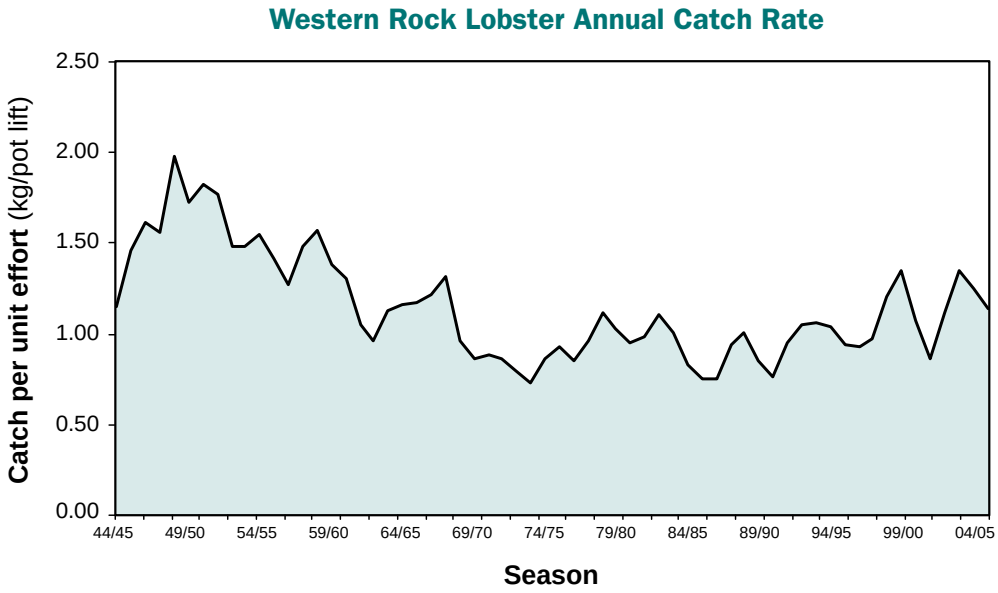
The telephone diary survey will continue in 2006/07 to further improve relationships between phone and mail survey results. It is proposed in the forthcoming survey to increase the telephone diary survey sample size, so as to achieve a result with a standard error of less than 10%.

External Factors

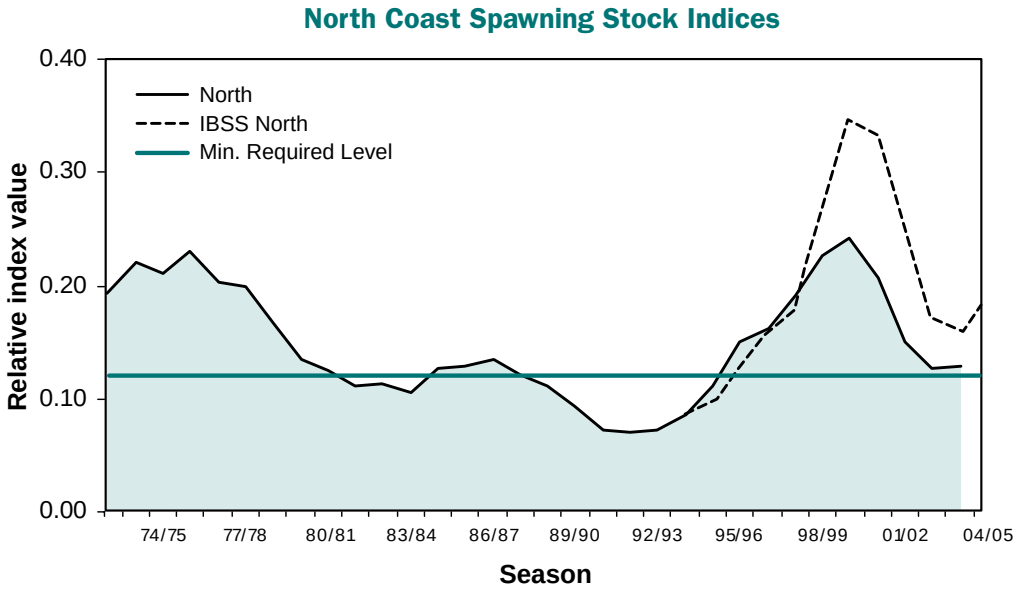
The variations in western rock lobster catches both commercially and recreationally are largely a result of variable levels of puerulus settlement due to changes in the Southern Oscillation (El Niño or La Niña events in the Pacific Ocean) and their effect on the Leeuwin Current. A positive relationship exists between Leeuwin Current strength and levels of puerulus settlement. The southward-flowing Leeuwin Current also affects the spatial distribution of puerulus settlement along the coast. Catches are also dependent upon the environmental conditions at the time of fishing.



WEST COAST ROCK LOBSTER FIGURE 1
Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2005/06.

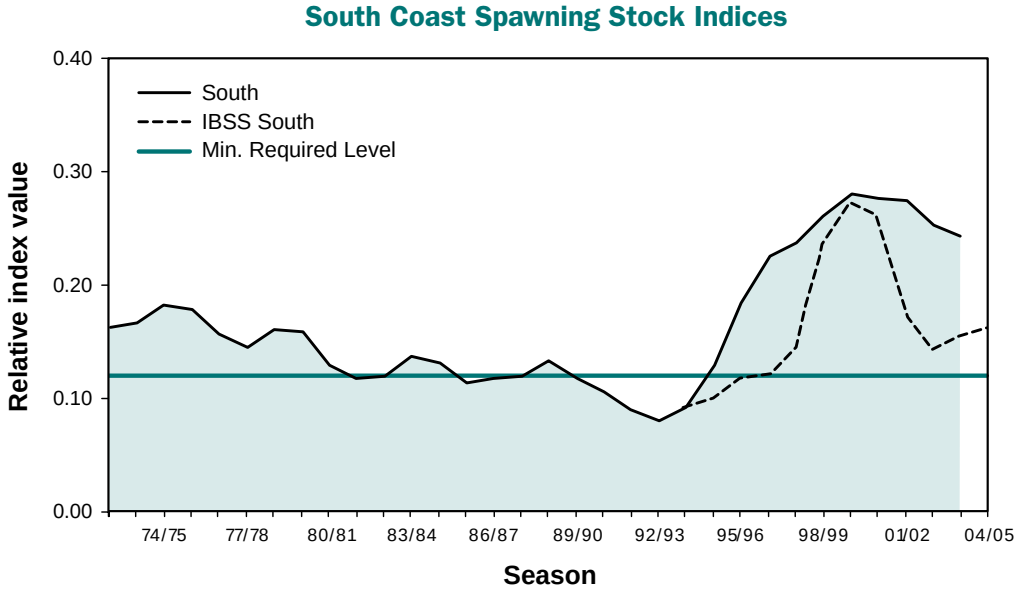


WEST COAST ROCK LOBSTER FIGURE 2
Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2005/06.



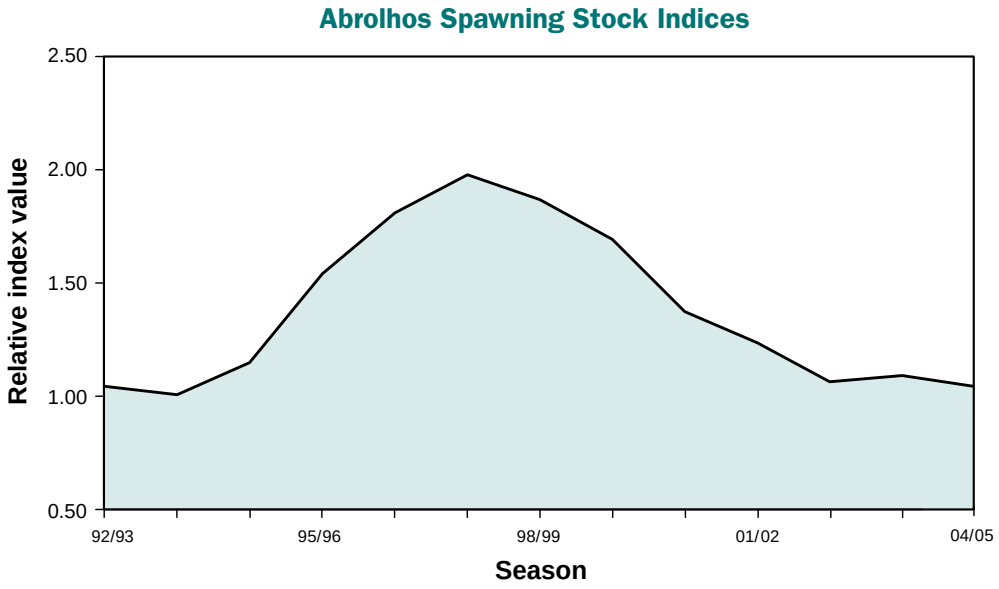
WEST COAST ROCK LOBSTER FIGURE 3

3-point smoothed average of the northern (Jurien and Dongara) spawning stock indices derived from commercial vessel monitoring (eggs per pot lift over the whole season) and from the fishery-independent breeding stock survey (eggs per pot lift in October/November). The initial value of the independent index has been scaled to be equivalent to the 1992/93 average of the monitoring index.

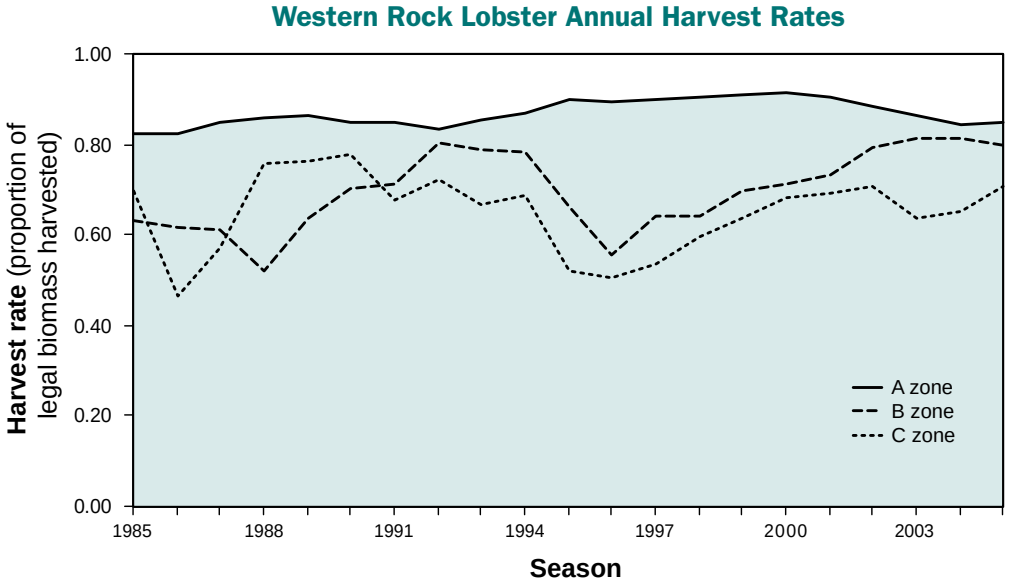


WEST COAST ROCK LOBSTER FIGURE 4

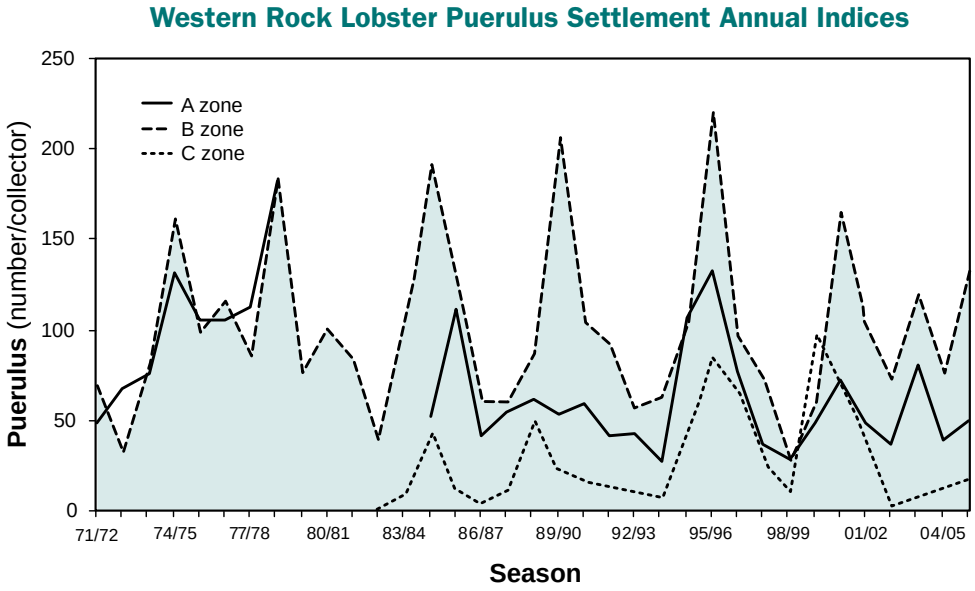
3-point smoothed average of the southern (Fremantle and Lancelin) spawning stock indices derived from commercial vessel monitoring (eggs per pot lift over the whole season) and from the fishery-independent breeding stock survey (eggs per pot lift in October/November). The initial value of the independent index has been scaled to be equivalent to the 1992/93 average of the monitoring index.



WEST COAST ROCK LOBSTER FIGURE 5
Egg production indices as measured by the independent breeding stock survey at the Abrolhos Islands smoothed by a moving average of 3 years.

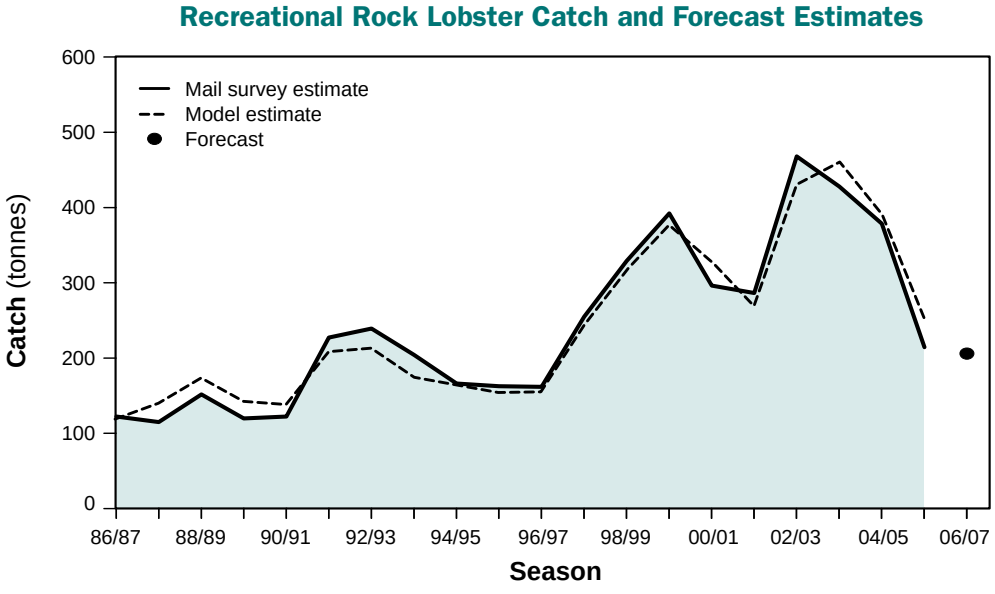


WEST COAST ROCK LOBSTER FIGURE 6
Annual harvest rates of western rock lobster in Zones A, B and C smoothed using a moving average.



WEST COAST ROCK LOBSTER FIGURE 7

Annual indices of puerulus settlement for the Abrolhos (A Zone), Seven Mile Beach (Dongara) (B Zone) and Alkimos (C Zone).



WEST COST ROCK LOBSTER FIGURE 8

Estimates of the recreational rock lobster catch since 1986/87 using adjusted mail survey results, and model estimates of catches in 2006/07 based on puerulus settlement 3 to 4 years earlier and expected licence usage.

Roe's Abalone Managed Fishery Status Report

A. Hart, J. Brown and T. Baharthah.
Management input from K. Saville

Fishery Description

The Western Australian Roe's abalone (*Haliotis roei*) fishery is a dive and wade fishery, operating in shallow coastal waters along WA's western and southern coasts. Roe's abalone are found in commercial quantities from the South Australian border to Shark Bay, although they are not uniformly distributed throughout this range.

The commercial fishery harvest method is a single diver working off 'hookah' (surface supplied breathing apparatus) using an abalone 'iron' to prise abalone off rocks. Abalone divers operate from small fishery vessels (generally less than 9 m in length).

The recreational fishery harvest method is primarily wading and snorkeling, with the main focus of the fishery being the Perth metropolitan stocks (West Coast Fishery).

Governing legislation/fishing authority

Abalone Management Plan 1992
Ministerial Policy Guideline no. 10
Abalone Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)
Recreational Fishing Licence

Consultation process

Abalone Management Advisory Committee
Meetings between the Department of Fisheries and industry
Recreational Fishing Advisory Committee

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8 (Roe's Abalone Figure 1).

Recreational

The recreational abalone fishery regulations relate to 3 zones: the Northern Zone, the West Coast Zone, and the Southern Zone (Roe's Abalone Figure 2). The West Coast Zone is the centre of the fishery.

Management arrangements

Commercial

The commercial Roe's abalone fishery is managed primarily through output controls in the form of total allowable commercial catches (TACCs), set annually for each area and allocated to license holders as individual transferable quotas (ITQs).

The overall TACC for 2006 was 112.7 t whole weight (note this small species is always landed in the whole condition). The TACC is administered through 25,180 ITQ units, with a minimum unit holding of 800 units generally applying, although some Roe's abalone licences are permitted to operate below this minimum in recognition of historical fishing practices.

The licensing period (fishing year) runs from 1 April to 31 March of the following year.

The legal minimum length for Roe's abalone is 60 mm shell length in most parts of the fishery (the same as in the recreational fishery). However, commercial legal minimum lengths of 75 mm and 70 mm apply in Area 1 (Western Australia/South Australia border to Point Culver) and Area 7 (Cape Bouvard to Moore River) respectively.

Recreational

The recreational Roe's abalone fishery is managed under a mix of input and output controls. Recreational fishers must purchase a dedicated abalone recreational fishing licence or an umbrella licence (which covers all licensed recreational fisheries). These licences are not restricted in number.

The fishing season in the Northern and Southern Zones extends from 1 October to 15 May. The West Coast Zone is only open for 6 Sundays annually, and the time of fishing in 2006 was reduced from 90 to 60 minutes (between 7 a.m. and 8.00 a.m.), commencing on the first Sunday in November.

These restrictive management controls on the west coast are necessary to ensure the sustainability of an easily accessible (and therefore vulnerable) stock located adjacent to a population in excess of 1.6 million people (including Geraldton).

For Roe's abalone, the minimum legal size is 60 mm shell length, the daily bag limit is 20 per fisher, and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 80.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of Roe's abalone. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Abalone divers provide daily catch information on the total weight of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. These data are used to assist in research, compliance and management matters.

Current research is focused on stock assessment, using catch and effort statistics and research surveys of stocks in the Perth metropolitan area. New initiatives include digital video imagery (DVI) assessment by industry divers, who survey selected sites with an underwater video camera.

Roe's industry divers collect size-frequency and abundance information *in situ* from 28 video survey sites across the fishery.

Current annual recreational catch and effort estimates are derived from a field survey of the Perth metropolitan fishery, and a telephone diary survey covering the entire state. The field survey estimates the catch and effort from each distinct Roe's abalone stock within the Perth fishery (West Coast Zone).

Field survey estimates are based on average catch (weight and numbers), catch rates (derived from 1,600 interviews in 2006), and fisher counts conducted by VFLOs (Volunteer Fisheries Liaison Officers) and research personnel from shoreline vantage points and aerial surveys.

This method provides a comprehensive assessment, but is too resource-intensive to be applied routinely outside of the Perth metropolitan area.

The telephone diary survey estimates the catch of all 3 species on a state-wide basis. In 2006, around 480 licence holders were randomly selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted each month by telephone for the duration of the abalone season.

In addition, an annual telephone recall survey is conducted annually to gather information on a range of licensed recreational fisheries. While this is no longer used as a primary data source for the recreational abalone fishery owing to some identified difficulties with recall bias, it does provide a useful time series for validation and comparison of overall trends in the Perth metropolitan Roe's abalone fishery (see Roe's Abalone Figure 3).

A fishery-independent survey of Perth metropolitan stocks is carried out annually. Size and density of Roe's abalone across the near-shore sub-tidal reef habitat has been measured at 10 indicator sites between Mindarie Keys and Penguin Island.

Retained Species

Commercial production (season 2006):
98.4 tonnes whole weight

The TACC for the 2006 quota year was 112.7 t whole weight for Roe's abalone. The catch of 98.5 t whole weight for 2006 (Roe's Abalone Table 1) was 2% higher than in 2005 and 14.3 t lower than the TACC.

Recreational catch (season 2006):
Roe's Perth Fishery 30.2 tonnes
Roe's rest of state 13.7 tonnes

Recreational catch: **21 – 34% of total catch**

The catch estimate for Roe's abalone from the Perth metropolitan area in 2006 is 30 t, as estimated from the field survey (Roe's Abalone Figure 3). This is an increase of about 13% from 2005, caused mainly by increases in catch rates as a result of good weather conditions.

Catch estimates of Roe's abalone from the phone diary surveys were 23.2 t (range: 20.3 – 26.2 t) in the Perth Fishery, 12.0 t (range: 7.0 – 17.0 t) in the West Coast Fishery, and 1.7 t (range: 1.1 – 2.4 t) in the South Coast Fishery (Roe's Abalone Table 3). These estimates are similar to the 2004 telephone diary survey estimates.

The Perth Fishery estimates from the telephone diary survey are slightly lower than the estimates from the field survey as they were in 2004.

Recreational fishing represented about 21 – 34% of the total (commercial and recreational) Roe's abalone catch across the state in 2006. This is similar to the 2004 estimate of 23 – 31% of the total catch.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2006 was 625 diver days, which was the lowest effort on record (Roe's Abalone Table 1). This low level is consistent with stocks being in good shape.

Recreational

For the 2006 season, around 21,000 licences were on issue – a slight increase from 20,000 in 2005 (Roe's Abalone Figure 3).

Effort in the 2006 metropolitan fishery of 10,435 hours was the lowest since the field survey began in 1999 (Roe's Abalone Table 2). This was a decrease of 15% from 2005 (12,328 hours). The decrease was primarily due to the shortening of the daily fishing time from 1.5 hours to 1 hour.

Effort estimates for recreational abalone fishing from the 2006 telephone diary survey were 12,600 days (9,900 – 15,400 days) in the Perth metropolitan area, 8,000 days (4,700 – 11,300 days) on the west coast (excluding the Perth metropolitan area), and 2,800 days (1,600 – 3,900 days) on the south coast (Roe's Abalone Table 3).

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

The catch rate for dedicated Roe's abalone divers in 2006 was 136 kg/day, which was higher than the 2005 catch rate of 131 kg/day and the highest catch rate since 2000 (Roe's Abalone Table 1).

The catch, effort and catch rate statistics indicate that, overall, Roe's abalone stocks are in an acceptable state and at higher than historically average levels. The total effort of 625 diver days in 2006 is the lowest effort on record.

However, since 1999, increases in diver fishing efficiency have occurred because of management changes (the lifting of the 100 kg daily catch limit in the Area 7 stocks), and accurate weather predictions on the Internet. Consequently, the years used to set the Governance ranges in the fishery (1994 – 1998) were reviewed to account for these efficiency increases (see Fishery Governance).

The overall TACC was not caught principally because of poor weather in Area 1 of the fishery (Roe's Abalone Figure 1), and catches below the TACC in Area 5 (88% of TACC caught) and Area 8 (80% of TACC caught). A reduction in Area 8 TAC from 15 to 12 t was recommended for 2007, resulting in an overall TACC reduction to 109.7 t (Roe's Abalone Table 1).

The catch rates of recreational fishers in the Perth metropolitan fishery of 29 abalone/hour was the highest since surveys began in 1999 and is partly due to weather conditions.

Size distributions and densities for *Haliotis roei* were measured from 10 indicator reefs in the Perth metropolitan fishery. Nine of these are fished while the tenth is the Waterman's Reserve Marine Protected Area (MPA). Surveys were conducted in January and February 2007, and measured the state of abalone stocks following the recreational fishery in November and December of 2006 (Roe's Abalone Table 4). Increases in number of sites sampled, and modifications to statistical models have resulted in different estimates of mean densities from the 2006 assessment, however trends have remained essentially unchanged.

Densities of sub-legal animals (less than 60 mm in size) on the reef platform habitat increased from 33 in 2006 to 37 abalone m^{-2} in 2007, which is the highest level since 2001 (Roe's Abalone Table 4). On the sub-tidal reef habitat, densities of sub-legal animals decreased from 6.8 to 5.6 abalone m^{-2}, which is still the second highest since the survey began in 1997.

Densities of legal-sized animals (60+ mm) on the reef platform habitat in 2007 was the same as 2006 (19 m^{-2}; Roe's Abalone Table 4), and are at the lowest levels in recent years, due principally to localised declines at Penguin Island and Mettams Pool. These locations will be closely monitored in continuing years.

In the sub-tidal reef habitat, legal-sized densities increased from 9 in 2006 to 11 abalone m^{-2} in 2007 (Roe's Abalone Table 4). The increased abundance of sub-legal animals should result in increased abundances in legal-sized animals in the future, particularly at Mindarie Quays and Penguin Island.

Mean densities of legal-sized Roe's abalone in the MPA are about twice the density of animals within the fished stocks, for both platform and sub-tidal habitats (Roe's Abalone Table 4). This indicates a similar fishing mortality, relative to natural mortality, in both habitats.

Research has shown that the size at sexual maturity (50% of animals mature) of Roe's abalone in the Perth metropolitan area is approximately 40 mm (2 to 3 years of age). Preliminary growth data for these same metropolitan Roe's abalone indicate that they have a minimum of 1 year's spawning before reaching 60 mm, the minimum legal size at which Roe's abalone are harvested anywhere in Western Australia.

This is considered to provide adequate protection for the breeding stock under normal environmental conditions, especially since the commercial fishery's legal minimum size in Area 7 (the Perth metropolitan area) is 70 mm – 10 mm larger than that used by the recreational sector. In Area 1, the commercial fishery's legal minimum length is 75 mm.

The main performance measure for the fishery relates to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of the level of quota achieved and the effort required to achieve the quota, both of which reflect stock abundance.

In 2006, catch and effort in most areas fished were within the agreed ranges, indicating that overall breeding stock levels were adequate (Roe's Abalone Table 5). Adverse weather conditions limited fishing in the remote Area 1, and to a lesser extent Area 5 (88% of TAC caught). A reduction in Area 8 TAC (15 t to 12 t) was recommended for 2007 to account for lower productivity stocks.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.

Protected species interaction: **Negligible**

The only potential protected species interaction in this fishery would be with the great white shark (*Carcharodon carcharias*) while fishing in some of the more open-water locations. Some Roe's abalone divers are adopting the 'shark shield' technology generally used by greenlip/brownlip divers for their personal protection.

Ecosystem Effects

Food chain effects: **Negligible**

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region.

Habitat effects: **Negligible**

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave energy environment. As abalone feed on drift algae, their removal is unlikely to result in any changes to the algal growth cover in areas fished.

Social Effects

There are 26 vessels fishing for Roe's abalone, employing approximately 50 people across Western Australia. The dispersed nature of the Roe's abalone fishery means that small coastal towns from Kalbarri to Eucla receive income from the activity of divers.

Over 20,000 licences were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 3). The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy.

Economic Effects

Estimated annual value (to commercial fishers) for 2006: $2.9 million

The estimated average price for Roe's abalone in 2006 was $29/kg – a reduction from $33/kg in 2005. On the basis of the average price the fishery was worth approximately $2.9 million, a decrease from the 2005 value of $3.1 million. Overall, the price of Roe's abalone has dropped by almost 50% since 2000, when it was $55/kg whole weight. This is due to the value of the Australian dollar, which has also increased from US$0.58 in 2000 to US$0.75 in 2006, and to competition from abalone produced by aquaculture.

Fishery Governance

Target effort range (current): 679 – 914 diver days

Target effort range (revised): 620 – 750 diver days

To assess whether the catch quota set in 2006 is appropriate (sustainable) relative to the stock available, Roe's abalone catches should be taken within the range of effort (679 – 914 diver days) recorded over the 5-year period 1994 – 1998. This range reflects the acceptable variation in catch rates due to weather and recruitment cycles.

The effort value of 625 diver days in 2006 falls below the expected effort range, suggesting stocks are at historically high levels. However increases in fishing efficiency have occurred (see Stock Assessment), and the target effort range was reviewed.

From 2007 onwards, the target effort range will be based on the 1999 – 2006 fishing years (620 – 750 diver days), as this better reflects the current management measures in place. Furthermore, some localised stock declines (see Stock Assessment) warrant a small reduction in TACC. TACC for 2007 was reduced from 112.7 to 109.7 t (Roe's Abalone Table 1).

New management initiatives (2006/07)

There were no new management initiatives introduced in 2006/07, though consultation took place with industry on relatively minor operational changes to the *Abalone Management Plan 1992*. These matters are currently being progressed.

The Perth metropolitan Roe's abalone fishery is the second fishery subject to the IFM allocation process. An allocation report containing recommendations on how the catch should be shared between the commercial, recreational and indigenous sectors has been completed. The preliminary key recommendations in the report are that:

- 200 kg should be allocated for customary fishing;
- proportional allocations for the recreational and commercial sectors should be deferred;
- when proportional allocations are implemented, the starting point should be 53% recreational and 47% commercial; and
- a total allowable catch should be introduced for the recreational sector.

External Factors

The main external factor influencing the Roe's abalone fishery has been the decline in beach price and overall economic value. The small size of Roe's abalone means that, as a fishery product, it is likely to be in direct competition with small hatchery-produced greenlip abalone, which are now being released on to the market.

Roe's abalone being checked for legal size.

ROE'S ABALONE TABLE 1

Roe's abalone catch and effort[1] by quota period

Quota period[2]	Roe's TACC kg whole weight[3]	Roe's caught kg whole weight	Diver days[4] (Roe's divers only)	Kg whole weight per diver day (Roe's divers only)
1990	105,000	116,447	936	112
1991	101,000	109,489	832	118
1992	105,000	111,341	735	134
1993	128,000	115,281	832	123
1994	125,960	117,835	908	113
1995	125,960	114,501	1,047	98
1996	125,960	118,715	1,004	106
1997	126,790	118,738	855	120
1998	93,960[5]	86,425	695	108
1999	119,900[6,8]	112,949	659	149
2000	115,900[6]	107,735	647[7]	144
2001	107,900[6]	99,174	685	126
2002	107,900	100,471	700	125
2003	110,900	96,005	723	118
2004	110,900	107,593	736	126
2005	112,700	96,496	672	131
2006	112,700	98,370	625	136
2007	109,700			

Notes

1. Data source: quota returns.
2. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar year.
3. Standard conversion factors for meat weight to whole weight for Roe's abalone were 2.5 prior to 2000 and 3.0 from 2000.
4. Effort (diver days) for dedicated Roe's divers only. This year, database improvements allowed a better estimate, and, consequently, figures vary slightly from last year.
5. Reduced quota for a 6-month season.
6. Industry-instigated voluntary 6 t reduction in quota for 1999 and voluntary 4 t reduction in 2000 and a 2 t reduction in 2001 in response to concerns over the low abundance of legal-sized abalone in Area 8.
7. Prior to 2000, effort estimates (diver days) extracted from days when catch was processed; from 2000 onwards, effort estimates extracted from daily CDR counts.
8. In 1999, fishing restrictions (100 kg daily catch limit) in the Perth metropolitan area were lifted.

ROE'S ABALONE TABLE 2

Summary of effort (fisher hours), catch rate (abalone per hour), catch (number of abalone and tonnes whole weight) and mean whole weight (g) for the Perth recreational Roe's abalone fishery, from annual field surveys.

Field Survey					
Year	Effort (hours)	Catch rate	Catch (number)	Catch (tonnes)	Mean weight (g)
1999	16,449	23	383,600	35.3	92
2000	15,818	21	330,300	30.2	91
2001	17,727	27	481,300	44.1	92
2002	18,127	22	401,500	36.0	90
2003	17,963	26	442,400	42.6	96
2004	14,614	24	342,900	31.7	93
2005	12,328	21	262,700	24.3	92
2006	10,435	29	297,000	30.2	101

ROE'S ABALONE TABLE 3

Summary of telephone diary surveys of effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the Roe's abalone recreational fisheries in 2004 and 2006.

Location	Year	Effort	Roe's	
			Catch Rate	Catch (tonnes)
Perth Metro[1]	2004	17,200 (14,000 – 20,500)	17.8	28 (25 – 31)
	2006	12,600 (9,900 - 15,500)	18.2	23 (20 – 26)
West Coast[1] (excluding Metro)	2004	10,100 (6,500 – 13,600)	11.0	10 (7 – 14)
	2006	8,000 4,700 – 11,300	14.7	12 (7 – 17)
South Coast[2]	2004	2,700 (1,700 – 3,700)	6.2	2 (1 – 3)
	2006	2,800 (1,600 – 3,900)	6.3	2 (1 – 2)

1. Both areas are within the West Coast bioregion.
2. Survey area is South Coast bioregion (i.e. east of Black Point).

ROE'S ABALONE TABLE 4

Mean densities (abalone/m^2) of sub-legal (< 60 mm shell length) and legal-sized Roe's abalone (60 mm and over) from 9 monitoring sites (fished stocks) and the Marine Protected Area (MPA) in the Perth fishery. The platform habitat is primarily the recreational fishery, while the sub-tidal habitat is primarily the commercial fishery. Data has been standardised by a GLM (Generalized Linear Models) analysis, as the sites are not the same for all years, and, consequently, 2006 density estimates vary from 2005.

Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1997	32	29	44	26	4.2	12	9	21
1998	42	27	51	37	5.2	13	11	29
1999	47	26	52	26	3.8	7	12	27
2000	45	24	29	35	2.7	10	8	31
2001	44	25	38	34	3.7	10	8	28
2002	35	27	42	39	3.2	10	7	31
2003	29	24	36	41	4.5	11	4	25
2004	31	21	33	52	3.8	9	5	20
2005	32	20	43	39	5.0	9	9	22
2006	33	19	49	38	6.8	9	6	20
2007	37	19	42	35	5.6	11	14	23

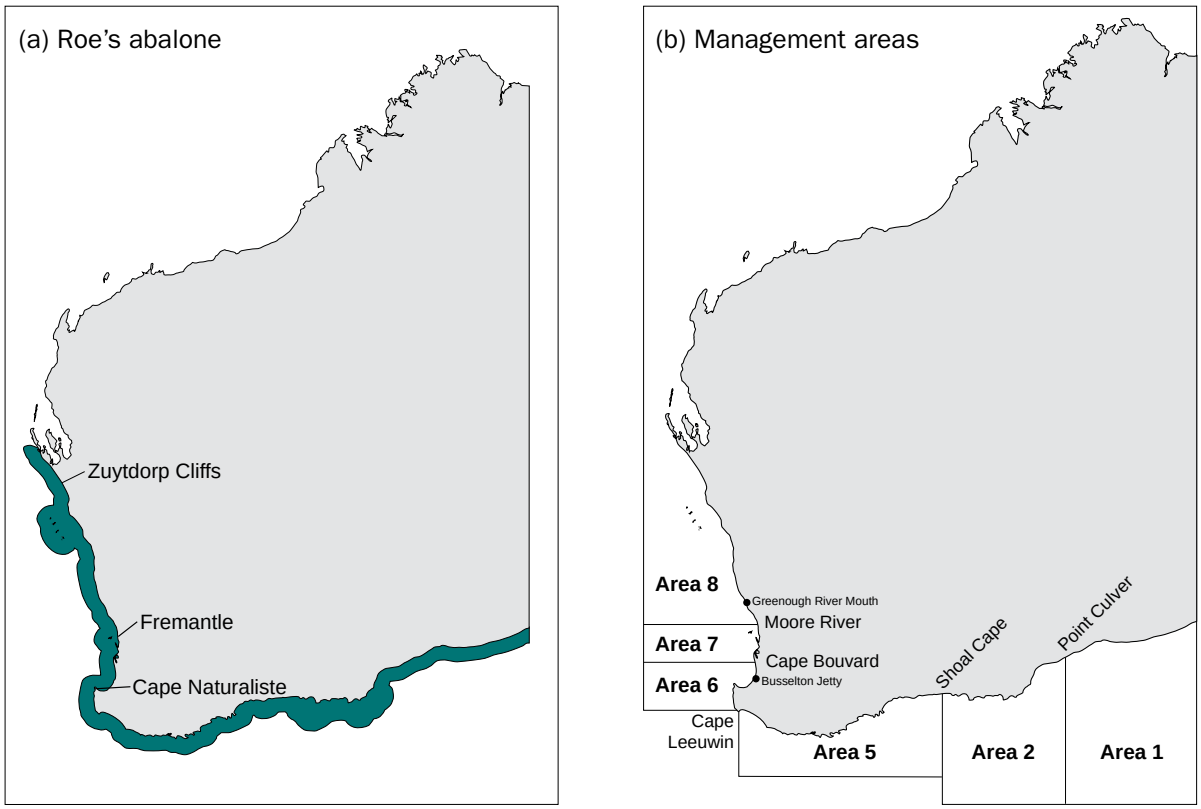
ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2006.

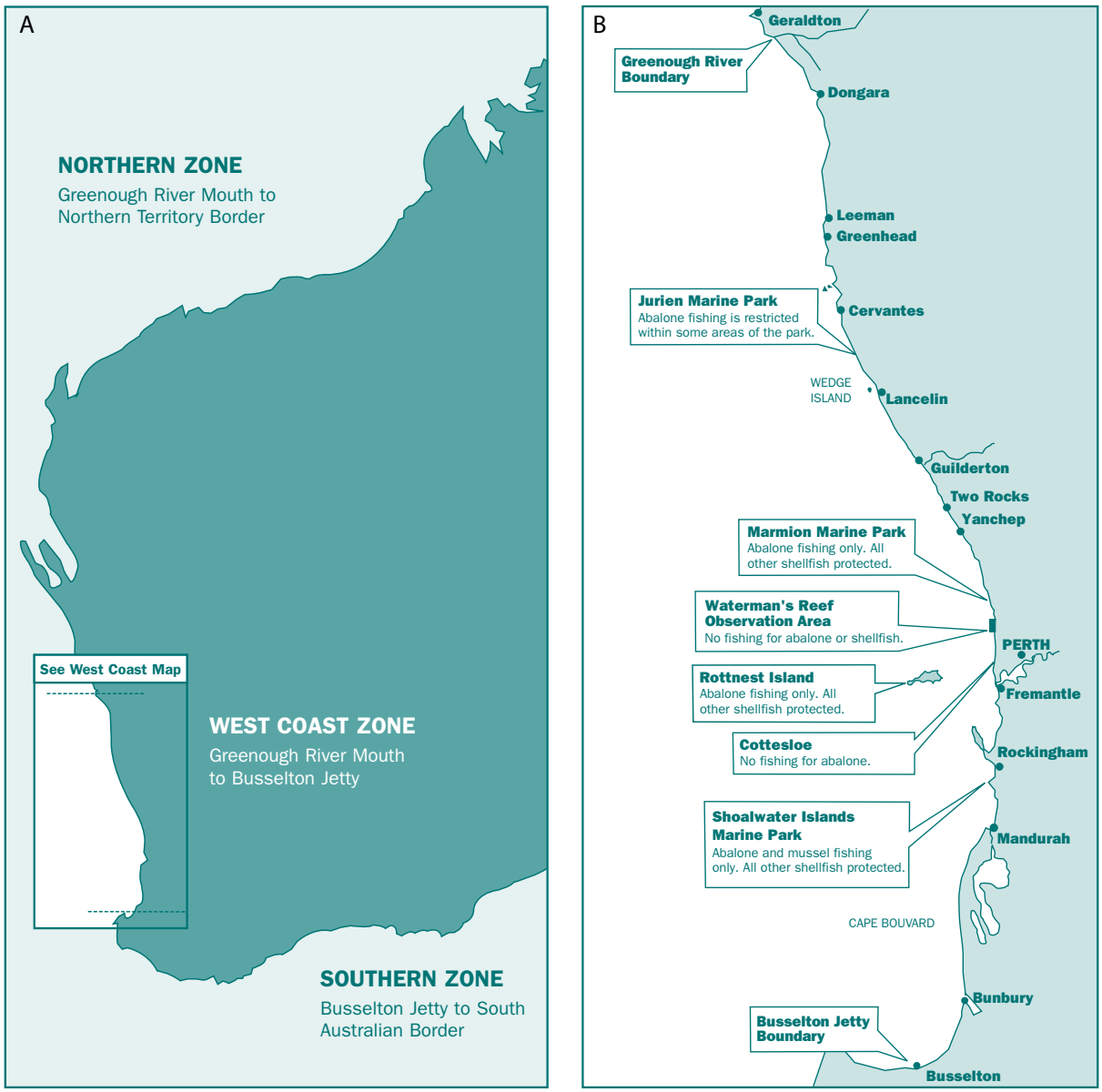
Performance Indicator	Performance Measure[1]	2006 Values	Assessment/Comments
Area 1			
Total catch (TACC)	9,900 kg	1,196	Exploratory quota – only a small percentage caught due to poor weather.
Total effort (diver days)	14 – 43	10	See above.
Area 2			
Total catch (TACC)	19,800 kg	19,635	Met – 99% of quota caught.
Total effort (diver days)	80 – 106	78	Met – within agreed level.
Area 5			
Total catch (TACC)	20,000 kg	17,582	Not met – 88% of quota caught.
Total effort (diver days)	100 – 140	98	Met – within agreed level.
Area 6			
Total catch (TACC)	12,000 kg	12,266	Met – 98% of quota caught.
Total effort (diver days)	80 – 127	110	Met – within agreed level.
Area 7			
Total catch (TACC)	36,000 kg	35,405	Met – 98% of quota caught.
Total effort (diver days)	175 – 215	196	Met – within agreed level.
Area 8			
Total catch (TACC)	15,000 kg	11,963	Not met – 80% of quota caught.
Total effort (diver days)	140 – 200	139	Met – within agreed level.

1. Note that these effort ranges (totalling 589 – 831 days) differ from the range presented in the governance section because they are spatially standardised, whereas the governance ranges are averaged over the entire fishery.

The Perth metropolitan Roe's abalone licensed fishery in full swing.

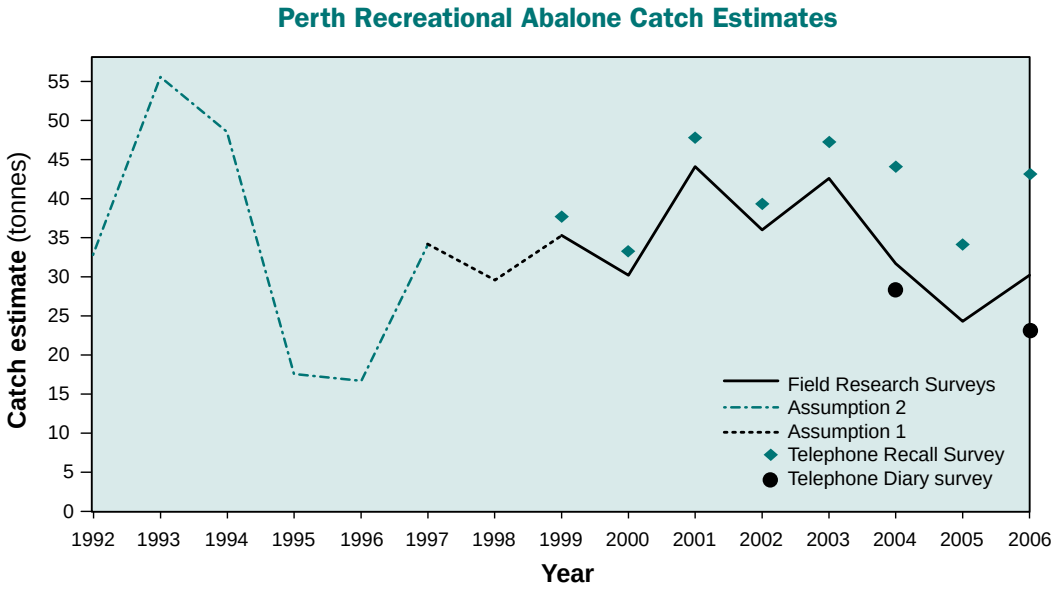


ROE'S ABALONE FIGURE 1
Maps showing (a) the distribution of Roe's abalone in Western Australia, and (b) the management areas used to set quotas for the commercial fishery.



ROE'S ABALONE FIGURE 2

Maps showing (a) the recreational fishing boundaries for abalone, and (b) the West Coast (Perth Fishery) zone, showing conservation areas within this zone.



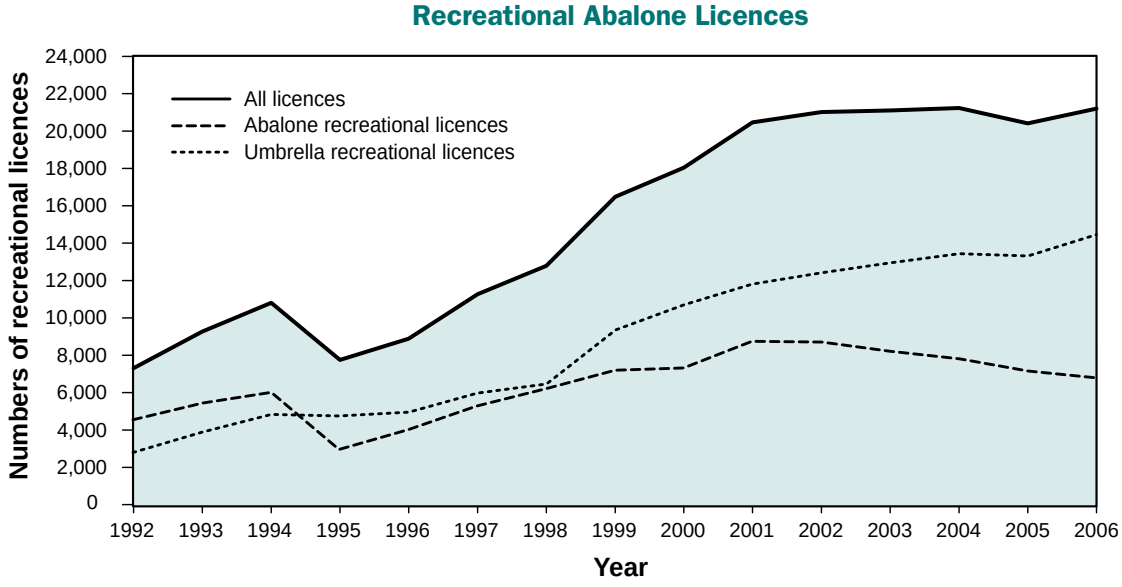
ROE'S ABALONE FIGURE 3

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2006, including backwards projections through time based on 2 assumptions.

Assumption 1: assumes that the mean weight of abalone taken during 1997 and 1998 is equal to the average of the 2 mean weight values measured for 1999 and 2000 (i.e. 91.6 g, averaged from 92 g in 1999 and 91.3 g in 2000). Numbers caught are estimated using the field survey technique (Roe's Abalone Table 3).

Assumption 2: assumes that effort from 1992 to 1996 is the average percentage of the potential effort utilised for the years 1997 to 2000; that the catch rate for the years 1992 to 1996 is the average of the annual catch rates for the years 1997 to 2000; and that the mean weight of abalone taken from 1992 to 1996 is the same as applied to 1997 and 1998 in Assumption 1.

Note that the recreational season totalled 16 days in 1993, 12 days in 1992 and 1994, 5 days in 1996 and 6 days in 1995 and 1997–2006. In 1992 – 1994, fishing was permitted for 2 hours per season day (7 a.m. to 9 a.m., Saturdays and Sundays). From 1995 – 2005, permissible fishing time per season day was 1.5 hours (7 a.m. to 8.30 a.m., Sundays only). In 2006, permissible fishing time per season day was 1 hour.



ROE'S ABALONE FIGURE 4

The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2006.

Abrolhos Islands and Mid West Trawl Managed Fishery

E. Sporer, M. Kangas and R. Allen
Management input from S. O' Donoghue

Fishery Description

The Abrolhos Islands and Mid West Trawl Managed Fishery (AIMWTF) is based on the take of southern saucer scallops *(Amusium balloti),* with a small component targeting the western king prawn *(Penaeus latisulcatus)* in the Port Gregory area. The catch is taken using otter trawls.

Governing legislation/ fishing authority

Abrolhos Islands and Mid West Trawl Management Plan 1993
Abrolhos Islands and Mid West Trawl Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are 'all the waters of the Indian Ocean adjacent to Western Australia between 27°51′ south latitude and 29°03′ south latitude on the landward side of the 200 m isobath'.

Management arrangements

The AIMWTF operates under an input control system, with restrictions on boat numbers and trawl gear size as well as seasonal closures and significant spatial closures protecting all near-shore waters. From 2006, the fishery also operated to an agreed minimum catch rate of 250 kg (meat weight) per 24 hours' trawling (fleet average).

The fishing gear (net size) in this fishery is unitised, with one headrope unit being equivalent to 4 fathoms (7.32 m) – a total maximum headrope length of 184 fathoms. In 2006, the scallop season officially opened on 6 April and closed on 6 June. The Port Gregory prawn trawl area of the fishery opened on 28 April and closed on 6 June.

Bycatch reduction devices to release large species are fully implemented in the AIMWTF as a licence condition. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats.

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of the target scallop species. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research monitoring of the scallop stocks in the fishery is undertaken using fishers' monthly returns data. Detailed research log books, validated by processor returns, must be completed for all boats in the fishery. These, together with an annual pre-season survey, provide the information required for assessing the fishery. Advice on the status of stocks and appropriate season opening and closing dates is provided to the fishing industry.

Retained Species

Commercial Landings (season 2006):
205 tonnes whole weight

The total landings for the 2006 season were 205 t whole weight (41 t meat weight) of scallops (Abrolhos Islands Scallop Figure 1). The predicted catch range for the 2006 season, based on a pre-season survey, indicated a low catch of scallops, between 250 and 500 t whole weight. The total landings were below the predicted catch range.

Recreational catch: **Nil**

Fishing effort/access level

For the 2006 season, 14 of the 16 licensed boats operated in the fishery, resulting in a total of 176 fathoms of net headrope (out of a maximum of 184 fathoms) being used. The swept area for this season was a total of 23 square nautical miles (adjusted to standardised effort).

A total of 879 trawl hours (nominal effort) were recorded for the 2006 season, equivalent to 776 standardised trawl hours (standardised to 14 fathoms headrope length) (Abrolhos Islands Scallop Figure 1). The effort in fishing days represents a fishing season of 9 days' duration in 2006, compared to 85 days in 2005. The fleet ceased fishing by 16 April.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Projected catch next season (2007):
150 – 225 tonnes whole weight

The catch rate in 2006 was 262 kg/hr (whole weight, standardised effort), compared with approximately 972 kg/hr for 2005. This reflected the low abundance of scallops located within a smaller area in 2006 compared to 2005.

This fishery is highly variable, being dependent on sporadic recruitment which appears to be strongly influenced by environmental conditions, e.g. the Leeuwin Current. A pre-season recruitment survey is undertaken annually. A relationship between catch rates during surveys and subsequent catch is evident.

Due to the patchy spatial distribution of recruits, it is not possible for pre-season surveys to cover all potential settlement areas, particularly in high abundance years. Therefore, the catch projection is for the areas covered by the survey only. In years

Abrolhos Islands' seascape.

when recruitment settlement is widespread, the prediction is likely to be conservative. In years when recruitment is low, the total catch is dependent on the level of effort that is applied.

This season's predictions were confounded because 1 survey tow provided very high scallop numbers that biased the data, resulting in an abnormally high index and catch prediction. Therefore the survey catch rate average for this area was adjusted, which resulted in a lower predicted overall catch range for the season of 250 to 500 t whole weight.

For 2007, the catch prediction, determined using all survey data, is expected to be low again, in the range of 150 – 225 t whole weight. Additional catches may be achieved in areas not covered by the survey.

The annual fishing season is managed so that the majority of the mature scallops are able to spawn before fishing occurs. Breeding stocks are therefore protected, ensuring recruitment is dependent only on environmental conditions each year.

Specified areas were closed to scallop fishing towards the end of the season because of the high numbers of small scallops observed. This initiative was the result of collaboration between the Department of Fisheries' Research Division and industry to protect areas of small scallops, which will contribute to the catch and the breeding stock abundance in the following year.

The main performance measure for the fishery relates to maintaining breeding stocks of scallops by setting season length according to the residual stock index. The 2006 fishing season was set at 2 months, consistent with the low yield predicted from the survey in November 2005. Hence, the breeding stock indicator was met.

Non-Retained Species

Bycatch species impact: **Low**

The trawl fleet operates over a small portion of the licensed fishing area, focusing on scallop aggregations on the relatively bare sand habitat associated with this species. In 2006, the total area of the fishery that was fished by scallop boats was approximately 2%. The maximum area coverage has been 11%, which occurred during the 2003 season when the scallops were widespread and in very high abundance.

Since 2002 the coverage has been 4% or less, except for the 2003 season. Owing to the focused nature of this fishery, the confined area fished in 2006 and the large mesh size (100 mm), little bycatch was taken during the fishing season.

Protected species interaction: **Low**

While turtles do occur in the Abrolhos Islands, these species are towards the southern extent of their range, and do not breed in the Abrolhos Islands area because water temperatures are too low. Consequently, interactions with turtles have always been minimal. Now that grids are compulsory in the fishery, their capture should be eliminated. No records of turtle captures were made in 2006. Few other protected species occur in this area.

Ecosystem Effects

Food chain effects: **Low**

The total biomass taken by this fishery is generally very small. Moreover, due to the high natural variability of scallop stock abundance, it is unlikely that any predators are highly dependent on this species.

Habitat effects: **Low**

The fishers generally operate over a very small proportion (approximately 4% on average) of the licensed area and therefore the total area impacted by trawling is small. Trawling was not extensive during 2006 and was confined to trawl grounds of high scallop abundance, rather than occurring throughout the fishery.

The areas associated with scallops are sandy habitats and trawling activity does not impact these significantly. An underwater survey was undertaken by the Department of Fisheries in 1994 to delineate trawlable sand habitats in the Abrolhos Islands and trawling is largely contained within these areas.

Social Effects

This scallop fishery utilises large crews of up to 13 per boat to carry out on-board processing during the short period of fishing that occurs during the season. During the 2006 season, crew numbers were restricted to 8. The estimated employment in the fishery for the year 2006 was 112 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$0.7 million**

The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $3.50/kg whole weight or $17.50/kg meat weight. Meat weight is approximately 20% of the whole weight.

Fishery Governance

Target catch range: **95 – 1,830 tonnes whole weight**

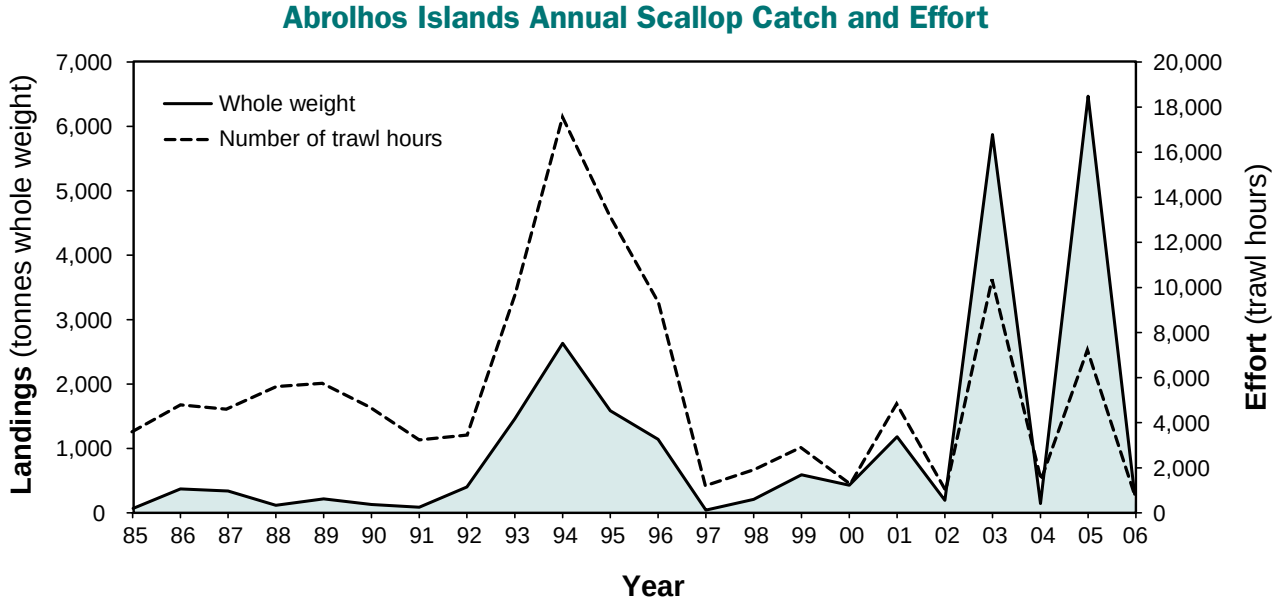
Apart from the exceptional catches of the mid-1990s, 2003 and 2005, which were due to beneficial environmental conditions increasing the success of recruitment, the historic catch range for this fishery is 95 – 1,830 t whole weight. The catch in 2006 was predicted to be within the lower part of this range, due to the survey showing low pre-season recruitment.

New management initiatives (2006/07) **None**

External Factors

The high level of recruitment seen in late 2002 and 2004, following very low catch in previous seasons and then by another low recruitment in 2005, highlights the dependence of successful recruitment upon environmental conditions, such as the state of the Leeuwin Current, rather than spawning stock levels. It also illustrates the extreme level of annual variability in recruitment.

As more years of pre-season survey and fishing season catch and effort data become available, the relationship between environmental factors and recruitment success can be further evaluated, providing a better understanding of the scallop fishery.



ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2006.

South West Trawl Managed Fishery Status Report

M. Kangas
Management input from S. O'Donoghue

Fishery Description

This fishery includes 2 of the state's smaller scallop fishing grounds – Fremantle and Geographe Bay. It is a multi-species fishery which targets western king prawns (*Penaeus latisulcatus*) and saucer scallops (*Amusium balloti*) using otter trawls.

Governing legislation/fishing authority

South West Trawl Management Plan 1989
South West Trawl Managed Fishery Licence

Consultation

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are 'all the waters of the Indian Ocean adjacent to Western Australia between 31°43′27″ south latitude and 115°08′ east longitude where it intersects the high water mark at Cape Leeuwin, and on the landward side of the 200 m isobath'.

The area is further divided into 4 management zones, with a limited number of operators (indicated in brackets) permitted access to fish within each zone as follows:

Zone A	from 31°43′27″ S to 32°16′ S	(3 boats)
Zone B	from 32°16′ S to 115°08′ E	(12 boats)
Zone C	north-east of Cape Naturaliste	(0 boats)
Zone D	Comet Bay off Mandurah	(3 boats)

Management arrangements

The fishery is managed under an input control system, limiting boat numbers, gear sizes and fishing areas. A total of 14 boats are licensed to operate in this fishery, some in more than 1 zone. Zone A and B boats may fish between 1 January and 15 November and Zone D boats can fish all-year-round.

Access to Zone C ceased, following a Fishery Adjustment Scheme in which all 4 authorisations were removed prior to the 2003 season. The management plan also includes large closures to protect sensitive coastal habitats (including seagrass beds) and fish nursery areas such as Cockburn Sound, Warnbro Sound and inshore Geographe Bay.

Research summary

Research monitoring of the scallop stocks in this fishery is undertaken using fishers' monthly returns data.

Retained Species

Commercial production (season 2006): Prawns 8 tonnes
Scallops < 1 tonne (whole weight)

Landings

The total landings for the season were 8 t of western king prawns and less than 1 t (whole weight) of scallops. The catch of king prawns was 40% down on the catch of 2005, while the scallop catch was very low, similar to 2005.

The fishery also lands a mixture of by-product species, of which the most abundant species recorded was 5 t of blue swimmer crabs (*Portunus pelagicus*) and 1 t of western sand whiting. All other landings of by-product species were less than 1 t each.

Fishing effort/access level

A total of 153 days were recorded as being fished. This is the lowest effort recorded in the fishery since 2002 and reflects the high cost of fishing and low catches.

Recreational component: Nil

Stock Assessment

Assessment complete: Not assessed

Exploitation status: Not assessed

Breeding stock levels: Not assessed

Non-Retained Species

Bycatch species impact: Low

Trawling for scallops is focused on a few small offshore areas, while the prawn catch is mainly taken from Comet Bay. An extensive study (Laurenson *et al.* 1993b) of the environmental effects of this fishery has shown that the fishery has minimal impact on bycatch species populations.

Protected species interaction: Negligible

Protected species susceptible to capture by trawling do not occur regularly in this fishing area.

Ecosystem Effects

Food chain effects: Low

The food chain effects are considered to be low owing to the low overall exploitation rate and the very small percentage (less than 5%) of the fishing area within the legislated boundary that is trawled annually.

Habitat effects: Low

Laurenson *et al.* (1993b) concluded that the fishery has minimal impact on the benthic sand habitats involved.

Social Effects

The estimated employment in the fishery for the year 2006 was 8 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2006:
Prawns $102,000
Scallops negligible

***Prawns*:** Wholesale prices for prawns vary depending on the type of product and the market forces operating at any one time. Generally, prices for king prawns averaged $12.50/kg.

***Scallops*:** The estimated value of the catch has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $3.40/kg whole weight or $17/kg meat weight. Meat weight is approximately 20% of the whole weight.

Fishery Governance

Acceptable catch range for next season: **Not available**

New management initiatives (2006/07)

Although a legislative amendment to provide for the introduction of the vessel monitoring system has been approved, it has continued to be 'on hold' pending resolution of a number of issues.

External Factors

The level of fishing activity and quantity of catch within the South West Trawl Managed Fishery is variable. This variability has largely been driven by the level of scallop recruitment to these grounds and also the product price paid to fishers, as well as the rising costs of fishing. Variations in recruitment are naturally high in scallop stocks, and in other Western Australian scallop fisheries are thought to be related to the flow of the Leeuwin Current.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from C. Syers

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth.

The majority of the commercially and recreationally fished stock, however, is concentrated in the coastal embayments between Geographe Bay in the south and Port Hedland in the north. Crabbing activity in the West Coast bioregion is centered largely on the estuaries and coastal embayments from Geographe Bay north to the Swan River and Cockburn Sound.

Blue swimmer crabs account for nearly all of Western Australia's commercial inshore crab landings, with more than 3-quarters of the annual catch traditionally coming from Shark Bay and Cockburn Sound.

Blue swimmer crabs are targeted using a variety of fishing gear. Originally, commercial crab fishers in WA used set (gill) nets or drop nets, but most have now converted to purpose-designed crab traps. The State's prawn and scallop trawl fisheries also retain crabs as a by-product.

Blue swimmer crabs are commonly targeted by recreational fishers, particularly in the estuaries and bays between Albany and Fremantle, and around Nickol Bay in the Pilbara region. They represent the most important recreational inshore species in the south-west of Western Australia in terms of numbers caught. While the majority of recreational fishers use either drop nets or scoop nets, diving for crabs is becoming increasingly popular.

This report is based on the blue swimmer crab fishery in the West Coast bioregion and there are separate reports for fisheries in the Gascoyne and North Coast bioregions.

Governing legislation/fishing authority

West Coast Estuarine Fishery (Interim) Management Plan 2003
Cockburn Sound (Crab) Management Plan 1995
Warnbro Sound (Crab) Management Plan 1995
Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994
Exemptions under Section 7 of the *Fish Resources Management Act 1994*

Consultation process

Meetings between the Department of Fisheries and industry
Meetings between the Department of Fisheries and the Recreational Fishing Advisory Committee and RecFishWest

Boundaries

The Cockburn Sound (Crab) Managed Fishery encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.

The Warnbro Sound (Crab) Managed Fishery includes Warnbro Sound itself and adjacent waters, extending from Becher Point to John Point.

The West Coast Estuarine Fishery encompasses the waters of the Swan and Canning Rivers, located in the Perth metropolitan area, and the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers, located in the Mandurah region.

The Mandurah–Bunbury Inshore Crab Fishery covers the waters south of the Shoalwater Islands Marine Park (32°22′40″ S) to just north of 'The Cut' (33°18′ S), and offshore to 115°30′ E. The fishery is further divided into a northern zone with one 80-pot exemption (the Comet Bay Oceanic Crab Pot Trial zone) and a southern zone with 4 60-pot exemptions (waters between Cape Bouvard and the southern boundary of the fishery). The area separating the 2 zones is closed to commercial fishing.

The former Geographe Bay fishery covered the waters south of a line drawn from the north-west tip of Cape Naturaliste to McKenna Point lighthouse in Bunbury. This commercial fishery was officially closed on 21 January 2005 to reduce conflict between the recreational and commercial fishing sectors.

Commercial fishing in the Leschenault Estuary at Australind ceased in 2000.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications and seasonal and daily time restrictions (West Coast Blue Swimmer Crab Table 1).

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Except for males at Shark Bay, which mature at 115 mm carapace width (CW), blue swimmer crabs become sexually mature below 100 mm CW. The legal minimum size range varies between 127 – 130 mm CW in the fisheries of the West Coast bioregion, well above the size at sexual maturity.

Recreational fishing for blue swimmer crabs in Western Australia is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity. A minimum legal size limit of 127 mm CW applies in State waters, along with a bag limit of 20 crabs per person or 40 crabs per boat in 2005/06. Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures.

A voluntary Fisheries Adjustment Scheme resulted in the number of licenses in the Swan/Canning River (Area 1 of the West Coast Estuarine Fishery) being reduced from 4 to 2 at the start of the 2005/06 season. The current government policy to phase-out commercial fishing the Swan/Canning Estuary is likely to result in the establishment of further adjustment schemes in the future.

Research summary

Data for the assessment of blue swimmer crab stocks in the West Coast bioregion are obtained from a variety of sources. Commercial catch and effort and catch population dynamics are assessed using fishers' compulsory catch and effort returns, voluntary daily log books from fishers in the Mandurah to Bunbury developing fishery, and data from on-board catch monitoring conducted by the Department of Fisheries' research staff.

Trawl programs using both *RV Naturaliste* and *RV Snipe* provide information on the status of the spawning stock and subsequent strength of recruitment, along with data on the general crab population. Additional information on the biology and ecology of blue swimmer crabs has been provided by a number of projects funded by the Fisheries Research and Development Corporation (FRDC) and conducted by the Department of Fisheries and Murdoch University.

An FRDC project completed in 2005 developed a catch prediction model for the Cockburn Sound blue swimmer crab fishery that forecasts future commercial catches in the fishery.

Research funding (from the Development and Better Interest Fund) was obtained in 2006 to:

a. examine the genetic difference between the Cockburn Sound stock with that in Warnbro Sound and the Swan River;

b. undertake recreational surveys in the Peel-Harvey; and

c. undertake commercial monitoring of the fleet in the West Coast Estuarine, Warnbro Sound and Mandurah-Bunbury fisheries.

Retained Species

Commercial landings (season 2005/06): 160 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2005/06 was 896 t (West Coast Blue Swimmer Crab Figure 1). This represents a 13% decrease from the record of 1,033 t taken in 2004/05, primarily due to a reduction in take by the Shark Bay trawl fleet and a further fall in catch from the Cockburn Sound crab fishery. Total landings for the West Coast Bioregion during this period also declined 29% from 225 t in 2004/05 to 160 t in 2005/06.

The commercial catch from dedicated trap fishers in Cockburn Sound for the 2005/06 season was 53 t, representing a 37% decrease from the previous year. It is the lowest catch in over 20 years and again fell well below the target annual catch range of 200 – 350 t (West Coast Blue Swimmer Crab Figure 2). The lower than expected catch in 2005/06 is primarily due to reduced fishing effort in response to low stock abundance, with almost all commercial fishing ceasing in May.

The commercial catch from the Peel/Harvey Estuary (Area 2 of the West Coast Estuarine Fishery) for 2005/06 was 72 t – a slight decrease from the 79 t taken in 2004/05 (West Coast Blue Swimmer Crab Figure 3).

A 22% reduction in catch was reported by the commercial fishers in the Mandurah to Bunbury Experimental Crab Fishery during 2005/06, with landings of 17 t of blue swimmer crabs compared with 22 t the previous year (West Coast Blue Swimmer Crab Figure 4).

While catch and effort levels in the second half of 2005 were within normal ranges, illness and a focus by fishers on other endorsements led to little effort being expended in the crab fishery during the first half of 2006.

Trawlers operating in Comet Bay off Mandurah landed 4.7 t of blue swimmer crabs during 2005/06, an increase from 1.6 t in 2004/05. A further 22 t of blue swimmer crabs were caught in the remaining areas of the West Coast Bioregion during 2005/06(West Coast Blue Swimmer Crab Figure 1).

Recreational catch: (approximately) 60% of total catch

Most of the recreational blue swimmer crab fishing in Western Australia occurs in the West Coast bioregion. Departmental surveys have estimated recreational catches of blue swimmer crabs in this bioregion to be about 60% of the total catch.

The recreational take was dominated by catch from the Peel/Harvey Estuary, where surveys in 1998/99 estimated the catch made by the recreational sector to be 289 t. Recent surveys produced recreational catch estimates for Cockburn Sound of 18 t, 23 t and 18 t for the 2002, 2003 and 2004 calendar years respectively.

The Cockburn Sound recreational fishing surveys have shown that catch share agreements were initially successful in increasing the proportional share of total blue swimmer crab catches taken by the recreational sector – from 8% between September 1996 and August 1997 to 15% between September 2001 and August 2002. However, the estimated proportion taken by the recreational sector declined to 9% in 2003 and was 12% in 2004.

A 12-month survey of recreational fishing in the Swan/Canning Estuary Basin conducted between August 1998 and July 1999 estimated a total recreational blue swimmer crab catch of 7.3 t. In the 1998/99 financial year, 24 t of blue swimmer crabs were caught in the Swan/Canning commercially, and in subsequent years commercial catches have ranged between 10 t and 20 t while no further recreational surveys have been undertaken.

Commercial fishing for blue swimmer crabs in Geographe Bay was prohibited from January 2005. This fishery is now exclusively for recreational use.

Fishing effort/access level

Effort in the Cockburn Sound Crab Fishery decreased during 2005/06 to its lowest level since moving to a trap fishery as result of the decline in abundance of blue swimmer crabs. Commercial crab fishers reported 109,138 trap lifts – an almost 30% decrease from the 153,365 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 2).

Commercial fishers in the Peel-Harvey Estuary maintained a similar level of fishing pressure during 2005/06 as in the previous year, with a slight reduction in effort reflecting a similar decrease in landed catch. A total of 54,522 trap lifts were reported in the fishery during 2005/06, marginally less than the 59,762 trap lifts reported for 2004/05 (West Coast Blue Swimmer Crab Figure 3). The annual fishing effort in the estuary has been found to follow variations in the abundance of the resident crab stock.

There was a 41% reduction in effort by commercial fishers in the Mandurah to Bunbury Experimental Crab Fishery during 2005/06, reporting a total of 12,200 trap lifts compared to 20,792 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 4).

While effort levels in the second half of 2005 were within normal ranges, there was little effort expended in the crab fishery during the first half of 2006 due to a number of factors unrelated to this fishery.

Stock Assessment

Assessment complete: Yes

Breeding stock level:

Cockburn Sound: Indequate

Other West Coast Fisheries: Adequate

Catch rates from fisheries within the West Coast Bioregion provide an index of abundance that can be used to assess individual fishery performance from year to year.

The mean catch rate for the Cockburn Sound Crab Fishery during 2005/06 was 0.48 kg/trap lift, marginally down on the 2004/05 catch rate of 0.54 kg/trap lift (West Coast Blue Swimmer Crab Figure 2). The catch rates represent a dramatic fall from the mean catch rates of 1.0 – 1.4 kg/trap lift experienced in the late 1990s.

Historically, commercial blue swimmer crab fishers in Cockburn Sound have experienced large fluctuations in annual catch (e.g. 362 t in 1996/97 versus 92 t in 2001/02), with variations in effort reflecting variations in stock abundance. Inter-annual variations observed since 1977 are presumably related to variable recruitment, while the shift by commercial fishers to move from set nets to crab traps in 1993/94 coincided with a marked increase in average total crab landings by the late 1990s.

A preliminary stock-recruitment-environment relationship has been developed to investigate the factors affecting recruitment. The high yields between 1996 and 2003 are not considered to have initiated the Cockburn Sound crab stock collapse because, even at these levels of fishing, egg production was adequate.

The minimum legal size for both the commercial and recreational crab fishery (130 mm carapace width (CW) and 127mm CW respectively) are set well above the size at sexual maturity (98mm CW), allowing crabs to spawn at least once before entering the fishery. But it appears that 3 years of reduced recruitment since 2003, most likely due to unfavourable environmental conditions, coupled with continued high levels of fishing pressure, has resulted in a significant reduction in the levels of relative egg production.

Since the introduction of traps, crab catches have increased significantly over the winter months (April to September), which had traditionally (prior to the introduction of the traps in the 1990s) been a period of minimal effort as the inclement weather meant gillnets could not be used. Length frequency analysis has shown that catches in these months are predominantly females, further jeopardising the potential for egg production in the fishery by removing this stock before their second year of spawning.

Research trawling has been conducted in Cockburn Sound since 1999 to collect data on juvenile blue swimmer crab abundance for the development of a catch prediction index. The numbers of recruits recorded from this research correlate strongly with catch levels the following year.

Sampling in 2006 found a lower abundance of recruits than experienced between 2003 and 2005 and hence catches in 2006/07 were predicted to be very low. Because of this low recruitment and the need to build up the spawning stock, the 2006/07 season was closed to commercial and recreational crab fishing.

The experience gained from this stock collapse will add considerable value to the understanding of blue swimmer crab stock management, which will prove beneficial in determining the way that crab fisheries in Cockburn Sound and elsewhere in the State are managed in the future.

The commercial catch from the Peel/Harvey estuarine system is relatively small compared to the recreational catch, which traditionally accounts for around 70% of total landings. However, the commercial catch does provide a useful tool to monitor the status of the resident crab stocks.

The annual commercial 'catch and effort' achieved since the introduction of traps has been relatively stable, with landings in the order of 50 – 80 t and effort from 45 to 60,000 trap lifts. This stability is further reflected in mean CPUE, as the level of effort is largely driven by stock abundance, which in turn is a reflection of recruitment to the fishery.

The mean catch rate for the 2005/06 financial year was 1.33 kg/trap lift (West Coast Blue Swimmer Crab Figure 3) – almost identical to the 1.32 kg/trap lift recorded the previous year. Other than 2002/03 (1.06 kg/trap lift), catch rates for the past 6 years have been markedly consistent at between 1.3 and 1.4 kg/trap lift.

Trap catch rates in the Mandurah to Bunbury Experimental Crab Fishery have increased steadily since the commencement of exploratory fishing along the coast south of Mandurah to Bunbury, reflecting the more efficient fishing of blue swimmer crab stocks in the region as the commercial operators' knowledge of the spatial distribution of resident stocks and localized environmental influences increased over time. The mean catch rate for 2005/06 in the Mandurah to Bunbury fishery was 1.03 kg/trap lift (West Coast Blue Swimmer Crab Figure 4) – a marginal increase on the 2004/05 catch rate of 0.98 kg/trap lift.

Non-Retained Species

Bycatch species impact: **Negligible**

The shift from using gillnets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these stocks.

Discarded bycatch from trawl fisheries taking crabs as a by-product is dealt with in the status reports that are specific to each trawl fishery.

Protected species interaction: **Negligible**

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

Ecosystem Effects

Food chain effects: **Low**

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually and subject to high levels of natural variation in abundance, secondary food chain effects are likely to be minimal in these fisheries.

Habitat effects: **Negligible**

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macrobenthos.

Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Social Effects

During 2005/06, approximately 33 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion. This is a highly popular recreational fishery, particularly in the Peel-Harvey and Geographe Bay regions.

Checking a blue swimmer crab is legal size.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: $0.7 million

The value of blue swimmer crab fishing across the state for the 2005/06 season was estimated to be $4 million, with the West Coast bioregion valued at $0.7 million. This total represented a 13% decrease on the $4.6 million generated in 2004/05.

Despite the smaller state catch in 2005/06, beach prices for blue swimmer crabs remained between $4/kg and $6/kg live weight in the major fisheries, with the average price for the year around $4.50. The catch from the West Coast bioregion was sold largely through local markets.

Fishery Governance

Target catch (or effort) range **Under review**

For the managed fishery in Cockburn Sound, the commercial target range under the previous management regime was 200 – 350 t. This range is based on catches in the 5-year period from 1995/96 to 1999/2000, after the fishing effort was converted to trapping.

However, the fishery has subsequently undergone further effort reductions since this time. Viewed in the light of recent recruitment failures to the fishery, this current target range will need to be reviewed once the fishery is re-opened.

Current fishing (or effort) level:

Cockburn Sound: **Under review**

Other West Coast Bioregion fisheries: **Under review**

The level of commercial and recreational fishing effort in Cockburn Sound will be considered as part of a comprehensive review of commercial and recreational fishing effort.

While the current level of commercial fishing effort in the Peel-Harvey Estuary is considered to be at a sustainable level, concerns have been raised over anecdotal reports of increases in the level of recreational fishing effort. An application has been approved to fund research surveys aimed at quantifying current recreational catch and effort in the Peel-Harvey Estuary in 2007 and 2008. Subsequently, the level of commercial and recreational fishing effort considered acceptable in the estuarine system will be determined after the survey work has been completed.

The current level of effort in the Mandurah to Bunbury Experimental Crab Trap Fishery is under review.

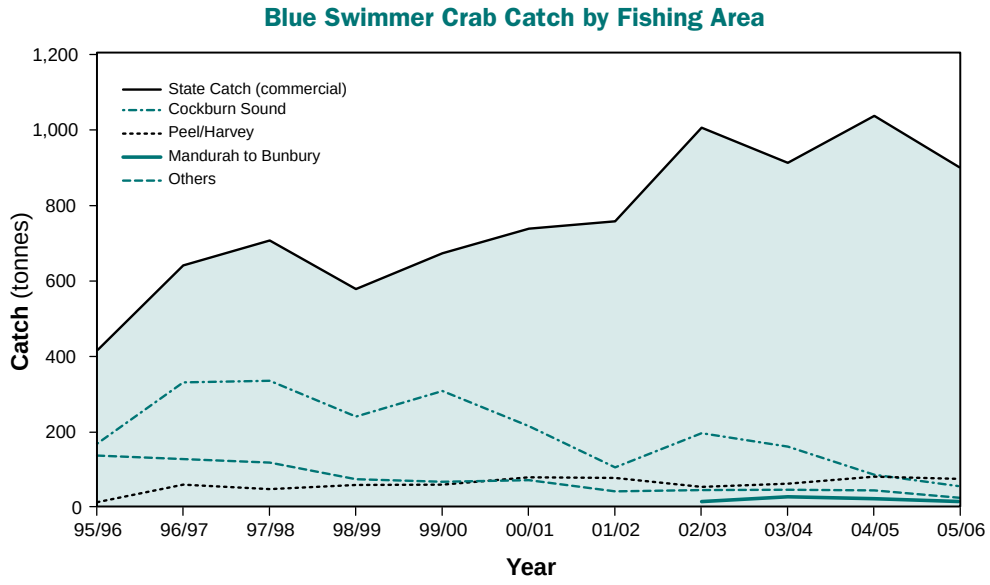
New management initiatives (2006/07)

In response to the decline of the crab stocks in Cockburn Sound, the Minister for Fisheries closed the Cockburn Sound crab fishery to both recreational and commercial fishing on 15 December 2006. The closure was implemented under Section 43 of the *Fish Resources Management Act 1994* for a period of at least 12-months to enable levels of breeding stock to rebuild.

In response to community concerns over the perceived status of the crab stock in the Peel Harvey Estuary and given the events in Cockburn Sound, the Minister approved funding for a dedicated crab research projected commencing in early 2007.

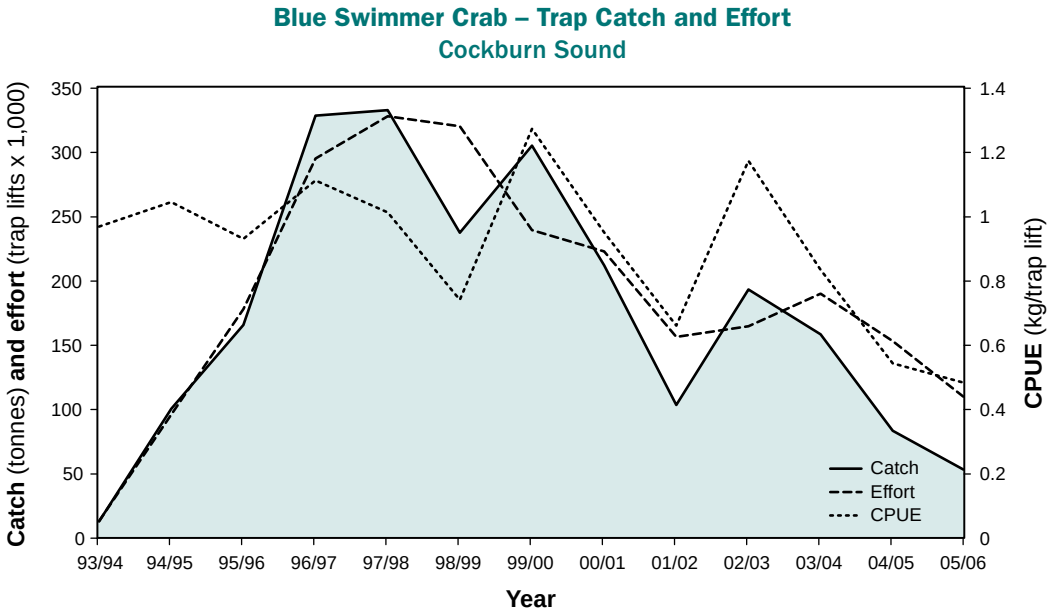
External Factors

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of this variation are not fully understood, it is considered most likely due to environmental influences on larval survival. The relationship between environmental factors, recruitment and catch will be further evaluated as data becomes available.



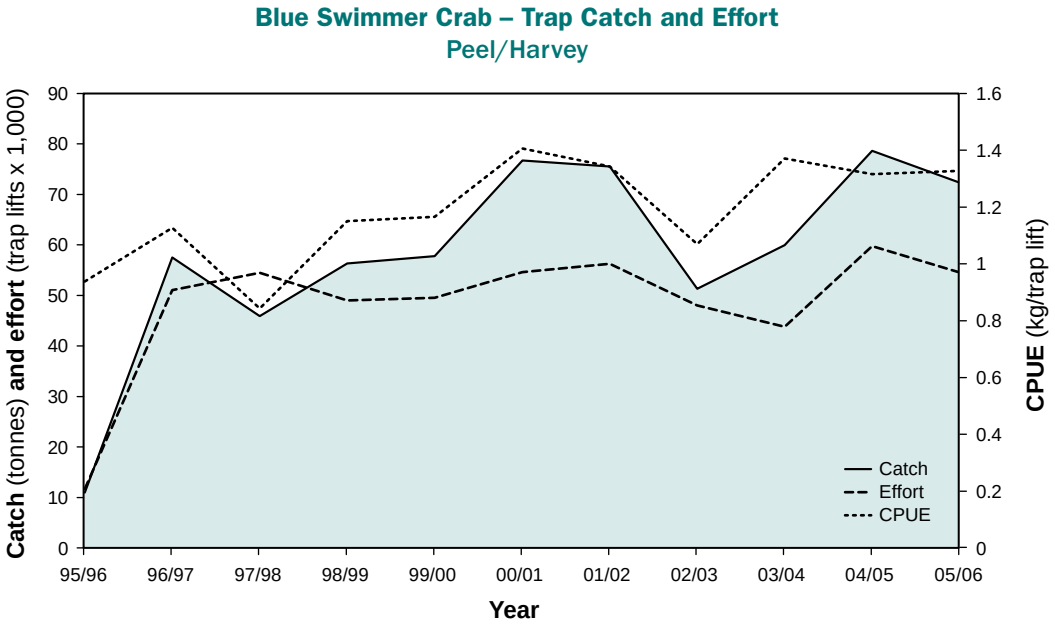
WEST COAST BLUE SWIMMER CRAB FIGURE 1

Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia compared with fisheries in the West Coast bioregion between 1995/96 and 2005/06.



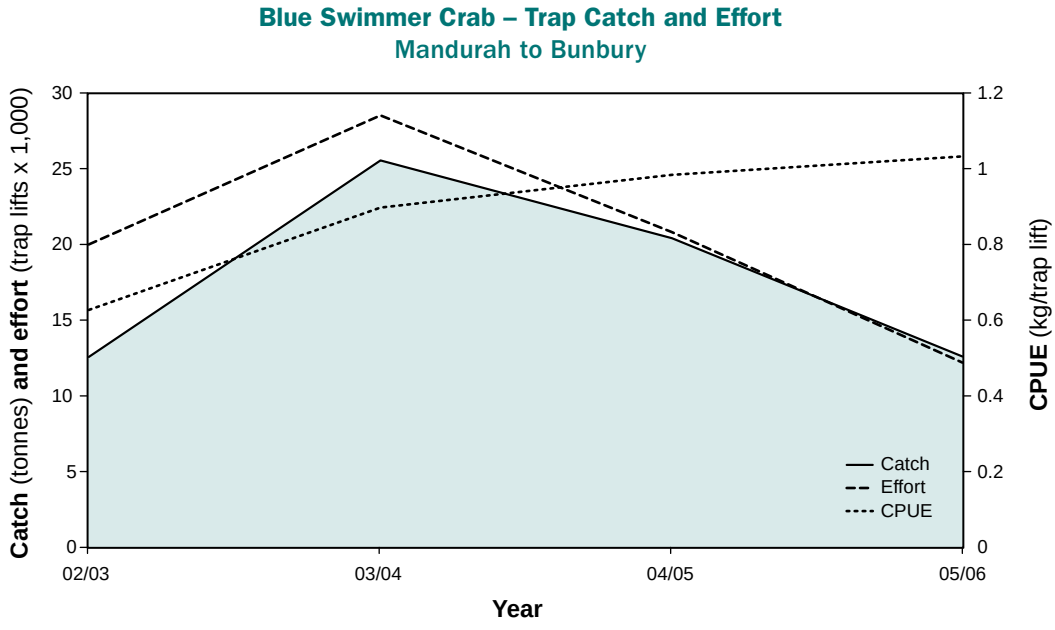
WEST COAST BLUE SWIMMER CRAB FIGURE 2

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Cockburn Sound Crab Fishery between 1993/94 and 2005/06 using traps.



WEST COAST BLUE SWIMMER CRAB FIGURE 3

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Area 2 of the West Coast Estuarine Fishery (the Peel-Harvey Estuary) between 1995/96 and 2005/06 using traps.



WEST COAST BLUE SWIMMER CRAB FIGURE 4

Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the Mandurah to Bunbury Experimental Crab Fishery between 2002/03 and 2005/06.

West Coast Deep Sea Crab (Interim) Managed Fishery Status Report

R. Melville-Smith
Management input by T. Reid

Fishery Description

The West Coast Deep Sea Crab (Interim) Managed Fishery targets giant (king) crabs (*Pseudocarcinus gigas*), crystal (snow) crabs (*Chaceon bicolor*) and champagne (spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a longline formation in the offshore waters of the west coast.

Governing legislation/fishing authority

West Coast Deep Sea Crab Fishery (Interim) Management Plan 2003
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The West Coast Deep Sea Crab Fishery, which, during the season being reported (2006) was in an interim management phase, operates between Cape Leeuwin and the Northern Territory border and is divided into 5 areas. Vessels are only permitted to fish outside the 150 m depth contour.

Management arrangements

The West Coast Deep Sea Crab (Interim) Managed Fishery is a limited entry 'pot' fishery. The fishery operates in depths of 150 – 1,200 m, with the only allowable method for capture being baited pots (traps). Each licensee is permitted to use 700 pots in the fishery. These are operated in 'long lines', which have between 50 and 100 pots attached to a main line marked by a float at each end.

For all species of deep sea crabs the Department of Fisheries either has in place, or is currently introducing, regulations to protect breeding females by the establishment of appropriate minimum size limits.

There are currently 5 full-time permits and 2 part-time permits to operate in the fishery. The current interim management plan is due to expire 31 December 2007 and will be replaced by a new interim management plan on 1 January 2008.

The new interim management plan will introduce a number of key management changes such as rezoning of the fishery, removing part-time permits and initiating a quota management system, with individual transferable quota for each existing permit holder. Consultation with industry regarding the draft new interim plan has been finalised and the plan is expected to be gazetted in late 2007, to commence in January 2008.

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery determined that performance should be measured annually against measures relating to the breeding stocks of deep sea crabs. These have now been defined as the catch level remaining within an acceptable range.

Research summary

Research for this fishery has involved assessing the current status of the west coast deep sea crab stocks based on commercial catch returns, log book information and at-sea research monitoring of the catch.

Funding was granted in 1999 by the Fisheries Research and Development Corporation (FRDC) to develop an understanding of the biology and fishery of champagne crabs. Further funding was made available in 2001 for similar research to be undertaken on crystal crabs. The Murdoch University component of this work has become available (September 2004) and the Department of Fisheries component will be available in mid-2007.

Retained Species

Commercial landings (season 2006): 188 tonnes

A catch of 188 t of crystal crabs was taken in the fishery in 2006 – a decrease of 8% on the catch taken in the 2005 season (205 t) and the lowest catch since 2000 (West Coast Deep Sea Crab Figure 1). There were no catches of giant crabs and only 2.2 t of champagne crabs landed by the fishery during the 2006 season.

Recreational catch estimate (season 2006): Nil

There is no recreational fishery for any of the deep sea crab species, as a result of the distance offshore and depth of the fishing grounds, which require large vessels and specialist gear.

Fishing effort/access level

Effort increased by 6% from an estimated 109,000 pot lifts in the 2005 season to 116,000 pot lifts in the 2006 season. The effort estimate in this fishery is based on detailed catch and effort log book returns, which are required to be completed by fishers in this fishery during its developmental status.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The standardised catch per unit of fishing effort for crystal crabs decreased by 26%, from 1.78 kg/pot lift in 2005 to 1.32 kg/pot lift in 2006. This decrease in CPUE brought catch rates in 2006 to approximately the levels that were recorded in 2003 and ended the consecutive increases in catch rate that have been recorded over the last 2 years (West Coast Deep Sea Crab Figure 2).

Decreases in CPUE were recorded in all zones in the fishery, but there would not appear to be cause for concern at this stage. It is not clear to what extent the changes in CPUE in this fishery are influenced by efficiency increases resulting from improvements by fishers in the type of gear that they use and the way that they deploy it, compared to variations in the catchability and local abundance levels of the crabs.

FRDC funded research has shown crystal crabs are very slow-growing, as are most other deep-water species. Preliminary estimates suggest that the males attain maturity at around 12 years and reach legal minimum size at about 14 years. Ageing estimates were not made for females, but size at maturity information shows that they mature well below the legal size limit and probably moult once after reaching maturity, which means that their contribution to the fished biomass is small and that egg production in the fishery is well protected by the legal size limit.

The performance measure for this fishery uses catch level as an indicator of breeding stock. In the case of crystal crabs, the catch is required to remain within the range 100 – 250 t. This criterion was met (see 'Retained Species' section on page 47)[1].

Non-Retained Species

Bycatch species impact: **Low**

The gear used in this fishery generates minimal bycatch and the design of the pots is such that they do not 'ghost fish' if lost.

Protected species interaction: **Negligible**

The pots and ropes used in crab longlines have minimal capacity to interact with protected species in this fishing area.

Ecosystem Effects

Food chain effects: **Negligible**

Catches of the 3 species of deep sea crabs landed represent a very small biomass, and any impact of fishing on the general food chain is expected to be minimal. Most of the commercial crystal crab catch is taken between 500 – 800 m depth. A rough estimate of the amount of ground between 500 – 1,000 m over the distributional range of crystal crabs is about 50,600 km^2. Assuming that all the ground is equally productive, this means that roughly 4 kilograms of crabs are being removed each year per square kilometre of ground.

Habitat effects: **Low**

Crab potting is considered to have a low impact on the largely soft mud habitat over which the fishery operates.

Social Effects

The developing fishery is based on mobile vessels that employ 2 or 3 crew. The product is landed live at ports between Carnarvon and Fremantle, generating some additional economic activity and benefits.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$2.4 million**

The beach value of the fishery was about $2.4 million in 2006, based on an average beach price of $13/kg for crystal. The majority of the catch is exported live to south-east Asia.

Fishery Governance

Target catch (or effort) range: **100 – 250 tonnes**

The effort in this interim managed fishery during 2006 was restricted to 5 full-time and 2 part-time fishers spread throughout the range of the fishery. Not all these permits are being used. The fishery has probably been fully exploited since about 2000 and at current levels of fishing a catch of 100 – 250 t would be expected in the next few years.

Current fishing (or effort) level: **Acceptable**

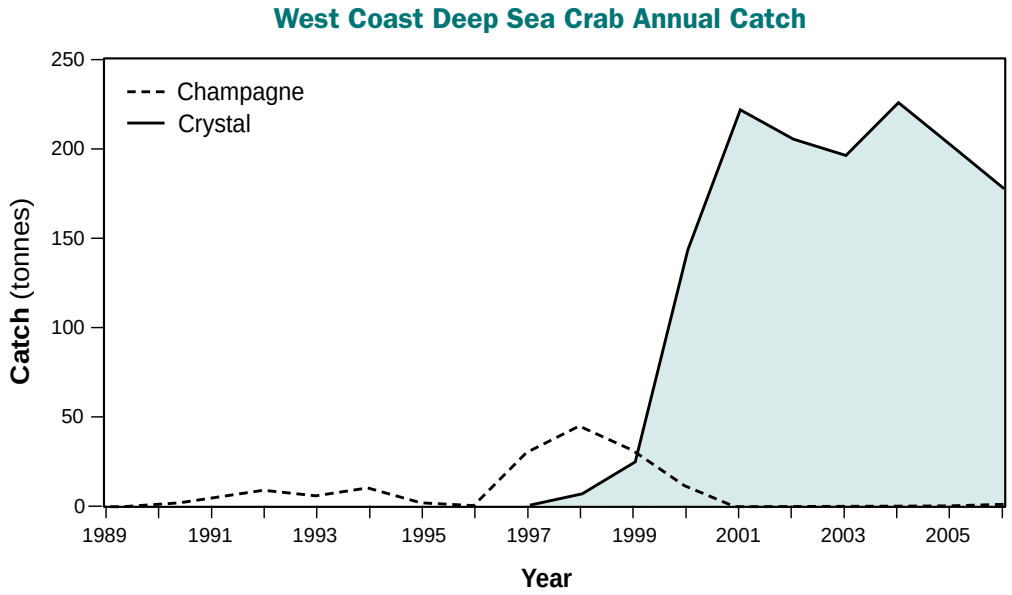
The catch in the crystal crab fishery has fluctuated between 188 and 233 t over the last 6 years. Over this same period, fishing effort has been more variable. This is a new commercial fishery that has only been fished on a full-time basis since 2000 and the target is a long-lived species. Given its recent history, sustainable levels of fishing are still being determined.

New management initiatives (2006/07)

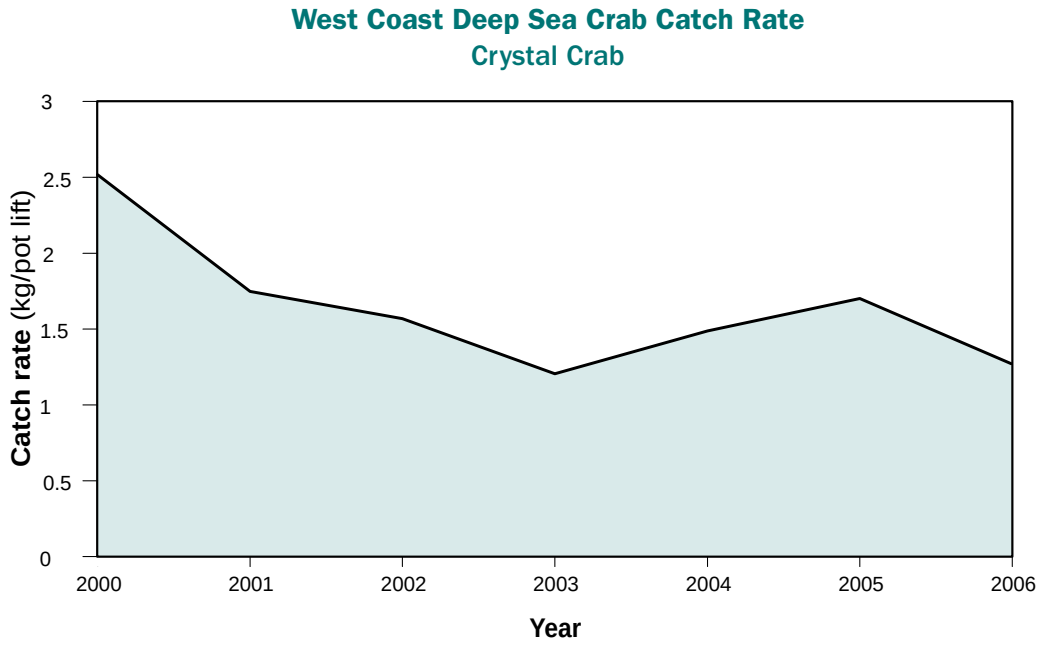
It is expected that the fishery will move to a new unitized, quota-based interim management plan in late 2007/early 2008. It is intended that the new interim plan will run for a further 5 years and provide for 7,000 individual transferable units (1,000 per permit holder).

The West Coast Deep Sea Crab (Interim) Managed Fishery uses baited pots.

[1] Updated from last year following recommendations from the Commonwealth's Department of Environment and Water Resources, resulting from the assessment of the fishery for Wildlife Trade Operation approval.



WEST COAST DEEP SEA CRAB FIGURE 1
Annual catches of crystal and champagne crabs since 1989. Annual giant catches have always been small, and they have therefore been excluded.



WEST COAST DEEP SEA CRAB FIGURE 2
Catch per unit effort since 2000 for crystal crabs.

West Coast Estuarine Fisheries Status Report

K. Smith and J. Brown
Management input from C. Syers

Fishery Description

The West Coast Estuarine Managed Fishery (WCEF), which operates in the Swan/Canning and Peel/Harvey estuaries, is a multi-species fishery targeting blue swimmer crabs and many finfish species. The blue swimmer crab component of the fishery is reported in the West Coast Blue Swimmer Crab Fishery Status Report.

The Hardy Inlet fishery, although not included in the WCEF (Interim) Management Plan implemented during 2003, is also reported here as it shares the characteristics of the other west coast estuaries.

The main fishing methods used are gillnets and haul nets, with crab pots used only in the Peel/Harvey estuary.

Governing legislation/fishing authority

Swan/Canning and Peel/Harvey Estuaries
West Coast Estuarine Fishery (Interim) Management Plan 2003
West Coast Estuarine (Interim) Managed Fishery Permit

Hardy Inlet
Closed waters and Permitted Gear Orders under Section 43 of the *Fish Resources Management Act 1994*
Condition 19 on a Fishing Boat Licence
Condition 17 on a Commercial Fishing Licence
Directions to Licensing Officers

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

Swan/Canning and Peel/Harvey Estuaries: The management plan encompasses all estuaries on the west coast between 27° S and 33°11´ S. However, the plan incorporates a broad range of closures, so that in general terms (but with some exceptions) the only areas open to fishing are:

- The Swan and Canning rivers upstream from a line connecting Point Resolution to the Point Walter jetty to:
  - (in the Swan) a line from Plain Street running 100 m off the tip of Heirisson Island to the southern bank of the river; and
  - (in the Canning) a line connecting the northern extremity of Second Avenue, Rossmoyne to the southern extremity of Sulman Avenue.
- The exceptions relate to closures around Canning Bridge, waters around a number of jetties and some areas of Perth Water.
- The Peel/Harvey estuary, with a complex series of closures that effectively limit the fishery to the main body of the estuary.

Note: The closures in both the Swan/Canning and Peel/Harvey fisheries are complex – please refer to the management plan, the related legislation and regulations for details.

Hardy Inlet: Areas open to fishing are all waters of Hardy Inlet and the Blackwood River upstream from a line connecting Point Irwin to the Irwin Street boat ramp to a line drawn across the river from the eastern boundary of Sussex Location 133 (approximately Great North Road).

Management arrangements

The west coast estuarine fisheries are managed primarily through input controls in the form of limited entry and gear restrictions, as well as seasonal and time closures, area closures and size limits. Fishing methods are restricted to gillnets and haul nets, but crab pots are also permitted in the Peel/Harvey estuary.

The implementation of the WCEF (Interim) Management Plan in 2003 saw a move from the historic 8 ‘family fishing units’ in the Peel/Harvey estuary to the issuing of interim managed fishery permits to all 12 individual operators, although only 11 were taken up. This was an administrative change only and did not represent a change in effective effort.

A Voluntary Fisheries Adjustment Scheme resulted in the number of licenses in the Swan/Canning estuary being reduced from 4 to 2 in 2005. The current Government policy to phase-out commercial fishing in the Swan/Canning Estuary is likely to result in the establishment of further adjustment schemes in the future.

Research summary

Historically, monitoring of fisheries and fish stocks in west coast estuaries has been based on monthly catch and effort statistics (CAES) provided by commercial fishers. The CAES database has provided a valuable and consistent long-term source of information for monitoring estuarine fish, including recreationally important stocks where they are harvested by both sectors.

However, levels of commercial fishing activity have been declining since 1992 as a result of the voluntary buy-back of commercial access, making the CAES data set less useful in assessing the status of certain estuarine species. The CAES database is still an important source of data for stock assessments, but it is now being used for this purpose in combination with increasing amounts of data from other sources, namely recreational fisheries and fishery-independent surveys.

Comprehensive assessments of fish stocks in west coast estuaries will require data from both the commercial and recreational sectors and from independent surveys. The Research Angler Program (including recreational fisher log books) and annual fishery-independent surveys of juvenile fish recruitment (including cobbler, herring, whiting, mullet and several other species) are among the strategies now being employed by the Department of Fisheries to meet future data requirements.

While commercial fishery catch levels in west coast estuaries are determined annually from data reported in compulsory

commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. The most comprehensive estimates of recent recreational catches in west coast estuaries are available from the National Recreational and Indigenous Fishing Survey in 2000/01 (Henry and Lyle 2003). This survey included shore- and boat-based recreational fishing.

In addition, creel surveys were conducted by the Department of Fisheries in 1998/99 in the Swan/Canning, the Peel/Harvey and Leschenault estuaries (Malseed *et al.* 2000, Malseed and Sumner 2001a, 2001b). However, each of these creel surveys was focused on blue swimmer crabs and collected limited information on recreational landings of finfish.

Finally, a creel survey was conducted in the Hardy Inlet by Murdoch University in 2005/06 (Prior and Beckley 2006). This survey collected comprehensive information about finfish landings in the Hardy Inlet and Blackwood River. The 2005/06 survey used very similar methods to a previous survey of this system conducted by the Department of Fisheries in 1974/75 (Caputi 1976).

A considerable amount of knowledge on the biology of estuarine fish is available from many previous and ongoing research projects conducted on the south coast by universities and the Department. This knowledge assists in interpreting trends in monitoring data described above and provides a basis for management decisions.

This report presents specific data for 4 species that are important in west coast estuaries, namely blue swimmer crabs (*Portunus pelagicus*), cobbler (*Cnidoglanis macrocephalus*), black bream (*Acanthopagrus butcheri*) and King George whiting (*Sillaginodes punctata*).

Where only a small number of fishers are actively involved in a particular fishery, the data are subject to the Department of Fisheries' confidentiality policy as it relates to the *Fish Resources Management Act 1994* and are not reported separately. While not able to be published here, these confidential data are used by the researchers to monitor the status of the stocks and provide advice to management.

Retained Species

Commercial landings (season 2006): 228 tonnes

In 2006 the total catch from west coast estuaries was 228.4 t, including the following catches of key target species:

Blue swimmer crabs	*Portunus pelagicus*	89.7 t
Sea mullet	*Mugil cephalus*	72.8 t
Yellow-eye mullet	*Aldrichetta forsteri*	26.2 t
Western sand whiting	*Sillago schomburgkii*	19.8 t
Australian herring	*Arripis georgianus*	9.0 t
Perth herring	*Nematalosa vlaminghi*	3.3 t
Black bream	*Acanthopagrus butcheri*	2.2 t
King George whiting	*Sillaginodes punctata*	2.0 t
Tailor	*Pomatomus saltatrix*	0.8 t
Cobbler	*Cnidoglanis macrocephalus*	0.6 t
Other species		2.2 t

Swan/Canning: Total annual catch in the Swan/Canning Estuary declined during the 1990s, primarily as a result of a decline in fishing effort associated with a reduction in the number of vessels operating in the fishery. Since the year 2000, the total catch along with fishing effort has remained relatively stable.

The total fishery catch in 2006 was slightly lower than in 2005 (actual figure not reportable owing to the small number of operators). This lower amount can be attributed to a further reduction in effort, from 3 active vessels in 2005 to 2 in 2006.

The 2006 catch was composed primarily of blue swimmer crab and sea mullet, with small quantities of Perth herring, black bream and yellow-eye mullet. In total, at least 28 different species were caught in the Swan/Canning estuary during 2006.

Peel/Harvey: Reported catches in the Peel/Harvey Estuary since 1980 are shown in West Coast Estuarine Figure 1. From the mid-1970s until 1990, total annual landings declined markedly, mainly due to declines in annual catches of yellow-eye mullet, sea mullet and cobbler. From 1990 to 1998, annual catches were stable and averaged 313 t. Annual catches declined from 329 t in 1998 to 188 t in 2000, but were then relatively stable from 2000 to the present. In 2006, the total Peel/Harvey estuary catch was 185 t.

As in the Swan/Canning Estuary, the catch trend in the Peel/Harvey estuary after 1990 closely followed the decline in fishing effort. In both estuaries, declines in total annual landings were due to declines in finfish landings. Unlike finfish landings, annual crab landings in these estuaries have gradually increased since 1980 despite declining effort levels.

In 2006, approximately 44% of the total Peel/Harvey catch consisted of blue swimmer crabs, with sea mullet, yellow-eye mullet, western sand whiting and Australian herring making up 96% of the finfish catch.

Hardy Inlet: The total fishery catch in the Hardy Inlet in 2006 was slightly lower than in 2005 (actual figure not reportable owing to the small number of operators). The catch level trend has been stable since 1996. In 2006, the Hardy Inlet catch consisted of only 3 different species. Western sand whiting comprised the majority of the catch (74%), with small quantities of sea mullet (25%) and black bream (1%) comprising the rest.

Key species

Blue swimmer crabs: See 'West Coast Blue Swimmer Crab Fishery Status Report' elsewhere in this volume.

Black bream: Commercial landings of black bream were reported from the Swan/Canning estuary, Hardy Inlet and the Peel/Harvey estuary in 2006, although the amount caught in the latter was minimal. In the Swan/Canning estuary and Hardy Inlet, the catch in 2006 was lower than in 2005, and well below the 10-year (1996 – 2005) average for this species in each estuary.

Cobbler: In 2006, cobbler was primarily caught in the Peel/Harvey estuary, with a minor amount caught in the Swan/Canning Estuary. The annual catch of cobbler in the Swan/Canning Estuary declined

dramatically after 1988, when 10.4 t was reported. Since 1998, annual catches have not exceeded 170 kg.

Recent catches of cobbler in the Peel/Harvey estuary were also low relative to historic levels. The 2006 catch in the Peel/Harvey estuary was 0.6 t, down from the 2.9 t caught in 2005. Since 2000, the annual catch in the Peel/Harvey estuary has averaged 2 t, which is significantly less than the average annual catch of 57 t in the previous 25 years (1976 – 1999).

King George whiting: In 2006, commercial landings of King George whiting were reported only from the Peel/Harvey Estuary (2 t). Catches in recent years have been highly variable in response to strong fluctuations in recruitment. From 1985 to 1995, the average annual catch of King George whiting in the Peel/Harvey Estuary was 1.4 t.

Strong recruitment led to significantly higher catches between 1996 and 2000, including a peak of 20.3 t in 1998. These recruits eventually matured and moved offshore. The catch then declined to pre-1996 levels and averaged 2.6 t from 2001 to 2006.

Recreational catch:
30 – 75% of total catch (approximately)

In 2000/01, the National Recreational and Indigenous Fishing Survey collected data on all target species. The recreational finfish catch during this survey was estimated to be similar to the commercial finfish catch in the Swan/Canning Estuary, about 50% of the commercial finfish catch in the Peel/Harvey Estuary and about 3 times the commercial finfish catch in the Hardy Inlet/Blackwood River.

With recent declines in commercial fishing effort and the continued growth of the recreational fishing sector, it can be reasonably expected that the recreational catch component in these estuaries has increased from when the last survey was conducted.

The national recreational fishing phone survey in 2000/01 estimated the total retained catch of finfish in the Swan-Canning estuary and its tributaries was numerically dominated by black bream (35%), Australian herring (20%), toadfish (*Torquingener pleurogramma*) (12%), whiting (9%) and tailor (9%) during the survey period.

In the Peel/Harvey estuary and tributaries, the retained finfish catch was numerically dominated by Australian herring (56%), whiting (17%) and tailor (14%). In Leschenault Inlet and tributaries, the total retained finfish catch was numerically dominated by small baitfish (34%), redfin perch (*Perca fluviatilis*, caught in river only) (34%), wrasse (Labridae) (10%) and tailor (7%).

In the Hardy Inlet and its tributaries, the national phone survey estimated that the total retained finfish catch was numerically dominated by whiting (63%), Australian herring (23%) and black bream (7%) during the survey period. This was similar to the results from the 2005/06 creel survey of the Hardy Inlet/Blackwood River, which also found the total retained recreational catch to be numerically dominated by whiting (47%) and Australian herring (17%). In 2005/06, a total of 8 t of finfish, comprising 17 species, was estimated to have been retained by recreational fishers in this system.

In the Swan/Canning, Peel/Harvey and Leschenault estuaries, prawns were a significant component of recreational landings.

Fishing effort/access level

Commercial fishing effort

Swan/Canning:	level of access – 2 licensees
Peel/Harvey:	level of access – 11 licensees
Hardy Inlet:	level of access – 1 licensee

The levels of access listed above are as at August 2006. Licence holders in the west coast estuaries that are open to commercial fishing are endorsed to fish a single estuary system only.

Fishing effort in the Peel/Harvey estuary, which has traditionally been reported here as the number of units of access, is now reported as the number of days fished by each method. It is considered that 'method days fished' provides a more accurate measure of the effort undertaken in this estuary.

Fishing effort in the Swan/Canning estuary will continue to be reported as the average number of boats fishing per month. This measure of effort provides a general indication of effort changes over time. In these fisheries, the licence buy-back scheme applied to commercial fishing licences has resulted in a decline in effort and hence lower catches.

Swan/Canning: Fishing effort has steadily declined over recent decades. The mean number of active fishing units per month fell from about 25 in the mid-1970s to 2 in 2006.

Peel/Harvey: During the 1980s, fishing effort (number of method days fished) averaged 5,372 days per year, but this included a period of rapid decline between 1988 and 1990. Effort then stabilised and averaged 3,463 days per year from 1990 to 2000. After another pronounced decline between 1998 and 2000, effort again stabilized, with an average of 2,040 days fished per year between 2000 and 2006 (West Coast Estuarine Figure 1).

Hardy Inlet: Fishing effort (mean monthly number of fishing units) in the Hardy Inlet has declined from 3 in the 1970s to 1 in 2000 and subsequent years, including 2006.

Recreational fishing effort

In 2000/01, the National Recreational and Indigenous Fishing Survey estimated that the vast majority of total recreational effort expended in west coast estuaries and their tributaries occurred in the Peel/Harvey (43% of fishing events), Swan/Canning (32%), Hardy Inlet (8%) and Leschenault Inlet (8%) systems during the survey period.

A range of fishing methods was reported in these estuaries including line fishing (with bait or lure), drop netting, scoop netting, hand collecting, diving and spearfishing.

In the Swan/Canning, the most popular recreational methods were line fishing (80% of fishing events) and drop netting (14%). The vast majority of recreational fishing events in this system were shore-based.

In the Peel/Harvey system, the most popular recreational methods were line fishing (57% of fishing events), drop netting (27%) and scoop netting (13%). The majority of drop netting was undertaken by boat-based fishers, whereas the other 2 methods were mainly undertaken by shore-based fishers.

In the Leschenault system, the most popular recreational methods were scoop netting (48% of fishing events), line fishing (36%) and drag netting (13%). The vast majority of recreational fishing events in this system were shore-based.

In the Hardy Inlet system, the main recreational method recorded during the 2000/01 phone survey was line fishing (86% of all fishing events). The majority (72%) of line fishing events were undertaken by boat-based fishers. The creel survey in 2005/06 also found that the majority of fishing in Hardy Inlet/Blackwood River was boat-based. In 2005/06, the total annual recreational angling effort was estimated to comprise 44,655 boat-based hours and 26,910 shore-based hours. The total effort (boat + shore) was very similar to that estimated in 1974/75, during a similar survey of this system undertaken by the Department of Fisheries. However, boat-based effort represented a much greater proportion of the total effort in 1974/75 than in 2005/06.

Stock Assessment

Assessment complete: **Preliminary**

Breeding stock levels (black bream, King George whiting): **Adequate**

Breeding stock levels (cobbler): **Not adequate**

The annual abundances of the individual species that contribute to fishery landings in west coast estuaries are highly variable. For species such as black bream and cobbler that exhibit an estuarine-dependent life history, factors other than fishing, e.g. algal blooms, can cause high mortality and may necessitate changes to management.

Black bream: Black bream populations are genetically unique within each west coast estuary. The catch rates of bream increased markedly after 1990 in the Swan/Canning estuary and have been gradually increasing since the mid-1990s in the Hardy Inlet. These trends suggest recent increases in bream stock abundance in these estuaries.

Since the mid 1990s, several batches of reared black bream fingerling have been released into these estuaries. However, higher fishery catch rates over this period were due to natural recruitment and were not related to stocking.

Increasing catch rates of black bream in the Swan Estuary suggest that breeding stock levels are currently adequate to maintain recruitment. However, in recent years, fishery landings of black bream in the Swan/Canning estuary have been dominated by relatively small/young fish. This suggests that the stock is subject to a relatively high rate of mortality.

Environmental factors and fishing are both likely to be significant sources of mortality. Stock status in the Peel/Harvey system is unclear due to limited data, but is probably similar to that of the Swan/Canning stock.

Black bream possess different growth rates and attain maturity at different sizes in different estuaries. In all Western Australian estuaries, the legal minimum length is set above the length at maturity and therefore affords protection to each breeding stock.

Cobbler: Cobbler populations are genetically unique within each west coast estuary. They exhibit different growth rates, depending on the estuary in which they reside. In all locations, the size at maturity is less than the legal minimum total length, which would normally afford protection to each breeding stock. However, breeding stock levels in the 3 main west coast estuaries appear to be very low, due to a combination of environmental factors (e.g. loss of breeding habitat), fishing pressure and the biological characteristics of this species (e.g. low fecundity, aggregating behaviour) that make it inherently vulnerable to depletion.

The decline of this once important fishery species is reflected in declines in commercial and recreational catch rates commencing in the 1980s. Current stock levels in each estuary are not considered adequate to ensure their sustainability.

King George whiting: King George whiting breed in the open ocean at age 4+, but juveniles (aged 0 to 3+) use estuaries and coastal waters as nursery habitats. They are most vulnerable to capture while residing in estuaries. The age at which King George whiting become vulnerable to capture is typically 2+ to 3+ years, which corresponds to a length of about 250 mm.

The legal minimum length in the fishery is 280 mm, while the length at 50% maturity is 413 mm for females. Hence, the size at capture in estuaries is considerably less than the size at maturity.

Recent reductions in the number of commercial fishers in estuaries and coastal waters are likely to have reduced the inshore fishing pressure on this stock. However, targeted recreational fishing for this species, both inshore and offshore, is essentially unconstrained and will need to be monitored to ensure overall fishing mortality does not increase to an unsustainable level in the future. The current breeding stock level is considered adequate.

Non-Retained Species

Bycatch species impact **Low**

These small-scale fisheries mainly use mesh nets that are deployed in a targeted manner. Few non-target species are taken. Mesh size regulations ensure that target species caught by this method are within an appropriate size range. Minimal discarding occurs because virtually all fish taken are retained and can be marketed in the greater Perth metropolitan area.

Protected species interaction: **Negligible**

No protected species occur in these fisheries that are susceptible to capture by the fishing gear used.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Low**

The operation of gillnets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries.

Social Effects

In 2006, there was an average of 15 fishers operating each month in the west coast estuarine fisheries, largely supplying fresh fish to meet demand for locally-caught product.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$1.6 million**

Fishery Governance

Target catch range: **75 – 220 tonnes (Peel/Harvey only)**

Under the current management regime, the target range for total catch in the Peel/Harvey fishery is 75 – 220 t. The 2006 catch of 185 t was well within this range. This range was derived by a statistical quality control chart using catch data from 1978 to 2002.

Catch ranges are designed to allow catch levels to fluctuate in response to normal fluctuations in stock abundance. If annual catches fall outside acceptable ranges, an investigation into the cause will be triggered which, if required, may lead to changes in the management arrangements.

Acceptable catch ranges for the Swan/Canning and Hardy Inlet fisheries cannot be derived at this time, given the recent decreases in the number of commercial fishers operating in these estuaries and the low amount of data now available from each estuary.

Current fishing level (2006): **Acceptable**

Commercial effort levels have been gradually declining over recent decades, due to reductions in the number of licensees, and the current total annual effort is very low relative to historic levels. This licensee reduction process has reduced catch levels and eased commercial fishing pressure on key stocks in west coast estuaries.

Recent changes in stock abundance are thought to be primarily due to environmental factors rather than fishing. Current commercial fishing levels are considered acceptable.

New management initiatives (2006/07)

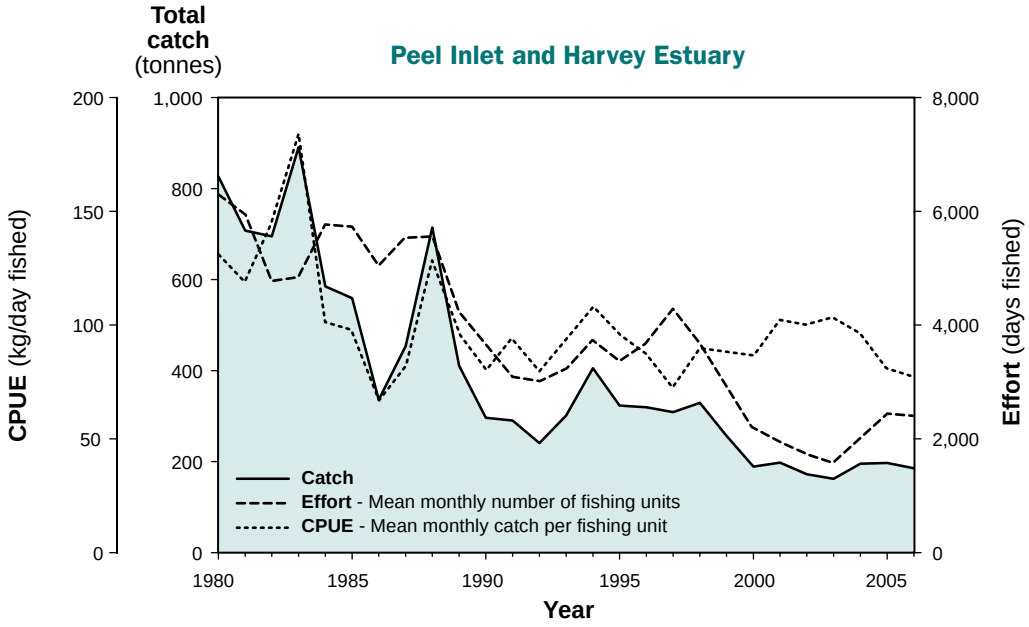
Arrangements are still underway to incorporate the management of the Hardy Inlet commercial fishery into the South Coast Estuarine Fishery Management Plan.

External Factors

West coast estuaries are highly modified, and often degraded, environments. In these estuaries, the impacts of environmental factors on stock abundances are likely to be at least as important as fishing pressure. Hence, the sustainable management of the fish communities in west coast estuaries requires a collaborative effort between fishery and habitat managers.

Anecdotal reports suggest that habitat and climatic changes have altered the composition and abundance of fish communities in west coast estuaries, although lack of historical monitoring makes many of these changes difficult to quantify. However, in the Swan/Canning estuary, abundant fishery data provides evidence of marked declines in fish abundance since 1990 or earlier (Smith 2006). Declines are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas.

In West Coast estuaries, the impacts of environmental factors on stock abundances are likely to be at least as important as fishing pressure. Photo: Cliff Young



WEST COAST ESTUARINE FIGURE 1
The annual catch, effort and catch per unit effort (CPUE) for the total fishery of the Peel/Harvey Estuary over the period 1980–2006.

Cockburn Sound Fisheries Status Report

K. Smith, J. Brown and M. Hammond
Management input from C. Syers

Fishery Description

Cockburn Sound is a large marine embayment, approximately 10,000 ha in size, which supports a number of commercial and recreational fishing activities (Cockburn Sound Figure 1). Collectively, these multiple fishing operations harvest a diverse array of finfish and invertebrates (Cockburn Sound Figure 2).

Since 2000, the majority of the finfish harvested annually within Cockburn Sound (approximately 60% by weight) have been baitfish taken by the West Coast Purse Seine Fishery (mainly pilchards *Sardinops sagax* and tropical sardines *Sardinella lemuru*). The remainder have been taken by the Cockburn Sound (Fish Net) Fishery (mainly Australian herring *Arripis georgianus* and garfish *Hyporhamphus melanochir*) and the Cockburn Sound (Line and Pot) Fishery (mainly pink snapper *Pagrus auratus* and various skates and rays), with minor quantities also taken by the West Coast Beach Bait Fishery (mostly whitebait *Hyperlophus vittatus*).

Since 2000, the majority of the invertebrates harvested within Cockburn Sound have been taken by the Cockburn Sound (Crab) Fishery. The remainder have been harvested by the Cockburn Sound (Line and Pot) (mainly octopus *Octopus tetricus* and squid *Sepioteuthis australis*), and by aquaculture (mussels *Mytilus edulis*).

Many of the species taken commercially in Cockburn Sound – including Australian herring, garfish, squid, blue swimmer crabs (*Portunus pelagicus*) and pink snapper – are also targeted by recreational fishers. Cockburn Sound is a very popular recreational fishing area.

This report describes the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries and the recreational fishery. Separate status reports are given elsewhere in this volume for the West Coast Beach Bait, West Coast Purse Seine and Cockburn Sound (Crab) Managed Fisheries and for mussel farming.

Fishing methods employed by the Cockburn Sound (Line and Pot) Fishery include handlines, longlines, squid jigs and unbaited octopus pots. The Cockburn Sound (Fish Net) Fishery uses gillnets and haul nets.

Governing legislation/fishing authority

Cockburn Sound (Fish Net) Management Plan 1995
Cockburn Sound (Line and Pot) Management Plan 1995
Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Meetings between the Department of Fisheries and industry
Recreational Fishing Advisory Committee
Regional Recreational Fishing Advisory Committees

Boundaries

The Cockburn Sound (Fish Net) and Cockburn Sound (Line and Pot) Managed Fisheries operate in within Cockburn Sound (Cockburn Sound Figure 1).

Management arrangements

The Cockburn Sound (Line and Pot) and Cockburn Sound (Fish Net) fisheries are primarily managed through input controls in the form of limited entry, gear restrictions and closed areas. Since the early 1990s, the number of licences in these 2 commercial fisheries has been substantially reduced via voluntary Fishery Adjustment Schemes. The removal of licences has eliminated a significant amount of latent effort (inactive licences) that previously existed in these fisheries.

A seasonal closure for pink snapper fishing was introduced in Cockburn Sound in 2000 and has since been applied annually. The annual closure applies to commercial and recreational fishing and protects the large breeding aggregations of snapper that occur in Cockburn Sound at that time.

From 2000 to 2004, a closed season operated in Cockburn Sound from 15 September to 31 October. In 2005, the closure was extended and operated from 1 October to 15 December in both Cockburn and Warnbro Sounds. The same closure was applied in 2006 although, in late December, the ongoing presence of spawning fish prompted the period to be extended to 10 January 2007.

In November 2006, a state-wide ban was introduced on the commercial harvest of sharks and rays, except for licensees in dedicated shark fisheries and a limited number of special permit holders. This measure resulted in cessation of commercial fishing for sharks and rays in Cockburn Sound.

From 15 December 2006, Cockburn Sound was closed to fishing for crabs for at least 12 months.

Research summary

Historically, monitoring of fishery stocks in Cockburn Sound has been based on monthly catch and effort statistics (CAES) provided by commercial fishers. The CAES database has provided a valuable and consistent long-term source of information for monitoring these stocks, including those of recreationally important species which are harvested by both sectors.

However, levels of commercial fishing activity have declined recently as a result of voluntary license buy-backs and closures, making the CAES data set less useful in assessing the status of certain species. CAES is still an important source of data for stock assessments, but is now being used for this purpose in combination with increasing amounts of data from other sources, namely recreational fisheries and fishery-independent surveys. In Cockburn Sound, a greater focus on recreational fishery data is particularly appropriate because this sector takes the majority of finfish (excluding baitfish) that are landed in this area.

The Research Angler Program (including recreational fisher log books) and annual fishery-independent surveys of juvenile fish recruitment are among the strategies now being employed by the Department of Fisheries to monitor the status of fishery stocks in Cockburn Sound.

Annual rates of juvenile recruitment by Australian herring, whiting, mullet and several other finfish species are assessed by research surveys at 6 sites along the south-west coast of WA. One of these sampling sites is in Cockburn Sound, as it is an important nursery ground for a number of key commercial and recreationally caught fish species. The recruitment indices derived from survey data are used to forecast fishery landings of each species.

A considerable amount of knowledge on the biology of key fishery species in Cockburn Sound is available from previous and ongoing research projects conducted by universities and the Department. This knowledge assists in interpreting trends in monitoring data described above and provides a basis for management decisions.

While commercial fishery catch levels in Cockburn Sound are determined annually from data reported in compulsory commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. The most comprehensive estimates of recent recreational catches in Cockburn Sound are available from the National Recreational and Indigenous Fishing Survey in 2000/01 (Henry and Lyle 2003). This survey included shore- and boat-based recreational fishing.

In addition, recent estimates of recreational landings by boat-based fishers are available from creel surveys of the west coast region that were conducted by the Department in 1996/97 (Sumner and Williamson 1999) and 2005/06 (Department of Fisheries, unpublished data). Additionally, a creel survey of shore- and boat-based fishing in Cockburn Sound was conducted by the Department in 2001/02. The main objective of the 2001/02 survey was to estimate recreational crab landings and, as a result, finfish landings may have been underestimated.

In addition to the compulsory monthly returns submitted to the Department of Fisheries, some commercial octopus fishers keep voluntary daily log books. A standardised annual catch rate is calculated from log book data and used as a relative index of octopus abundance in Cockburn Sound.

Australian herring, pink snapper, tailor (*Pomatomus saltatrix*) and blue swimmer crabs are among the main fishery target species in Cockburn Sound. For further details of research related to these stocks, see their separate status reports elsewhere in this volume.

Retained Species

Commercial landings (season 2006):
35 tonnes of finfish (non-baitfish)
49 tonnes of cephalopods

Since 1995, the total annual harvest by all commercial fisheries in Cockburn Sound, including finfish and invertebrates, has progressively declined from 977 t in 1995 to 204 t in 2006. This major reduction is largely due to declines in the landings of baitfish (mainly taken by the purse seine fishery) and crabs (mainly taken by the crab fishery) (Cockburn Sound Figure 2).

Between 1995 and 2006, annual landings of baitfish declined from 655 to 77 t and crab landings declined from 194 to 44 t. Over the same period, non-bait finfish landings declined from

120 t to 35 t, while the annual catch of cephalopods increased from 8 t to 49 t.

Further information about commercial landings of baitfish (whitebait, pilchard, scaly mackerel, anchovy and blue sprat) and crabs in Cockburn Sound can be found in the status reports for the West Coast Purse Seine, West Coast Beach Bait and the Cockburn Sound (Crab) Managed Fisheries. The remainder of the commercial catch in Cockburn Sound is described below.

The commercial catch reported here is primarily from the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries but does also include finfish (other than those 5 baitfish species mentioned above) caught in the West Coast Beach Bait and the West Coast Purse Seine Managed Fisheries, which conduct part of their respective operations within Cockburn Sound.

The annual commercial catch of non-bait finfish (hereafter 'finfish') in Cockburn Sound has steadily declined since reaching a peak of 165 t in 1992 (Cockburn Sound Figure 3). In 2006, the finfish catch was 34.5 t, which was the lowest catch on record.

The 2006 finfish catch included at least 16 teleost and elasmobranch species. Approximately 70% of the 2006 catch consisted of Australian herring and southern sea garfish, which were caught primarily by netting. The next most important components of the catch were sharks and rays (various species), pink snapper and yellowtail scad (*Trachurus novaezelandiae*).

Prior to 2000, the commercial catch of cephalopods in Cockburn Sound was relatively low (2 to 5 t per year) and mainly comprised squid and minor quantities of cuttlefish (*Sepia* sp.). Since 2000, annual landings of squid have remained stable at approximately 2 to 4 t, but the total cephalopod catch has been increasing rapidly due to the development of the octopus fishery.

Key species

Australian herring: After 1980, annual commercial landings of Australian herring in Cockburn Sound increased steadily to reach a peak of approximately 50 t in 1994. Since 1994, the catches of herring have been lower and relatively stable, fluctuating between 15 t and 30 t per year. In 2006, the herring catch was lower than in the previous year (actual figures cannot be reported as there are fewer than 5 operators catching this species) and was below the 10-year average for the period 1996 to 2005. Herring caught commercially in Cockburn Sound represent only a small proportion of the total state landings of this species.

Southern sea garfish: From 1995 to 2006, the total annual commercial catch of sea garfish in the west coast region ranged from 44 t to 11 t (Cockburn Sound Figure 4). In this period, annual catches were quite variable, but the overall trend was downward. Approximately 85% of total commercial landings of garfish each year on the west coast were taken in Cockburn Sound.

The annual landings of sea garfish in Cockburn Sound increased gradually after 1980 to reach levels of approximately 20 – 30 t per year during the late 1990s. Subsequent annual landings of garfish have been slightly lower and relatively stable, fluctuating between 10 t and 20 t per year. The 2006 catch was the lowest in the last 10 years (actual figures cannot be reported as there are fewer than 5 operators catching this species).

Octopus: The annual commercial catch of octopus in Cockburn Sound increased from 2 t in 2000 to 45 t in 2006 (Cockburn Sound Figure 5). About 20% of the total west coast commercial catch of octopus in 2006 was taken in Cockburn Sound. The majority of commercial landings of this species on the west coast are taken as a byproduct of the West Coast Rock Lobster Fishery (see the status report elsewhere in this volume).

Recreational catch: 80% of total finfish catch (approximately)

An estimate of the total recreational catch in Cockburn Sound is not available for the current year. The most comprehensive recent information on Cockburn Sound recreational shore- and boat-based fishing is from a national phone survey in 2000/01. The catches and effort estimated in 2000/01 are summarised in Cockburn Sound Table 1. The survey indicated that the majority of non-bait finfish landings in Cockburn Sound are taken by the recreational sector.

In 2000/01, about 40 finfish species were estimated to have been retained by recreational fishers in Cockburn Sound. The total finfish catch was numerically dominated by Australian herring (approximately 44% of catch), various species of whiting (14%), garfish (10%), tailor (5%), trevally (*Pseudocaranx dentex*) (4%), yellowtail scad (3%) and snook (*Sphyraena novaehollandiae*) (3%).

The 2000/01 survey indicated that the recreational shore-based catch was higher and more diverse than the boat-based catch in Cockburn Sound. Overall, 74% of all retained finfish were taken by shore-based fishers. Shore-based fishers mainly caught herring, garfish, whiting and tailor, while boat-based fishers mainly caught herring and whiting.

Approximately 70% of the boat-based catch and 90% of the shore-based catch was in the northern part of Cockburn Sound (i.e. north of Woodman Point).

In 2000/01, 3 cephalopod species were retained by recreational fishers in Cockburn Sound. Cephalopods were mainly taken by boat-based fishers and landings were numerically dominated by squid (estimated to be 76% of total retained cephalopods) and octopus (22%) with minor quantities of cuttlefish (2%).

Key species

The 2006 recreational catch levels of the following species in Cockburn Sound are unknown. The most recent estimates available are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01.

Australian herring: An estimated 438 t of herring was retained by recreational fishers in the west coast region in 2000/01, approximately 14% of which was taken in Cockburn Sound. Approximately 75% of the Cockburn Sound recreational catch during the survey was taken by shore-based fishers.

Southern sea garfish: In 2000/01, an estimated 213,072 garfish (or 35 t, assuming 164 g per fish) were retained by recreational fishers in the west coast region during the survey period, with 47% of this catch being taken in Cockburn Sound. Approximately 65% of the garfish caught recreationally in the west coast region (and virtually all garfish caught in Cockburn Sound) were taken by shore-based fishers during the survey. In 2000/01, recreational landings of garfish were estimated to comprise 70% of total west coast landings (i.e. 2000/01 recreational catch plus 2001 commercial catch).

Octopus: In 2000/01, an estimated 11,245 octopus were retained by boat-based recreational fishers in Cockburn Sound, which represented 74% of the total west coast recreational octopus harvest during the survey. The weight of octopus landings was not estimated in this survey. However, preliminary observations of the commercial catch suggest an average octopus body weight of 700 g. By applying this weight to the recreational catch, an estimated 8 t of octopus were retained by recreational fishers in Cockburn Sound in 2000/01.

Fishing effort/access level

Commercial fishing effort

Commercial fishing effort expended in the capture of finfish in Cockburn Sound is difficult to measure accurately because of the number of fisheries and fishing methods associated with the capture of each species. Fishing effort is measured here as the number of fishing boat days associated with finfish catches (excluding pot catches) from the Cockburn Sound (Line and Pot) and the Cockburn Sound (Fish Net) Managed Fisheries, plus the days fished in the West Coast Beach Bait where non-bait species were caught. This provides an approximate measure of the overall commercial effort expended in the capture of finfish in Cockburn Sound.

Annual commercial fishing effort associated with finfish landings in Cockburn Sound increased during the 1980s and then stabilised at 1,200 – 1,400 boat days per year during the early 1990s (Cockburn Sound Figure 3). It declined to 835 boat days in 1997 before rising to a record high of 1,468 boat days in 1999. After 1999, annual effort steadily declined and reached a record low of 353 boat days in 2005. In 2006 the number of boat days increased slightly to 461. The decline in commercial effort after 1999 reflected a reduction in the number of active fishers operating in Cockburn Sound.

Since the early 1990s, there has been a progressive decline in the number of commercial licences operating in Cockburn Sound as a result of voluntary Fishery Adjustment Schemes. In the early 1990s, there were about 45 licensees in the Cockburn Sound (Line and Pot) fishery and 6 licensees in the Cockburn Sound (Fish Net) fishery. Not all of these licensees were active in each fishery. From 1996 to 1999, there were 34 line and pot and 6 fish net licensees. In May 2000, these numbers were reduced to 26 and 2, respectively. In April 2003, these numbers were further reduced to 13 and 1.

The reductions in these 2 fisheries effectively eliminated a substantial amount of latent effort (inactive licences) that previously existed in Cockburn Sound.

Since 2003, the number of licenses in these 2 fisheries has been constant (1 Fish Net licence and 13 Line and Pot licenses) and this stability is reflected in the total reported effort. Total annual effort was relatively stable and averaged 447 boat days per year from 2003 to 2006 (Cockburn Sound Figure 3).

In contrast to finfish-related effort in Cockburn Sound, the commercial effort associated with the capture of octopus has increased recently. Octopus is mainly caught using pipes or pots. From 2000 to 2004, the total number of fishing boat days spent using these methods in Cockburn Sound was stable at approximately 275 per year. Effort then increased and was 498 days in 2005 and 451 days in 2006.

The increase was associated with an increase in the use of pipes, which became the main method of capture after 2003 and is now the basis of the developing octopus fishery. Current management arrangements allow an unlimited number of octopus pipes to be deployed by licensees in the Cockburn Sound (Line and Pot) fishery.

Recreational fishing effort

The national recreational fishing survey in 2000/01 estimated that the vast majority of recreational fishing effort in Cockburn Sound was by line fishing (bait or lure). This method was estimated to have been used in 94% of boat-based fishing events and 84% of shore-based fishing events during the survey period. Virtually all recreational landings of finfish and squid were taken by line fishing methods. Octopus was caught by hand collecting.

Approximately 48,000 boat-based line fishing events and 145,000 shore-based line fishing events were estimated to have occurred in Cockburn Sound during the 2000/01 survey period.

In 2000/01, considerably more shore-based line fishing occurred in the northern area of Cockburn Sound (north of Woodman Point) than in the southern area (south of Woodman Point) (84% and 16% of events, respectively). In contrast, the amount of boat-based line fishing was similar in both areas.

Stock Assessment

See separate status reports for assessments of Australian herring, pink snapper, tailor and blue swimmer crabs, elsewhere in this volume.

Assessment complete: **Preliminary**

Breeding stock levels: **Not assessed**

Southern sea garfish: Southern sea garfish are distributed across southern Australia from Kalbarri, Western Australia to Eden, New South Wales, and Tasmania. Genetic differences suggest that there is limited mixing between sea garfish populations on the lower west and south coasts of WA and that these should be managed as separate stocks (Donnellan *et al.* 2000). Until finer spatial scale information about stock structure becomes available, garfish caught in Cockburn Sound and elsewhere on the lower west coast are assumed to belong to a single breeding stock.

The breeding stock level of sea garfish on the west coast is currently not assessed. Fishery catch rates provide a relative annual index of adult abundance in this region.

Sea garfish has been targeted in a relatively consistent manner by the Cockburn Sound (Fish Net) Fishery since 1995. Thus, CPUE from this commercial fishery provides a useful long-term index of stock abundance. From 1995 to 2006 there was a downward trend in CPUE, suggesting a gradual decline in the west coast garfish stock level over this period. The CPUE trend was very similar to the total west coast catch trend, suggesting that annual variations in the catches are strongly influenced by annual variations in stock abundance. A pronounced peak in catch level and CPUE in 1999 possibly reflected strong garfish recruitment at this time.

The recreational sector is estimated to take about 70% of total west coast landings. A comprehensive assessment of garfish stock status requires more information from this sector than is currently available. In particular, an estimated 65% of the total recreational garfish landings in the west coast region are taken by shore-based fishers. More up-to-date information about the shore-based catch is required to assess the impact by the recreational sector on the west coast garfish stock.

Gloomy octopus: Gloomy octopus occur along the Western Australian coast from Exmouth Gulf to Albany. Adults are benthic but the larvae are planktonic and can occur up to 65 km from shore (Joll 1983). The stock structure is not known, but the dispersal of larvae by ocean currents probably ensures a genetically homogeneous stock along the west coast. At least some of the recruitment to Cockburn Sound is probably by larvae spawned elsewhere. Octopi in Cockburn Sound are assumed to belong to a single west coast breeding stock.

The breeding stock level of octopus on the west coast is currently not assessed. Fishery catch rates in Cockburn Sound, using unbaited pipes as the method of capture, provide a relative annual index of octopus abundance. A mean annual catch rate is calculated from data supplied by commercial fishers in voluntary daily log books since 2003. The annual catch rate in Cockburn Sound has been stable since 2003, indicating that recruitment has been adequate to sustain the relatively high recent catches.

Gloomy octopus have a short life cycle and attain a maximum age of 12 to 18 months. Each female spawns a single egg mass and then dies shortly afterwards (Joll 1983). Therefore, fishery landings are based on a single-year class and the population is replaced annually. If octopi in Cockburn Sound are mainly derived from spawning elsewhere on the west coast, then local recruitment will be independent of fishing pressure within Cockburn Sound.

Non-Retained Species

Bycatch species impact: **Low**

The small-scale commercial fisheries that operate in Cockburn Sound use lines and mesh nets. Targeted species are the dominant component of the finfish catch and minimal quantities of discarded bycatch are generated, as virtually all finfish species taken are marketed. Methods used to catch cephalopods are highly specific and result in virtually no bycatch of other species.

The recreational sector, which mainly uses line-based methods in Cockburn Sound, probably catches and releases a significant number of non-target species and undersized fish. This impact has not been assessed.

Protected species interaction; **Not assessed**

Ecosystem Effects

Food chain effects: **Not assessed**

Garfish and herring are consumed by a wide range of predators including larger fish, cetaceans and seabirds. Fishing may reduce the availability of prey to these predators.

Octopi are major predators of rock lobster. Higher fishery landings of octopus in Cockburn Sound may reduce localised predation of lobster and other species consumed by octopi.

Habitat effects: **Low**

The commercial fishing methods used in Cockburn Sound to target finfish and cephalopods do not impact significantly on the habitat.

Social Effects

During 2006, the total number of crew fishing for finfish in the Cockburn Sound (Line and Pot) Managed Fishery and Cockburn Sound (Fish Net) Managed Fishery was approximately 15. Landings from these fisheries are used to supply restaurant and retail sectors in the Perth metropolitan area.

Cockburn Sound is located within the Perth metropolitan area and is a very popular site for recreational activities including fishing and snorkeling.

Economic Effects

Estimated annual value (to fishers) for year 2006:
$145,462 (finfish)
$220,752 (cephalopods)

The annual value of this fishery is estimated from Perth market prices for each species. These values more accurately reflect the prices paid to Cockburn Sound fishers than state-wide average prices. In particular, the average price paid for Australian herring on the Perth metropolitan fresh fish market is significantly greater than the average state-wide price, which is greatly influenced by the large catch of the herring trap net fishery that is often sold at a lower price as bait for the rock lobster fishery.

Fishery Governance

Target catch range: **30 – 112 tonnes (finfish only)**

The target catch range for this fishery relates to non-bait finfish only. It was derived by applying an auto-regressive moving average quality control procedure to the annual catches from

1983 to 2002, subject to the corresponding fishing effort. The confidence intervals were obtained by estimating the variation of the observations compared with the variation of the predictions for the 20 years to 2002.

The target catch range assumes that future fishing effort will remain between 2000 and 2002 levels, although effort since 2004 has been substantially lower. The 2006 catch of 34.5 t was relatively low, but still within the target range. Relatively low effort levels are expected to continue in this fishery and will necessitate a revision of the target catch range in the future.

Current fishing level: Acceptable

The level of commercial fishing for sea garfish on the west coast is acceptable. The Cockburn Sound (Fish Net) fishery is responsible for approximately 85% of west coast commercial garfish landings. Effort in this fishery was substantially reduced after the late 1990s and is now at a historically low and stable level. Management arrangements effectively limit the maximum effort (and therefore the catch) in this fishery.

Recreational fishers, mainly shore-based, take an estimated 70% of the total west coast catch of sea garfish. However, the current catch level is uncertain because no estimates of shore-based recreational catch or effort within the last 5 years are available from the west coast region.

Garfish is listed as a Category 3 (low risk) species. There is no legal size limit. Available data indicate that the current recreational daily bag limit of 40 fish is rarely achieved and so does not constrain catch levels. Given the apparent decline in stock level over the past decade, as indicated by commercial catch trends, it is of concern that the total west coast catch level is essentially unconstrained under current management arrangements.

The recreational fishing level is probably acceptable, but more information about the recreational catch is needed and a review of the management of the recreational fishery is warranted.

The current catch level of octopus in Cockburn Sound is acceptable. In 2006, the majority (~80%) of octopus landings in the west coast region were taken by the rock lobster fishery, operating outside of Cockburn Sound. By comparison, the impact on the west coast octopus stock by fishing within Cockburn Sound was relatively low.

The octopus catch rate within Cockburn Sound has been stable for the last few years, indicating that recent recruitment has been adequate to maintain the catch level. At the same time, the octopus fishery in Cockburn Sound should continue to be closely monitored, especially while catch and effort levels continue to rise. The commercial catch has risen dramatically since 2006. In the Cockburn Sound (Pot and Line) Fishery, there are a limited number of licensees but they can deploy an unlimited number of octopus pots/pipes.

In the west coast region, recreational fishers are subject to a daily bag limit of 15 cephalopods (i.e. all octopus, squid and cuttlefish combined). A boat limit of 30 applies when 2 or more fishers are aboard.

New management initiatives (2006/07)

The appropriateness of the timing of the pink snapper fishing closure will be reviewed to ensure the closure adequately covers the peak spawning period. Large pink snapper are known to enter Cockburn Sound in early summer where they form spawning aggregations, although the exact timing of the peak spawning period varies from year-to-year due to environmental conditions and moon phases. A Government policy to eventually phase out commercial fishing for pink snapper in Cockburn Sound is likely to affect catches in the future.

A state-wide prohibition on the take of shark by all commercial fishers was implemented in November 2006. Under this initiative, all species of shark are commercially protected unless an authorisation specifically entitles a commercial fisher to take shark. No authorisations have been issued within Cockburn Sound.

External Factors

Annual variations in the strength of the Leeuwin Current influence the abundance and catch rate of Australian herring on the west coast.

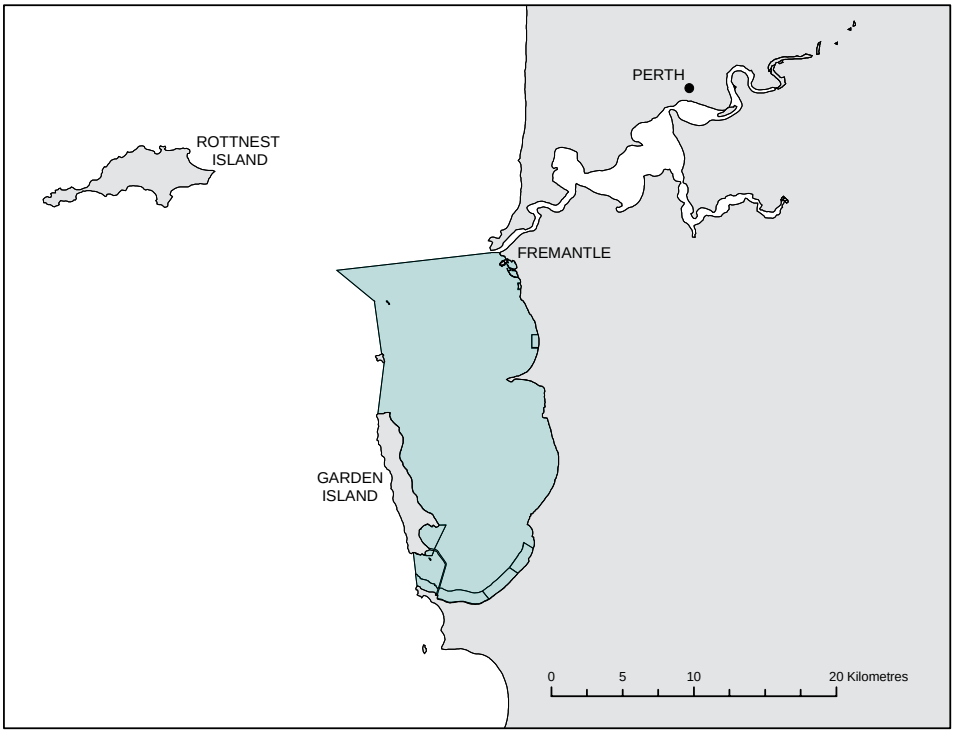
The abundance of sea garfish, octopus and other target species in Cockburn Sound is likely to be affected by the quantity and quality of coastal habitats (especially seagrass) that are available for spawning, feeding and/or nursery areas. Since the 1950s, approximately 80% of the seagrass meadows in Cockburn Sound have been lost as a result of environmental degradation (Cockburn Sound Management Council 2005).

COCKBURN SOUND TABLE 1

The catch, effort and the recreational catch share of the total catch of key recreational target species in Cockburn Sound during 2000-2001 estimated by the National Recreational and Indigenous Fishing Survey.

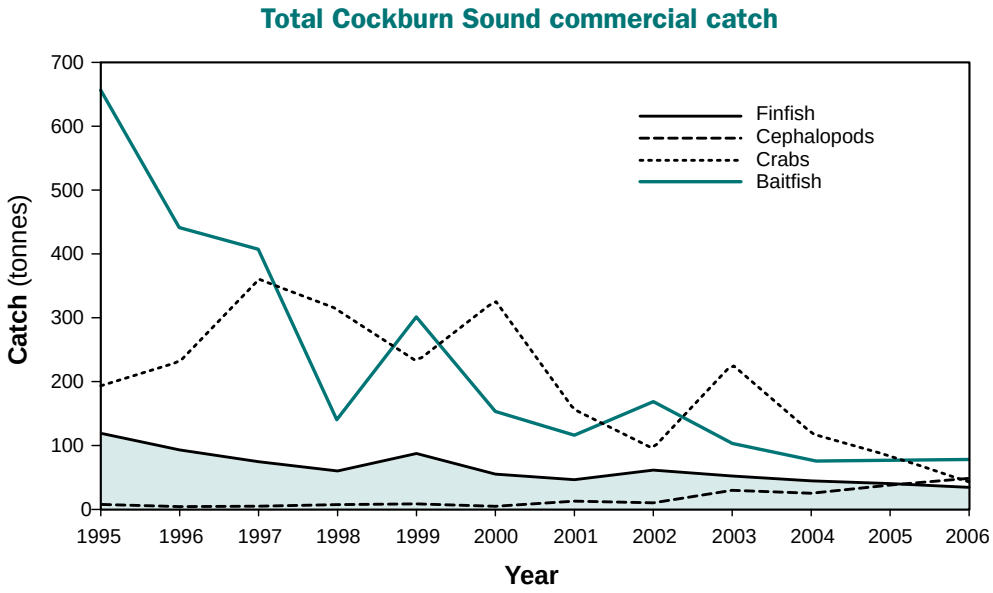
Estimated Recreational Catch 2000 – 2001			
FINFISH SPECIES	**Tonnes (t)**	**Percentage from shore**	**Percentage from boat**
Australian herring	62	76	24
Skipjack	27	57	43
Whiting	26	20	80
Garfish	18	99	1
Tailor	17	98	2
Dhufish	14	0	100
Pink snapper	11	0	100
Silver bream	7	95	5
CEPHLAPODS	**Tonnes (t)**	**Percentage from shore**	**Percentage from boat**
Squid	17	8	82
Octopus	8	0	100
EFFORT	**Days fished (line fishing events only)**		
Boat	66,700		
Shore	154,000		
Recreational catch share*	80%		

* Note: Recreational catch share is expressed as a percentage of combined (recreational and commercial) catch for the key finfish species (listed above) only.



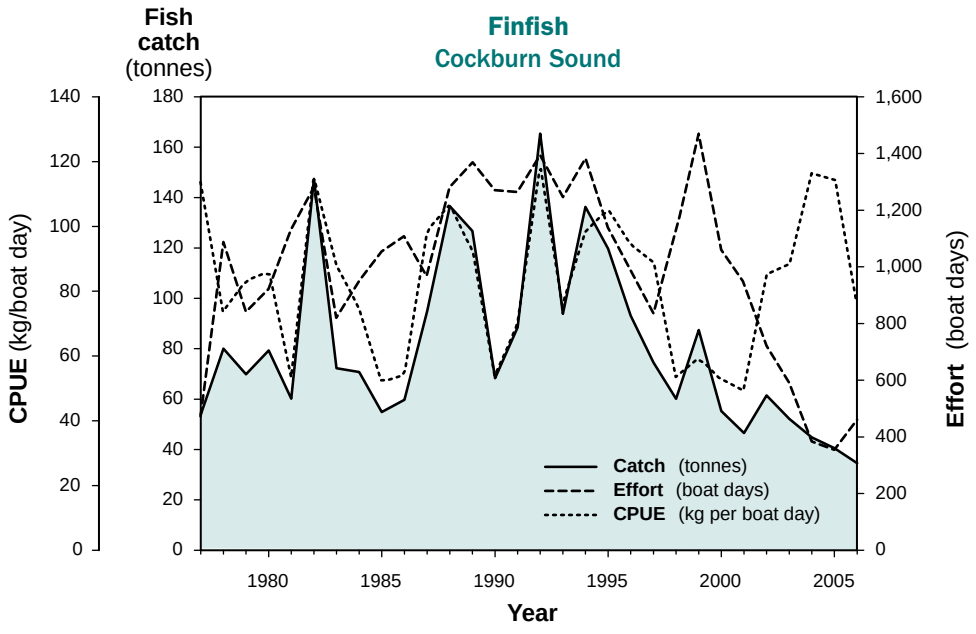
COCKBURN SOUND FIGURE 1.

Boundaries of the Cockburn Sound (Fish Net) and Cockburn Sound (Line and Pot) Managed Fisheries.



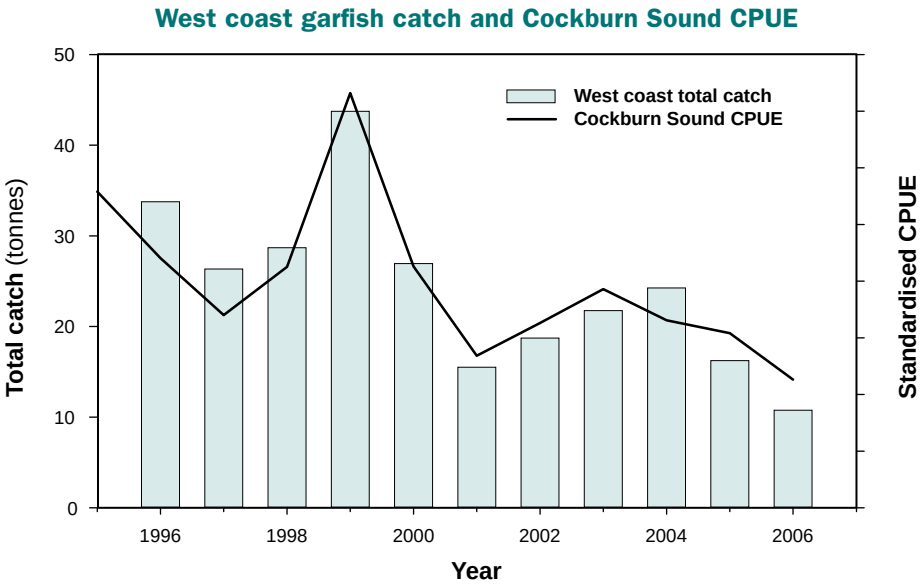
COCKBURN SOUND FIGURE 2

Total annual landings in Cockburn Sound by all commercial fisheries from 1995 to 2006. Finfish (non-baitfish) and cephalopods are mostly taken by the Cockburn Sound (Fish Net) and Cockburn Sound (Line and Pot) Managed Fisheries, as described in this report. Crabs and baitfish are mostly taken by the Cockburn Sound (Crab), West Coast Purse Seine and West Coast Beach Bait Managed Fisheries.

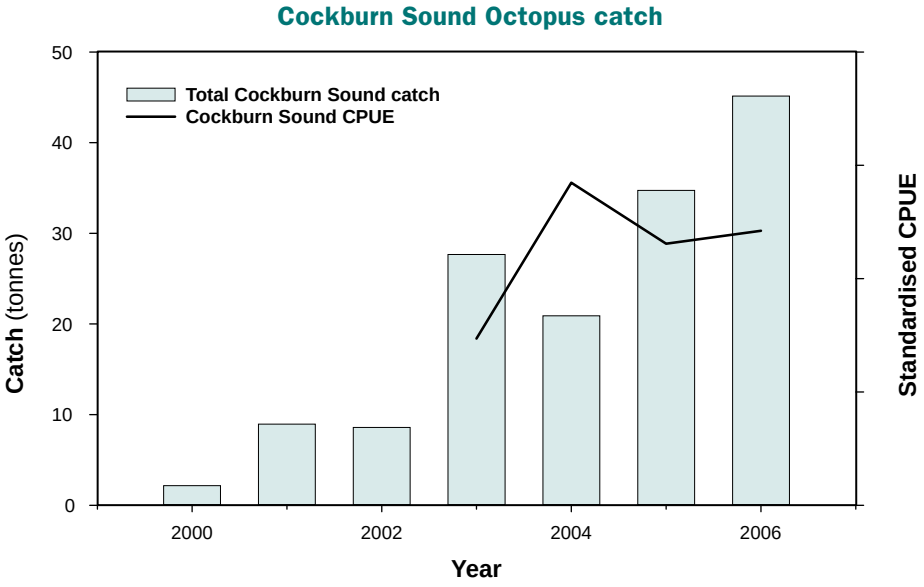


COCKBURN SOUND FIGURE 3

The annual catch, effort and catch per unit effort (CPUE) for finfish (excluding bait fish) for the Cockburn Sound fisheries over the period 1977 – 2006.



COCKBURN SOUND FIGURE 4
Total annual commercial catch in West Coast region and Cockburn Sound (Fish Net) Fishery standardised CPUE for sea garfish over the period 1996 – 2006.



COCKBURN SOUND FIGURE 5
Annual Cockburn Sound commercial catch and standardised Cockburn Sound commercial log book CPUE for octopus over the period 2000 – 2006.

West Coast Beach Bait Managed Fishery Status Report

A. Nardi, R. Lenanton and S.J. Newman

Fishery Description

The West Coast Beach Bait Managed Fishery (WCBBF) is reported on together with a much larger fishery to its south (South West Beach Seine Fishery) whose formal management is currently being developed, as both primarily target whitebait (*Hyperlophus vittatus*). The main fishing method is beach seine netting, although non-powered purse seining from small boats is also used. To a lesser extent, this fishery also targets sea mullet (*Mugil cephalus*) and blue sprat (*Spratelloides robustus*). Many of the fishers involved in the south-west beach seine fishery are also involved in the South West Coast Salmon Managed Fishery, which operates in different areas and primarily targets western Australian salmon (*Arripis truttaceus*) using larger beach seine nets than are used for whitebait fishing.

Governing legislation/fishing authority

West Coast (Beach Bait Fish Net) Management Plan 1995
Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The WCBBF extends from the mouth of the Moore River (31° 21.3′S, 115° 29.9′E) north of Perth, to Tim's Thicket (32° 39.2′S, 115° 36.6′E) in the south.

The south-west fishing activities (South-West Beach Seine Fishery occur from Tim's Thicket south to Point D'Entrecasteaux (35° 50.5′S, 116° 00′E), with activity typically concentrated in Geographe Bay (Cape Naturaliste to Preston Beach).

Management arrangements

The WCBBF is managed primarily through input controls (limited entry and gear restrictions). There are currently 2 Class A licences and 1 Class B licence.

The future management arrangements for the South West Beach Seine (SWBS) Fishery (Bunbury sector) have progressed through to the final stages of consultation. Currently, a discrete group of fishers (18 SWBS licensees) operate in this area, using similar methods to the managed beach bait fishers in the Perth metropolitan and Mandurah areas.

Research summary

This fishery is not currently the subject of any active research program, although a significant research project on the biology and stock assessment of whitebait was completed in 1996.

The annual catch of whitebait, obtained from the Department of Fisheries' CAES system, is used as a *de facto* indicator of abundance to report on the performance of the fishery. There is an ongoing research sampling program designed to predict recruitment of key inshore species, some of which contribute to this fishery.

Retained Species

Commercial landings (season 2006):

All species 268 tonnes
Whitebait 231 tonnes

The main target species in this fishery is whitebait, of which 231 t were caught in the 2006 season (West Coast Beach Bait Figure 1). Catches of whitebait are discussed here according to the region in which they were landed. Perth metropolitan and Mandurah landings form part of the WCBBF, while Bunbury landings are from the South West Beach Seine Fishery. Catches in each of the regions have varied significantly from the previous year; large inter-annual fluctuations in catch of whitebait are typical of this fishery (see the section 'Breeding stock levels').

Metropolitan: There was a slight increase on the 2005 seasons catch of 1 t to 1.8 t of whitebait caught in the Perth metropolitan region during 2006, continuing to reflect the low effort now applied in this area. The previous 3 seasons in the Perth metropolitan region have all returned small catches below 2 t.

Mandurah: The whitebait catch at Mandurah during 2006 (8 t) was significantly greater than last season's negligible return.

Bunbury: The Bunbury whitebait catch of 221 t for 2006 is the largest catch for the region since 1997 and is a significant increase on last seasons' catch of 157 t. The average annual catch for the Bunbury region is 165 t.

The total catch of all other species in all regions in this fishery was 37 t, which was dominated by sea mullet and blue sprat (West Coast Beach Bait Table 1). The catch of sea mullet decreased to 13 t from the 25 t landed in 2005.

Catches of other species were slightly lower than last year. Small quantities of pilchards (*Sardinops sagax*) and Australian herring (*Arripis georgianus*), sometimes caught in the beach seine fishery, are included in the catches reported for the West Coast Purse Seine Managed Fishery and the Australian Herring Fishery respectively (see elsewhere in this volume).

Recreational catch estimate (season 2006): Nil

There is no recreational fishery for whitebait.

Boat-based recreational catches of some non-whitebait species (e.g. western sand whiting, trevally) also landed by the WCBBF and the SWBS Fishery have recently (2005/06) been estimated. Total catches (i.e. boat-based and shore-based) by recreational fishers in the west coast bioregion are likely to be significantly larger than the commercial beach seine catches of these species.

Fishing effort/access level

Overall, for the 2 fisheries, 26 boats participated during 2006, with 17 reporting catches of whitebait. This is similar to the previous year's tally of 18 boats landing whitebait.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Given the schooling behaviour of whitebait (and most of the other retained species), the fishers' methods of targeting schools and the way the effort data are recorded on the monthly returns, these data are not useful for measuring the CPUE or the abundance of the whitebait stock.

The annual assessment for the whitebait stocks uses the total catch as an indicator of abundance, on the reasonable assumption that catchability remains stable but that fishing effort adjusts so as to take a similar proportion of the available stock in all years. The region of the fishery south of Mandurah contributes nearly all of the total whitebait catch and thus the Bunbury region catches dominate the overall trend (West Coast Beach Bait Figure 1).

The combined fishery catch of 231 t sits in the mid-range of the anticipated and acceptable catch.

Previous modeling and plankton sampling indicate that the typical stock size of whitebait is probably less than 1,000 t for the entire west coast. The cyclical nature of the fishery, whereby very good catches (usually related to a strong Leeuwin Current during the previous year) were often followed by 1 to 2 years of low catches, suggests that breeding stocks may become a limiting factor in years following environmentally-driven low recruitment.

Non-Retained Species

Bycatch species impact: **Low**

There is typically little non-retained bycatch in the targeted whitebait fishery. Where multi-species schools occur, for example of mixed whitebait and juvenile pilchards, catches are released because it is not economical to sort the catch. Most of the fish caught are saleable.

Protected species interaction: **Negligible**

The deployment of beach seine nets in this fishery is based on visual detection of fish schools and, as such, any larger protected species can easily be seen and avoided. Furthermore, few individuals of protected species occur in the near-shore fishing areas, which are in the main sandy habitats.

Ecosystem Effects

Food chain effects: **Low**

The highly variable recruitment cycle of whitebait, apparently related to oceanographic effects, means that predatory birds and fish cannot rely solely on the availability of whitebait as a major food source in all years. Furthermore, the constraints of the beach seine gear and fishing method largely limit fishing to within 80 m of the shore in accessible areas.

Stocks of whitebait are however more widely distributed, suggesting that natural predators have greater access to the fish than does the fishery. If catches in the Perth metropolitan and Mandurah sectors of the fishery (currently the 'managed' component of the fishery) were to increase, there might be some localised resource conflict between some birds and fishers. However, under current licensing arrangements and effort levels, this is not deemed a problem.

Habitat effects: **Negligible**

All fishing occurs over shallow sandy substrate. Near-shore sand habitats are naturally dynamic environments and resident fauna are adapted to cope with physical disturbances, thus the impact of the relatively small amount of very light fishing gear (fine gauge nets) would be negligible. Similarly, sandy beaches bear the traffic of fishers' vehicles but are subject to considerable natural cycles of erosion and accretion.

Social Effects

In 2006 a total of 26 boats, involving 65 crew members, participated in the beach bait fishery.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$462,344**

The majority of the whitebait landed were smaller fish, destined for human consumption and typically selling for approximately $2.00/kg. A small amount of larger sized fish, from the managed fishery, was utilised for recreational fishing bait.

Fishery Governance

Target catch range: **Whitebait 60 – 275 tonnes**

The target range remains the same as last year. The major portion of the whitebait catch is currently taken from the Bunbury sector, where the number of boats with access remains stable.

Current fishing (or effort) level: **Acceptable**

The catch of the fishery is within the acceptable range and, in combination with the adequate level of breeding stock, the current level of effort is considered to be acceptable.

New management initiatives (2006/07)

Besides continuing to progress the south-west beach seine fishing sector to more formal management arrangements, the Department of Fisheries is also exploring the option of changing the existing beach-seine-based fishery to a purse-seine-based fishery, due to the possibility of local council by-laws excluding fishers from beaches.

External Factors

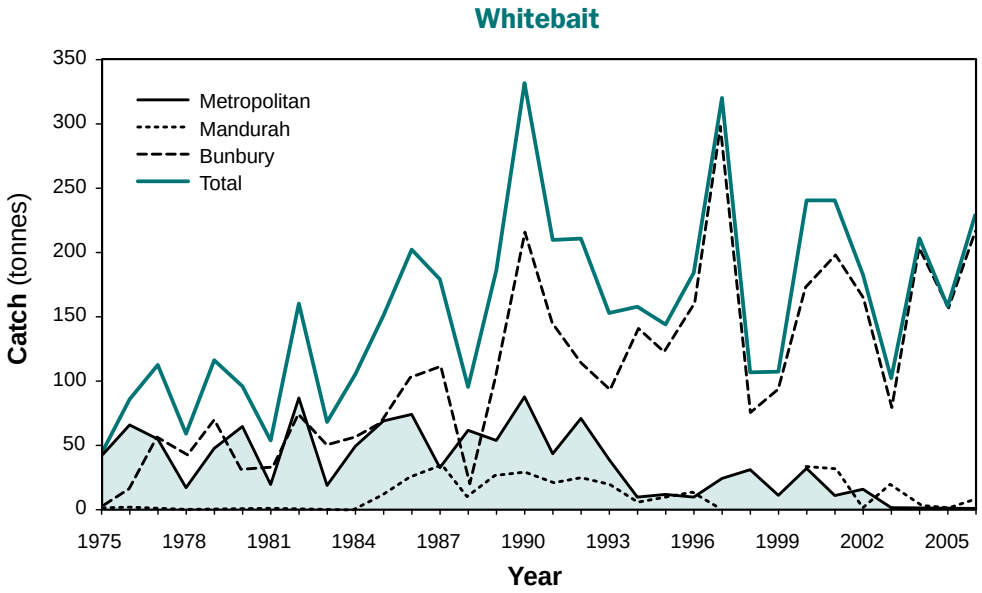
Annual catches in this fishery will most likely continue to exhibit large fluctuations under the influence of environmental factors. The fishery will therefore continue to be regulated through limited entry access and gear restrictions.

Increasing urbanisation of Western Australia's south-west region continues to impact on this fishery, as sectors of the community press to restrict access to beaches by 4-wheel-drive vehicles, including those needed by fishers to transport their gear and catches.

WEST COAST BEACH BAIT TABLE 1

Catches in 2006 of retained species other than whitebait from the West Coast Beach Bait Managed Fishery and South West beach seining sector.

SPECIES		CATCH (tonnes)
Sea mullet	*Mugil cephalus*	13
Blue sprat	*Spratelloides robustus*	12
Western sand whiting	*Sillago schomburgkii*	9
Trevally	*Carangidae*	1
Other fish varieties		2
Total		**37**



WEST COAST BEACH BAIT FIGURE 1

Annual catches of whitebait along the west coast, by fishing region.

West Coast Purse Seine Managed Fishery Status Report

A. Nardi, R. Lenanton and S.J. Newman
Management input from G. Baudains and T. Reid

Fishery Description

This fishery is based primarily on the capture of pilchards (*Sardinops sagax*) and the tropical sardine *Sardinella lemuru* (hereafter referred to as sardinella) by purse seine boats in the waters off the west coast of Western Australia. However, the management plan also covers the take of Perth herring (*Nematalosa vlaminghi*), yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*).

Governing legislation/fishing authority

West Coast Purse Seine Management Plan 1989
West Coast Purse Seine Managed Fishery Licence
Fisheries Notice no. 312 – Purse Seine Prohibition
Fisheries Notice no. 571 – Pilchard Fishing Prohibition
Fisheries Notice no. 476 – Net Hauling Restrictions
Condition 176 on a Fishing Boat Licence
Condition 93 on a Fishing Boat Licence (specific area)

Consultation process

Purse Seine Management Advisory Committee
Meetings between the Department of Fisheries and industry

Boundaries

The fishery operates between 33° S latitude and 31° S latitude (the Perth metropolitan fishery) and there are also 2 purse seine development zones currently operating north and south of this area. The Southern Development Zone, for which there are 3 operators, covers the waters between 33° S latitude and Cape Leeuwin. The Northern Development Zone covers the waters between 31° S latitude and 22° S latitude and consists of 1 active operator (whose catch is not currently reported for confidentiality reasons).

The Perth metropolitan fishery mainly targets pilchards and sardinella, the Southern Development Zone targets pilchards and the Northern Development Zone targets sardinella.

Management arrangements

This fishery is managed though a combination of input and output controls incorporating limited entry, capacity setting and controls on gear and boat size.

Currently a combined total allowable catch (TAC), covering both the Perth metropolitan fishery and the Southern Development Zone, is set for pilchards, while another is set for other small pelagic species. These TACs are divided amongst the fishery participants, but are not tradeable, as individually transferable quota units would be.

For the 2006/07 licensing period (1 April 2006 – 31 March 2007) there was a TAC of 2,328 t for pilchards, with a TAC of 672 t for the other small pelagic species (including sardinella) permitted to be taken by licensees. The Northern Development Zone has a separate TAC.

Research summary

Purse seine catches landed at Fremantle are regularly sampled to estimate age composition of pilchards and sardinella. The age-composition data provides an indication of relative recruitment strength.

Retained Species

Commercial landings (season 2006): 494 tonnes

The combined catch of pilchards, sardinella and other minor species for the metropolitan and Southern Development Zone fishery areas increased to 494 t from 379 t last season, but is still significantly lower than previous years' catches of 763 t in 2004 and 1,164 t in 2003. Pilchards dominated the total catch (67%) with sardinella comprising almost all of the remaining catch (32%).

Recreational catch estimate (season 2006): N/A

Fishing effort/access level

Fishing effort for the Fremantle fleet comprised 339 days, a decline of around 9% from the previous year's 370 days (see 'External Factors' below). It is not possible to estimate effort separately for the different species targeted.

Similarly, it is not possible to apportion the amount of effort dedicated to purse seine fishing in the Southern Development Zone, due to the multi-method and multi-species nature of the reporting required in that zone.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Stock assessment is completed only for pilchards. The time series of 8 fishery-independent spawning biomass surveys conducted between 1993 and 2004 indicated that the pilchard stock off the west coast varies in size between 8,000 and 45,000 t. However, the estimates of spawning biomass in the vicinity of 40,000 t appear to represent exceptional years rather than the typical situation. Furthermore, these estimates have very wide confidence intervals and this level of uncertainty must be considered when using the stock assessment information.

The considerable quantities of data and resources that have already been applied to researching pilchards in WA, including the development of simulation models for the south coast stock, now make it clear that there will likely always be considerable uncertainty in the biomass estimates for pilchards in WA. A significant contributor to this uncertainty is the additional mortality of larger fish that can be attributed to the ongoing effects of the herpes virus that is now a permanent fixture in the pilchard population. Therefore, rather than relying each year on point estimates against which an agreed exploitation rate can be applied, a holistic view of the biomass trends over the past 14

years or so has been used to provide a longer-term prognosis of the likely stock size of pilchards.

The likely future pilchard biomass on the west coast, if average-to-strong recruitment has been experienced over a number of years and environmental conditions favour pilchards as the dominant baitfish species, is 20,000 – 30,000 t. This range is considered to equate to the carrying capacity for small pelagic fish in this fishery.

Fluctuations in biomass level are driven by highly variable recruitment, along with environmental factors, that may lead to 'replacement' of pilchards by sardinella in the Perth metropolitan fishing grounds in some years. Recruitment of pilchards in 2006 was weaker than in previous years, but the strong recruitment in both 2004 and 2005 has resulted in an adequate age composition for this species.

The relatively small catch of pilchards, well below the accepted harvest rate of 10%, is likely to have negligible effect on the West Coast pilchard stock.

The age sampling for sardinella indicates a strong pulse of recruitment to the west coast region. The small catches of sardinella, in the context of this species' predominantly tropical distribution, do not constitute a threat to the overall spawning stock for this species. Furthermore, catch monitoring in the Fremantle region has yet to show regular or extensive spawning by sardinella in this region. As this fishery takes only mature-age fish, the above stock assessment relates directly to breeding stock levels.

Non-Retained Species

Bycatch species impact: **Low**

This fishery targets schools of small pelagic fish, so incidental bycatch is insignificant, but may occasionally include fish predators of the target species or other fish species accidentally captured when nets contact the benthos.

Protected species interaction: **Low**

There is currently no evidence to indicate any major interactions between protected species and the purse seine industry in the west coast region.

Ecosystem Effects

Food chain effects: **Moderate**

Ecosystem structure and function is reliant on flows of energy within an interconnected 'web'. Small pelagic fish occupy a pivotal role as a conduit between primary (phytoplankton) and secondary (zooplankton) production and the higher trophic levels.

The characteristics of small pelagics mean they are available as food for a number of populations of larger animals including predatory fish, pinnipeds, cetaceans and bird species. Catches of small pelagics on the west coast are carefully constrained, so as to leave a large majority of the estimated biomass available to predators. The quota for pilchards and other small pelagic species is set at a maximum of 10% of the spawning biomass, leaving more than 90% of the total biomass available to natural predators.

Habitat effects: **Negligible**

Purse seining generally has little direct effect on the habitat. Although the purse seine gear used in this fishery can contact the sea floor in some fishing areas, the relatively light construction of the gear suggests that there is no significant impact occurring to the benthos. Areas of hard reef are specifically avoided during purse seining, minimising the percentage of ground actually touched, as it is hazardous to the fishing gear.

Social Effects

The fishery employs approximately 18 full-time workers, most based in Fremantle. Owing to the inconsistent performance of the fishery, some of the skilled labour in the fleet has been attracted to other areas of employment.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$475,000**

Most small pelagic fish caught on the west coast were destined for human consumption (most typically sold as 'Fremantle sardines') this year, with lesser amounts directed to recreational bait, tuna feed, commercial rock lobster and finfish trap bait. The price paid to the boats in 2006 amounted to an average price per kilogram of $1.10 for pilchards, $0.90 for sardinella and $0.70 for maray. Thus, the value of the pilchard catch is estimated to be $362,000 and the value of the sardinella catch is estimated to be $113,000, representing a total catch value of $475,000.

The number of South Australian operators now entering the recreational bait market has adversely affected the margin on recreational bait and thus willingness to supply the market.

Fishery Governance

Target catch (or effort) range: **Not available**

The acceptable maximum catch is governed by changes in the TACs for pilchards and other small pelagic fish. The combined TAC of 3,000 t for all species in 2004/05 carried over into 2005/06. The irregular behaviour of this fishery in recent years precludes an estimation of a target effort range at this time. The anticipated introduction of a formal quota system (see below) may, depending on market forces, bring some stability to the fishery, after which it may be appropriate to estimate an acceptable effort range.

Current fishing (or effort) level: **Acceptable**

The relatively small catch of pilchards, well below the accepted harvest rate of 10%, is likely to have negligible effect on the West Coast pilchard stock and therefore the current level of fishing activity is regarded as acceptable.

New management initiatives (2006/07)

Following the release of a consultant's Final Report and subsequent Ministerial approval regarding the allocation of quota between existing zones, a new management plan is currently being developed for this fishery. The new management plan will include the Southern and Northern Development Zones. These 2 areas, along with the Perth metropolitan fishery, will thus be managed as 3 zones within a single West Coast Purse Seine Fishery, with all operators fishing under a managed fishery licence rather than under an endorsement on their fishing boat licence.

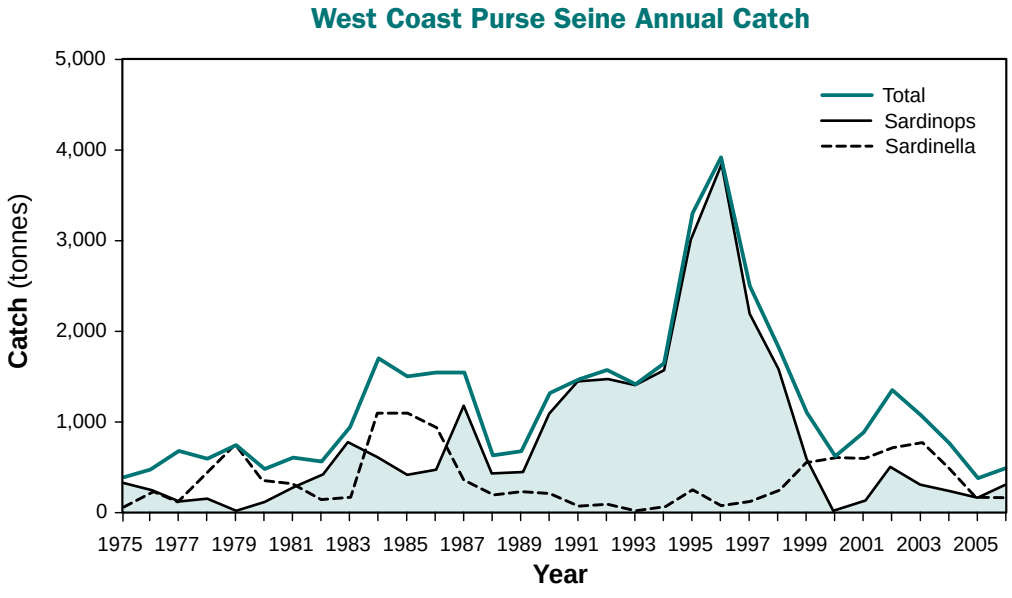
The implementation of the new management plan will move the fishery to a formal quota system, with tradeable, individually transferable quota units and a TAC. The ITQ unit values will be reviewed annually and changed, as required, depending on stock levels.

External Factors

Market forces continue to have a large impact on the fishery. The South Australian purse seine fishery, which catches considerably larger quantities of pilchards than the WA purse seine fisheries, has taken up a significant part of the Australian bait market, thus reducing demand and prices for the Fremantle product. A small specialist market remains for human consumption products, most typically sold as 'Fremantle sardines'.

The reduced effort applied in the fishery in recent years appears to have led to a loss of knowledge regarding behaviour of small pelagic fish. Thus, at those times when the fish are difficult to find, fishers have experienced difficulty in locating schools in 'new' locations.

It remains uncertain whether there have been changes in either schooling behaviour of the key small pelagic species or their spatial dynamics following both the mass mortality event of 1998/99 and the major El Niño event that occurred shortly thereafter. It appears that the influence of oceanographic variation plays a role in determining the relative catchability of the pilchards and sardinella.



WEST COAST PURSE SEINE FIGURE 1
Annual catches of pilchards (*Sardinops*) and sardinella in the West Coast Purse Seine Fishery.

West Coast Demersal Scalefish Fishery Status Report

J. St John and C. Johnson
Management input from T. Nicholas

Fishery Description

Commercial

The West Coast Demersal Scalefish Fishery includes the West Coast bioregion's commercial wetline fishery, which has access to species or fishing methods not currently subject to a management plan. The wetline fleet comprises both 'wetline-only' vessels and the 'wetline' activities of vessels with other managed fishery licences.

Currently, the wetline fishery is limited only by the overall ceiling on fishing boat licences, but this will change shortly – see below. Handlines and droplines are the main fishing methods in this fishery.

The West Coast Demersal Scalefish Fishery focuses primarily on West Australian dhufish *(Glaucosoma hebraicum)* and pink snapper *(Pagrus auratus)*, but also targets a number of emperors (*Lethrinus* species), baldchin groper *(Choerodon rubescens)*, eight-bar cod *(Epinephelus octofasciatus)* and coral trout (*Plectropomus leopardus*), as well as taking a range of other species. Some of these species are also caught either by handlines, in the recreational and charter boat sectors, or by demersal gillnets and longlines, in other commercial managed fisheries.

Fishing and Aquatic Tour Industry (Charter)

Demersal scalefish are the main species harvested by the fishing activities of the charter boat industry in the West Coast bioregion. As a result, the activities of this sector are included in the west coast demersal scalefish fishery report. Handlining is the main fishing method used by the charter industry.

Recreational

During 2005/06, activities of the recreational sector in the West Coast Demersal Scalefish Fishery were assessed in a creel survey of boat-based fishing activities carried out in the West Coast bioregion. Handlining is the main fishing method used by the recreational fishers.

Governing legislation/fishing authority

Commercial

Fish Resources Management Regulations 1995
Fishing Boat Licence

Fishing and Aquatic Tour Industry (Charter)

Fish Resources Management Regulations 1995 and recreational fishing regulations
Fishing Tour Operator Licence and/or Aquatic Eco-Tourism Licence

Recreational

Recreational fishing regulations

Consultation process

Commercial

Not applicable

Fishing and Aquatic Tour Industry (Charter)

Recreational Fisheries Advisory Committee (RFAC) and Charter Boat Owners & Operators Association

Recreational

RFAC and a network of 12 Regional Recreational Fishing Advisory Committees

Boundaries

Commercial

The West Coast bioregion encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30′ E. Once under formal management however, the northern boundary of the west coast demersal scalefish fishery will shortly change to latitude 26°30′ S and the commercial fishery will be divided into 4 management zones: Kalbarri (26°30′ S to 28° S), mid-west (28° S to 31° S), metropolitan (31° S to 33° S) and south (33° S to 115°30′ E).

Fishing and Aquatic Tour Industry (Charter)

The West Coast bioregion encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30′ E.

Recreational

The West Coast bioregion encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30′ E.

Management arrangements

Commercial

The West Coast Demersal Scalefish Fishery operated through open-access arrangements (but this to change shortly – see below). The term 'open-access' reflects the legislative nature of the 'wetline' fishery whereby fishers operate under the authority of a Fishing Boat Licence (FBL) and a Commercial Fishing Licence (CFL), rather than a managed fishery licence or other form of explicit authorization, to take species and utilize methods that are not otherwise prohibited under the *Fish Resources Management Act 1994* (primarily management plans, regulations and orders). Thus, the 'West Coast Demersal Scalefish Fishery' was not yet subject to explicit management arrangements or catch controls through a management plan but was managed primarily through size limits, some gear limits and closed seasons for some species (e.g. a baldchin groper spawning closure at the Houtman Abrolhos Islands and the Cockburn Sound snapper spawning closure).

The Wetline Review commenced in 2003 to examine the issues relating to, and to develop policy for, the future management of the 'wetline' fishery. The Wetline Review established 2 independent panels – the Commercial Access Panel (CAP) and the Management Planning Panel (MPP) to consult with stakeholders and the wider community to undertake these tasks.

After the panels delivered their final recommendations to the Minister in December 2005, these recommendations were released (as Fisheries Management Paper No. 205, 206 and 207)

for public comment in early 2006. The Minister subsequently released his proposed decisions for a final round of public consultation in late 2006.

On 29 May 2007, after considering the submissions and comments put forward by the community, the Minister announced his final 'Wetline Review' decisions for the future management arrangements for the 'wetline' fishery. The decisions, described in Fisheries Management Paper No. 224, will see the development of 2 new managed fisheries for demersal scalefish in the West Coast bioregion, to regulate line fishing and (inshore, beach-based) net fishing operations.

The new management arrangements for the West Coast Demersal Scalefish Fishery will be implemented in 2 stages. The first stage will commence in late 2007 and will introduce input controls (in the form of permits that provide access to the fishery by zone). In the second stage, transferable entitlement for each zone will be allocated to permits (in the form of units that provide entitlement in 'fishing days').

The fishery will also be managed using the Department of Fisheries' Vessel Monitoring System and via restrictions on the type and amount of gear that can be used (specifically, fishers will be permitted to operate a limited number of handlines and droplines, equipped with a maximum number of hooks on each line).

Fishers operating in the 2 new managed fisheries for demersal scalefish in the West Coast bioregion will be required to report their catch using trip catch and effort log books, which will provide the Department with a greater resolution for catch analyses.

Fishing and Aquatic Tour Industry (Charter)

In 2000, an independent assessment committee was developed to consider the initial charter licence applications. Applications were judged by this committee against entry criteria set down in Ministerial Policy Guideline No 12. Amongst the criteria was the requirement that the applicants show evidence of having operated in the charter sector prior to September 1997.

Depending on their history and where this had been generated, applicants may have been recommended for a particular licence category type and bioregion(s). These assessments, along with any recommendations, went to the Chief Executive Officer of the Department of Fisheries, who either approved or refused the granting of the licence. The Fishing Tour Operator licence category is capped.

The current licence category types are:

- **Fishing Tour Operators Licence:** Focus is on fishing.
- **Restricted Fishing Tour Operators Licence:** Focus is on eco-tourism type activities, with clients able to catch fish for a meal during a tour, but no fish are to be landed.
- **Aquatic Eco-Tourism Operators Licence:** Focus is entirely on eco-tourism activities and fishing is strictly prohibited.

All fishing is subject to recreational fishing regulations (see below). Within each category, there is the provision for a boat-based operation, a combination land/boat (boat size less than 7.5 m) based operation and a land-based operation.

Thus, catches reported in this document are from records of fishing from all vessels operating under the Fishing Tour Operators Licence and those vessels that fished operating under the Restricted Fishing Tour Operators Licence.

Recreational

The recreational fishery for west coast demersal finfish is currently managed through a mix of broad input controls (closures and size limits) and output controls (individual and boat catch limits). These too are expected to change during 2008.

Research summary

The sampling for a 3 year Fisheries Research and Development Corporation (FRDC)-funded project examining the regional variation in age and growth, reproductive biology and stock structure of dhufish and snapper populations was completed in 2006 and the draft final report was submitted to the FRDC in May 2007.

In addition to the annual collection of commercial and charter catch and effort statistics, a 12-month recreational creel survey of boat fishing in the West Coast bioregion and a 12 month phone-diary survey were carried out during 2005/06 to clarify catch share of the demersal finfish stocks among the various sectors. The recreational creel and phone-diary survey for the West Coast bioregion will be repeated in the near future.

The results of the analyses and stock assessments from the 2005/06 data are reported here. Regional stock assessments were done for the 2 primary target species – dhufish and pink snapper, while a single bioregional stock assessment was done for the less widespread baldchin groper.

Monitoring of the age structure of dhufish and snapper from various sectors, either recreational and/or commercial in specific management zones (Kalbarri, Mid-West and Perth metropolitan) is continuing and will be used to update current stock assessments. Ongoing research includes 2 other FRDC-funded projects on the post-release mortality of demersal fish species and spawning aggregations of samson fish and other west coast species. Both projects will be completed in late 2007.

As the West Coast Demersal Scalefish Fishery will change from monthly catch records to trip catch records when it becomes managed, daily/trip commercial returns have already been introduced to a small proportion of the fishery on a voluntary basis. This trial is designed to identify and resolve obstacles in the roll-out phase, as well as to ensure that the information collected fulfils the research requirements for the fishery.

Retained Species

Commercial production (season 2005/2006): 975 tonnes
Pink snapper 278 tonnes
Dhufish 181 tonnes
Baldchin groper 34 tonnes

Landings

The catch of the West Coast Demersal Scalefish Fishery refers to a suite of demersal scalefish. Over the last few years, wetliners have not been permitted to retain various seafood groups that are targeted in other managed commercial fisheries. This means the West Coast Demersal Scalefish catch will no longer include invertebrates, mackerels, tunas, sharks and rays caught using wetline methods, as they are generally part of other fisheries and are reported elsewhere in this document.

For example, when the interim mackerel management plan was introduced in 2005, wetliners were prohibited from keeping any species of mackerel caught. In December 2006, wetliners were prohibited from taking any shark species.

In 2005/06, the total catch of demersal scalefish was 975 t, down from 1,220 t in 2004/05. However newly excluded species comprised 101 t of the decline, with only 144 t representing an actual decrease.

The top 10 species landed during 2005/06 (West Coast Demersal Scalefish Table 1) included 5 shallow demersal species/groups, 4 deep water demersal finfish species and 1 non-demersal finfish species that together comprised 90% of the total catch of all species. The remaining 10% of the catch included more than 71 other scalefish species.

The 3 major targeted demersal species/groups (including 2 of the 4 indicator species) comprised 67% of the total catch of all species caught by handline and dropline in the fishery. Pink snapper were the largest portion at 278 t, next were the 2 lethrinid species, *Lethrinus nebulosus* and *Lethrinus miniatus* (variously reported as spangled emperor, sweetlip emperor, nor-west snapper and large nor-west snapper) with 194 t caught in the northern area. Dhufish ranked third with 181 t and there were 34 t of baldchin groper and 8 t of breaksea cod (West Coast Demersal Scalefish Table 1). Similar to last season, 44 boats caught 5 t of coral trout near the Houtman Abrolhos Islands. The greatest change in the catch occurred in grey-banded cod, with a 68% reduction in catch compared to 2004/2005 (West Coast Demersal Scalefish Table 1).

The West Coast Demersal Gillnet and Demersal Longline Interim Managed Fishery (WCDGDLF) and Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Interim Managed Fishery (JASDGDLF), which is located in the West Coast bioregion and primarily target sharks, landed a further 172 t of scalefish in 2005/2006. The Cockburn Sound finfish fishery landed small quantities of large, mature pink snapper.

Dhufish: The reported commercial dhufish catch in 2005/2006 was 181 t (West Coast Demersal Scalefish Table 1). The catch has declined 22% over the last 3 years, since the peak in 2002/2003, but is close to the 10-year average of 185 t. Approximately half of the annual commercial catch of dhufish is from the mid-west, 20% is from both the South and Metropolitan zones and 10% is from the Kalbarri zone (West Coast Demersal Scalefish Figure 1). Catches in all 4 zones have shown a general upward trend over the last decade, with the pattern of annual catches varying most in the mid-west and the Perth metropolitan catches following a similar pattern but at a lower level. Most of the reduction in catch in 2005/2006 occurred in Kalbarri and the Mid-west zones (West Coast Demersal Scalefish Figure 1). Other commercial catches of dhufish during 2005/2006 include 27 t caught in the southern 'shark' fisheries (WCDGDLF and zone 1 of JASDGDLF) (see West Coast Demersal Scalefish Figure 4). The catch of dhufish in the West Coast bioregion was similar for both commercial and recreational sectors.

Pink snapper: The total commercial catch of pink snapper declined by 55 t (17%) from the previous year to 278 t in 2005/2006, but remained above the 10-year average of 254 t (West Coast Demersal Scalefish Figure 2). Within the West Coast bioregion, the majority of snapper are caught in the 2 most northerly zones. Catches in these zones follow a similar annual pattern, but for the past 13 years the Kalbarri zone has had higher catches than those in the mid-west zone (West Coast Demersal Scalefish Figure 2). Catches in the Kalbarri zone have continued to decrease from a peak of 186 t in 2003/2004 to 130 t in 2005/2006, and catches in the Mid-west have decreased 20 t since last year to 86 t in 2005/2006. Catches in the Metropolitan and South zones have remained fairly stable at 37 t and 25 t respectively (West Coast Demersal Scalefish Figure 2). Other commercial catches of snapper during 2005/2006 include 21 t caught in the southern shark fisheries (WCDGDLF and zone 1 of JASDGDLF) (West Coast Demersal Scalefish Figure 5). Most of the pink snapper caught in the West Coast bioregion is caught commercially.

Baldchin groper: The commercial catch of baldchin groper in 2005/2006 was 34 t – down by 2 t from last year but above the 10-year average of 33.6 t (West Coast Demersal Scalefish Figure 3).

Recreational catch estimate (2005/06):
1,103,528 (number of fish)
Pink snapper 57 tonnes
Dhufish 207 tonnes
Baldchin groper 38 tonnes

In 2005/06 the total recreational catch of demersal scalefish (including charter) in the West Coast bioregion was 1,103,528. This does not include sharks, rays, tuna, mackerel, invertebrates and molluscs. The pink snapper, dhufish and baldchin groper catches represents approximately 7% of the total number of recreational species caught.

The top 10 species (in total numbers) from the recreational creel survey conducted during 2005/06 (ocean line fishing only) included 6 shallow demersal species/groups and 4 demersal scalefish species that represent 83% of the total number caught. The remaining 17% of the catch included more than 183 other different scalefish species (West Coast Demersal Scalefish Table 1).

The top 10 species (in total numbers) from the charter sector for 2005/06 were all demersal scalefish species that together account

for 80% of the total number of scalefish species caught. The remaining 20% of the catch included more than 108 other different scalefish species (West Coast Demersal Scalefish Table 1).

Fishing effort/access level

Commercial

Annual fishing effort by the demersal wetline sector is estimated from the monthly CAES (Catch and Effort Statistics) returns from fishers. This system does not distinguish effort as time spent targeting or fishing for different species, therefore effort days for each species can overlap due to the method of recording. For this reason, effort days can only provide a year-to-year comparison of wetline activity for each species.

During 2005/2006, 227 licensed fishing boats in the West Coast bioregion line-fished for demersal finfish and 51 of these boats were 'wetline-only'. Collectively, these vessels reported wetlining activities on a total of 10,665 days during 2005/2006. Overall, 197 boats reported catching dhufish, 212 boats caught pink snapper and 138 boats caught baldchin groper.

The effort days relating to each of the key indicator species are as follows.

Dhufish: In 2005/06, the number of effort days for dhufish was 8,595, which has effort dropping 7% per year since 2003/2004, but remains high compared to the previous decade (West Coast Demersal Scalefish Figure 3).

Pink snapper: At 9,539 fishing days for 2005/06, the number of effort days for pink snapper was 7% lower compared to the previous year, but this level has increased by 50% since the previous decade (West Coast Demersal Scalefish Figure 3).

Baldchin groper: Fishing days in 2005/2006 were recorded at 5,165, showing a slight decrease over 2004/2005 when 5,319 days were recorded. A 3-month, spawning season closed-area specific to baldchin groper has reduced effort on this species by only 11% since it was introduced in 2003. Fishing effort, however, remains high compared to the previous decade (West Coast Demersal Scalefish Figure 3).

Fishing and Aquatic Tour Industry (Charter)

The total fishing effort for the West Coast bioregion during 2005/06 was 26,500 fisher days – this was a slight increase from the previous year 2004/05 which was 25,600 fisher days.

Recreational

The total fishing effort estimated for the West Coast bioregion during the 2005/06 creel survey was 701,000 recreational boat hours, or 1,557,000 fisher hours for ocean line fishing only.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels:

Pink snapper: **low**

Dhufish: **declining**

The levels of exploitation on both dhufish and pink snapper are above international benchmark standards across all zones of the West Coast bioregion and for baldchin groper at the Abrolhos Islands. This indicates that these stocks are currently being over-fished and therefore are being depleted to levels below those necessary to ensure their long-term sustainability.

The current reliance of the dhufish catch on a single recruitment pulse, together with the extremely truncated age distribution of pink snapper, indicates that both these stocks are particularly vulnerable.

At the Abrolhos Islands, the level of fishing mortality on baldchin groper, combined with declining catch rates, indicate that localised over fishing of this species is occurring.

Stock assessments have not been done on any of the deepwater, long-lived, demersal species in this fishery. The grey-banded cod is a deepwater species that is targeted alongside hapuku. No change in the catch of hapuku between 2005/2006 and 2004/2005 suggests that fishing effort on the 2 species is similar. In contrast, the catch of grey-banded cod declined 68% (West Coast Demersal Scalefish Table 1), suggesting that its stocks have greatly reduced in abundance.

Non-Retained Species

Bycatch species impact: **Negligible**

Line fishing is a highly selective fishing method that targets demersal fishes using baited hooks. Only a small proportion of the overall catch, such as a small number of inedible species (e.g. silver toadfish) or small fishes (e.g. wrasses) is discarded. None of these bycatch species are likely to be affected by this fishery.

Protected species interaction: **Negligible**

Owing to the high selectivity of the fishing gear, commercial line fishing is highly unlikely to interact with protected species. A new commercial log book that will be released in November 2007 will include a specific section for protected species interaction.

No protected species interactions have been reported by the recreational or charter sector. A new log book soon to be released for the charter sector will include a specific section for protected species interactions.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The fishing methods used in the wetline fishery to target demersal fishes (baited handlines and droplines) have little physical impact on the benthic environment.

Social Effects

Commercial

Employment in this fishery is difficult to assess because 78% (186) of the boats in the wetline fleet are associated with other licensed fisheries. Only 53 boats in the wetline fleet hold no other licences and thus are 'wetline-only'. On average, the total fleet fished 47 days each, employing on average 2 crew to take demersal and other finfish during 2004/05.

Fishing and Aquatic Tour Industry (Charter)

Employment in this fishery has not been assessed, but the sector has currently has 311 licensed operators state-wide. During 2005/06 there were 161 licensed operators who could work in the West Coast bioregion, of which 61% of those operators actively reported using their license in the bioregion. The total number of clients reported by west coast operators in 2005/06 was 62,000.

Economic Effects

Estimated annual value (to commercial fishers) for year 2005/06: **$6.4 million**

The estimated value of the fishery in 2005/06 includes all scalefish species (excluding mackerel and tuna) caught by handlines and droplines on the west coast of Western Australia.

Over 90 species or taxa of scale fish were recorded as catch and sold for an estimated $6.4 million. The highest-valued catch was dhufish (at 38% of the total value), followed by pink snapper (21%), the lethrinids (16%), bight redfish (6%) baldchin groper (5%) and hapuku (2%).

No other finfish species had a catch valued at more than $100,000. Prices used to calculate the value of the fishery in 2005/06 were dhufish $13.50/kg, pink snapper $5.24/kg and baldchin groper $10/kg. At $12.50/kg, coral trout commanded the second highest average price of all species in the fishery.

As demand for popular fish species varies seasonally their prices fluctuates greatly and thus average prices used here are considered to be conservative.

Fishery Governance

Target catch (or effort) range: **558 – 798 tonnes (days)**

Commercial

The proposed target catch range is based on the mean from catches in the decade 1990/91 to 1999/2000 using 80% confidence limits around that 10-year mean. For the entire fishery, the target catch range has been recalculated at 558 – 798 t. Target catch ranges for individual species are 125 – 179 t for dhufish, 153 – 254 t for pink snapper and 27.5 – 35.5 t for baldchin groper.

For the fourth consecutive year, the commercial catch of 975 t is well above the proposed target range, reflecting the increasing mobilisation of the latent effort in the wetline fishery in the west coast bioregion. Similarly, all 3 indicator species (dhufish at 181 t, pink snapper at 278 t and baldchin groper at 34 t) have again exceeded their target catch ranges.

Current fishing (or effort) level: **Unacceptable**

New management initiatives (2006/07)

A review of the management arrangements for this proposed fishery is currently underway as part of the Wetline Review. Until specific management arrangements are implemented for this sector, the levels of exploitation, particularly for dhufish, can be expected to continue to rise as market demand remains favourable, catch rates remain profitable and vessels seek to maintain catch histories prior to management changes.

When management of the demersal wetline sector is introduced, the current target catch ranges will need to be reviewed and set to match long-term sustainable harvest levels and the commercial catch share agreed in the IFM process. This review will incorporate stock assessment information and an increased level of biological information on dhufish and other target species from the research program currently underway.

In the interim, previous research has already indicated that the current catch is too high, suggesting that action to stabilise or reduce catches should be considered.

External Factors

The productivity of the West Coast Demersal Scalefish Fishery relies on the maintenance of both the snapper and dhufish populations. The recent research on dhufish found evidence of high recruitment in only 4 consecutive years in the last 20 years.

A correlation between salinity and recruitment that indicates recruitment may be influenced by the strength and timing of the Capes Current and this relationship is currently being explored in more detail. In contrast, no recruitment peaks were evident in the snapper fishery, but this may be indicative of the few age classes in the population.

As the spawning aggregation in Cockburn Sound contained the largest, oldest and most fecund pink snapper in the West Coast bioregion, it is considered to be the most important spawning and nursery location for the productivity of this species in this fishery.

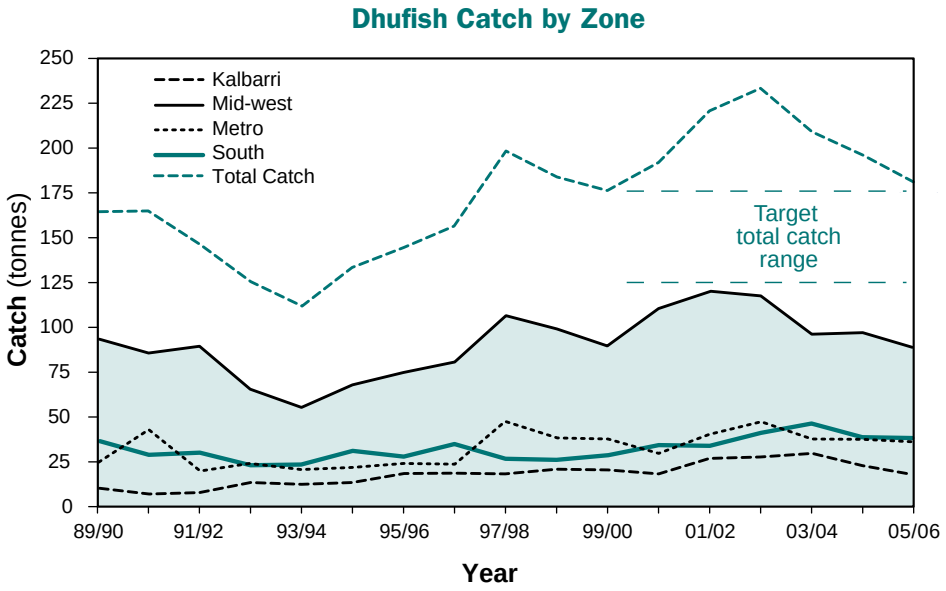
The Department of Fisheries is planning further research to investigate the relative importance of the 2 major spawning aggregations on the west coast – Cockburn Sound and Shark Bay (off Carnarvon) in the replenishment of this species in the West Coast bioregion.

WEST COAST DEMERSAL SCALEFISH TABLE 1

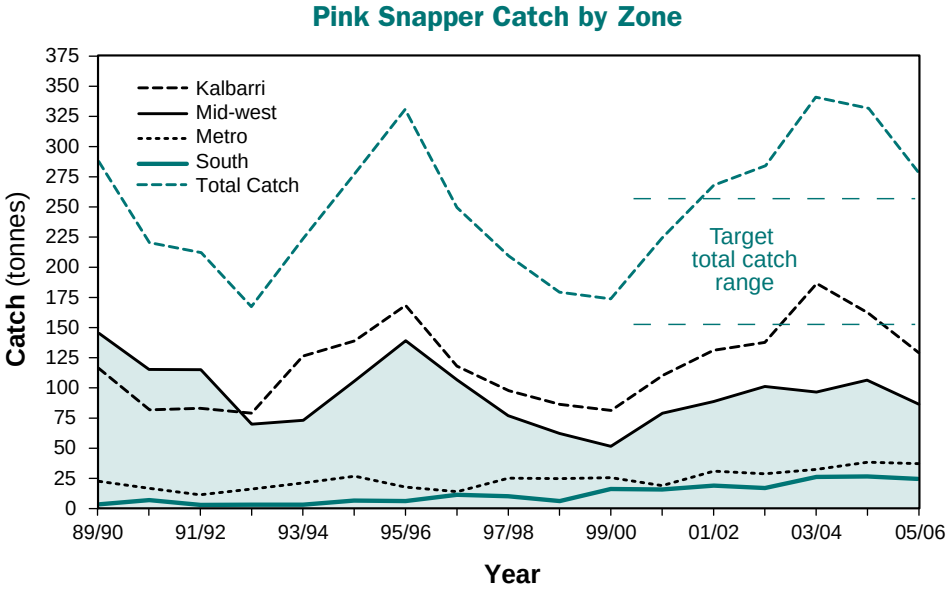
Ranked catch in tonnes (for the commercial sector) and numbers (for the recreational sector including charter) of the top 10 species of finfish caught from each sector (commercial, charter and ocean line recreational fishing) in 2005/06 by handline or dropline, grouped as either shallow demersal (less than 100 m), deep water demersal (>100 m) non-demersal and nearshore species. Major indicator species used to assess the fishery are in **bold type**. Landings in the top 10 species/groups for each sector are underlined.

Species		Landings (tonnes)		
		Commercial	Charter	Recreational
Demersal finfish – shallow water				
Pink snapper	*Pagrus auratus*	278.2	17	40
Lethrinid species	*Lethrinus nebulosus, L. miniatus*	194.5	6	7
Dhufish	*Glaucosoma hebraicum*	181	20.5	186
Baldchin groper	*Choerodon rubescens*	34	10	28
Sweetlip	Haemulidae	13	0.5	1.5
Breaksea cod	*Epinephelides armatus*	8	4	16.5
Demersal finfish – deep water				
Redfish[1]/red snapper	*Centroberyx* spp.	83	2.5	5
Hapuku	*Polyprion oxygeneios*	18	N/A	N/A
Grey-banded cod	*Epinephelus octofasciatus*	13	N/A	N/A
Ruby snapper	*Etelis carbunculus*	13	N/A	N/A
Swallow tail	*Centroberyx lineatus*	0.011	1.5	0.5
Non-demersal finfish				
Samson fish	*Seriola hippos*	48	11.5	25
Trevally skipjack/silver	*Pseudocaranx dentex*	9	5	37
Queen snapper, blue morwong	*Nemadactylus valenciennesi*	8	6	10.5
Sea sweep	*Scorpis aequipinnis*	0.4	2	3.5
Nearshore species				
Australian herring	*Arripis georgianus*	0.023	0.04	45.5
King George whiting	*Sillaginodes punctata*	0.37	0.1	17.5
Whiting, other (including southern school, sand, western school, yellow finned)	*Sillago* spp.	0.5	0.01	46

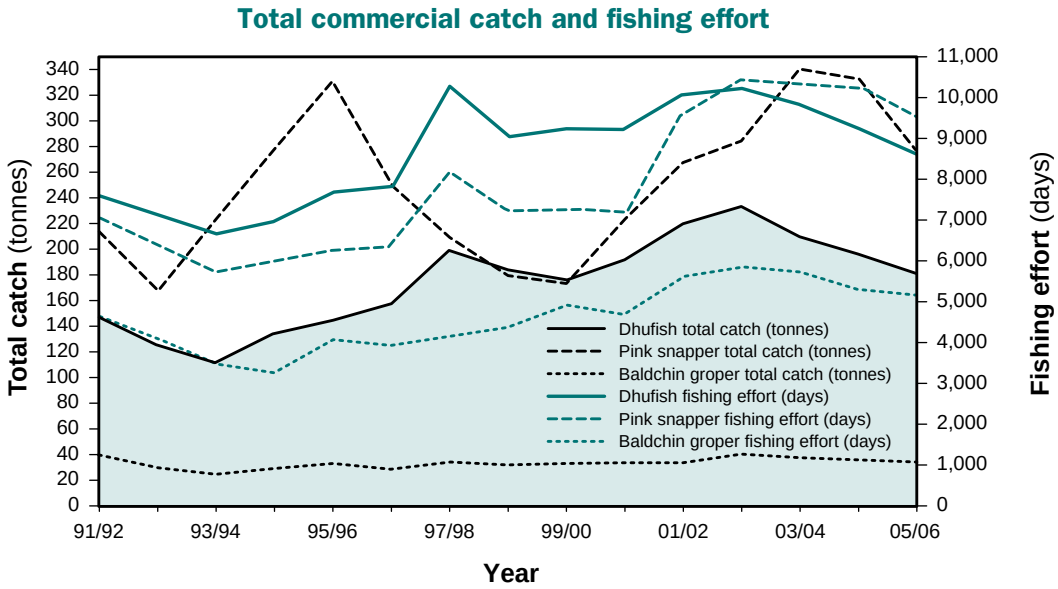
1. Expected to be Bight redfish or *Centroberyx gerrardi,* a deep-water species.



WEST COAST DEMERSAL SCALEFISH FIGURE 1
Annual commercial catch of dhufish in the 4 zones and total annual catch of dhufish in the West Coast Demersal Scalefish Fishery from 1989/90 to 2005/06.

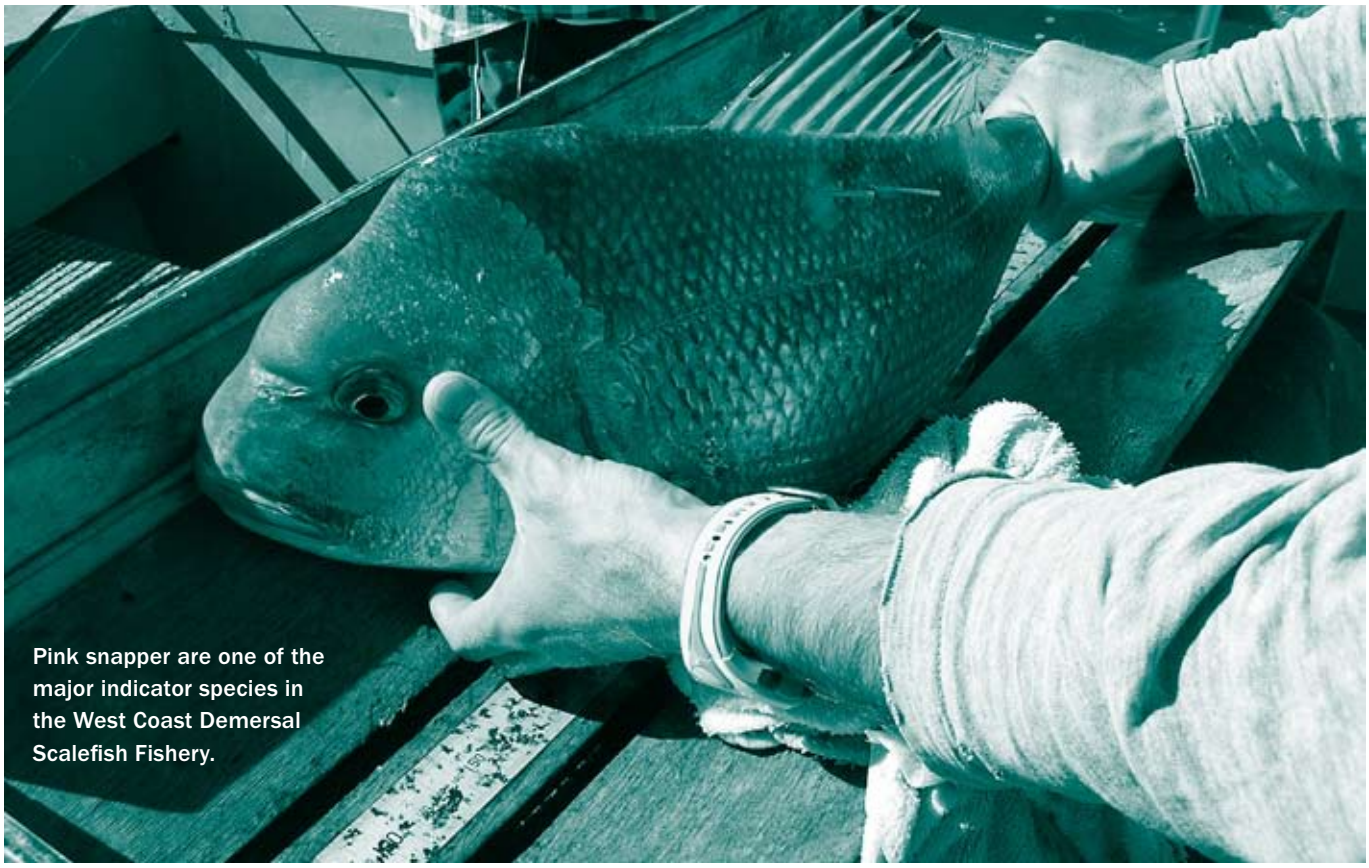


WEST COAST DEMERSAL SCALEFISH FIGURE 2
Annual commercial catch of pink snapper in the 4 zones of the West Coast Demersal Scalefish Fishery from 1989/90 to 2005/06.

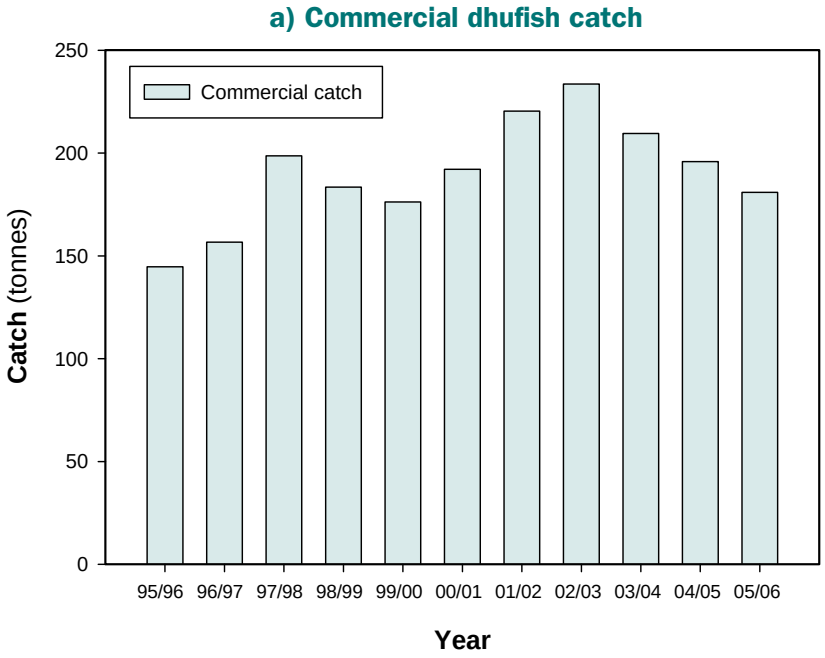


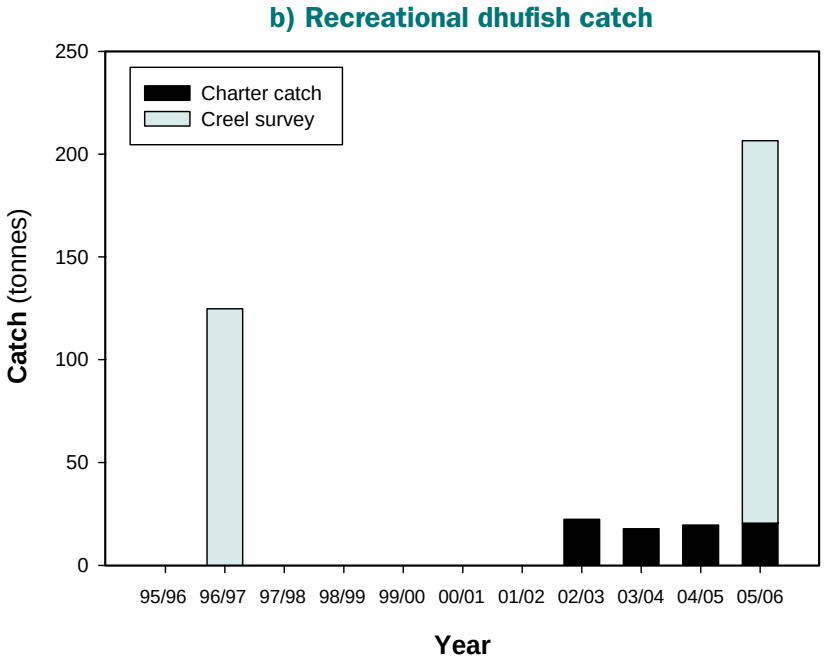
WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total annual commercial catch and days fishing for dhufish, pink snapper and baldchin groper in the 'West Coast Demersal Scalefish Fishery' from 1991/92 to 2005/06.



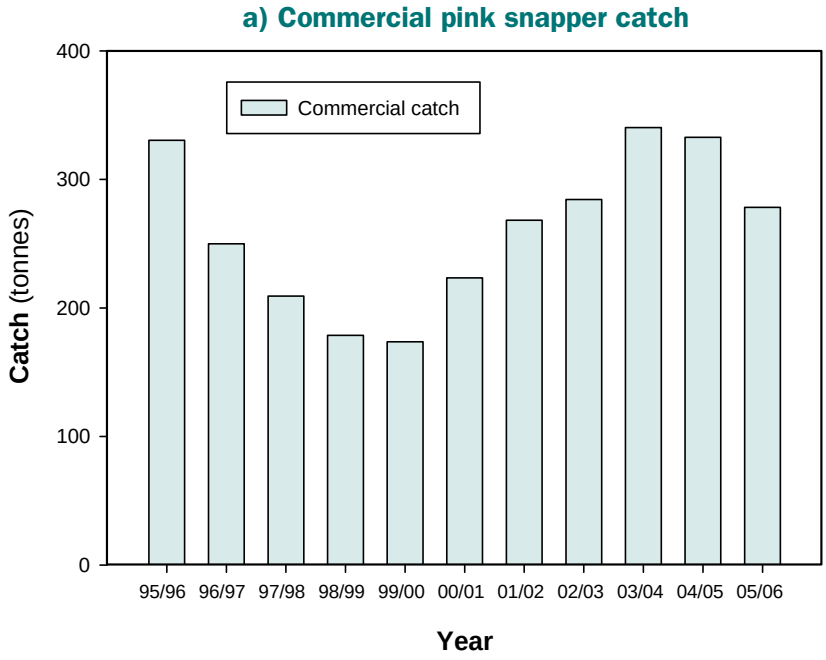
Pink snapper are one of the major indicator species in the West Coast Demersal Scalefish Fishery.

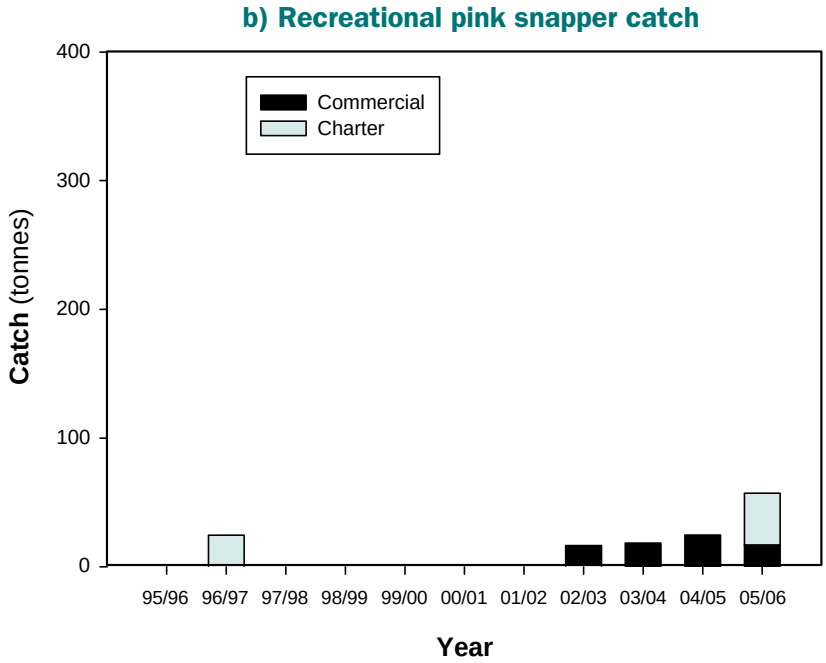




WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total annual catch of dhufish recorded for a) commercial and b) recreational sectors in the West Coast bioregion 1995/96 to 2005/06 by all fishing methods. Commercial sectors include wetline methods used by the West Coast Demersal Scalefish Fishery and gillnet and longline methods used by the southern shark fisheries (WCDGDLF and zone 1 of JASDGDLF). Note that data for the recreational sectors are not available for every year.





WEST COAST DEMERSAL SCALEFISH FIGURE 5

Total annual catch of pink snapper recorded for a) commercial and b) recreational sectors in the West Coast bioregion 1995/96 to 2005/06 by all fishing methods. Commercial sectors include wetline methods used by the West Coast Demersal Scalefish Fishery and gillnet and longline methods used by the southern shark fisheries (WCDGDLF and zone 1 of JASDGDLF). Note that data for the recreational sectors are not available for every year.

West Coast Tailor Fishery Status Report

K. Smith, J. Brown and M. Hammond
Management input from C. Syers

Fishery Description

Tailor *(Pomatomus saltatrix)* is a key target species for recreational anglers in estuaries, along beaches and around coastal reef systems on the lower west coast.

This accessible distribution, coupled with strong schooling behaviour, makes the stock relatively vulnerable to growth over fishing and potentially also to recruitment over fishing. These risk factors, together with naturally variable recruitment and growing inshore fishing pressure, were first recognised in the early 1990s. Since that time, daily bag limits have been reduced twice – from unlimited to 20, then from 20 to 8 fish per person.

The majority of the recreational catch of tailor in WA is taken from the Perth metropolitan area in the West Coast bioregion, while the bulk of the commercial catch comes from Shark Bay in the Gascoyne bioregion. Minor commercial and recreational catches are also taken on the south coast.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Recreational Fishing Advisory Committee (RFAC)
Regional Recreational Fishing Advisory Committees
Meetings between the Department of Fisheries and industry

Boundaries

Tailor inhabit coastal and offshore waters. They mainly occur between Shark Bay and the lower west coast, but they also occur in smaller numbers along the south coast.

Tailor can be taken commercially throughout this range by holders of an unrestricted fishing boat licence. Recreational fishing for tailor can occur in all WA waters except in areas closed to recreational fishing, i.e. marine reserves.

Management arrangements

Tailor is assigned to the 'medium risk' category. The daily bag limit for recreational fishers is 8, with a condition that only 2 of these fish may be over 600 mm in the west coast and south coast regions.

Tailor may be commercially caught by beach seine, set net and line methods by any licensed commercial fisher holding an unrestricted fishing boat licence, provided the use of this method is permitted in the particular area and the waters being fished are not subject to other fishery management arrangements.

The legal minimum length is 300 mm for recreational and commercial fishers.

As tailor is considered a prime recreational species, resource-sharing issues are a major consideration in future management arrangements for this fishery, particularly on the west coast.

Research summary

Tailor populations are genetically homogeneous along the west coast of WA, between Shark Bay and Cape Naturaliste. However, otolith carbonate analysis has suggested that the inner Shark Bay populations remain separate after recruitment from populations outside of Shark Bay. Thus, tailor located south of Shark Bay and within Shark Bay are managed as separate stocks.

Following concerns about increasing recreational fishing pressure on tailor in the greater Perth metropolitan area in the early 1990s, 2 research studies were instigated (a tagging study and a short-term hooking mortality study). The tagging study established that tailor from the Swan River estuary interchange freely with those in marine waters of the lower west coast. After this finding, a volunteer angling survey program was commenced to monitor the relative abundance of 0+ and 1+ juvenile year-classes in the Swan River.

Angler catch rates are an indicator of the strength of annual recruitment to the lower west coast population. The volunteer angling survey program began in 1995 and is ongoing at Point Walter, from February to April each year. Since 1995, the Department of Fisheries' Research Division has also been undertaking annual netting surveys of juvenile fish on ocean beaches, which yield another recruitment index for tailor on the lower west coast.

Recruitment indices have proven useful as predictors of commercial catch rates. Data emerging from recently introduced recreational angler log books suggest that recruitment indices will also be useful to forecast recreational catch rates on the west coast.

While commercial catch levels are determined annually from data reported in compulsory commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. Recent estimates of recreational tailor landings in ocean waters are available from a boat-based creel survey on the west coast in 1996/97 (Sumner and Williamson 1999), a national phone survey in 2000/01 (Henry and Lyle 2003) and a boat-based creel survey on the west coast in 2005/06 (Department of Fisheries, unpublished data).

Recent studies by the Department of Fisheries and Murdoch University indicated that tailor larvae off the west coast are restricted to surface waters over the middle and outer continental shelf. Therefore, variations in surface currents (including the southward Leeuwin Current and the northward Capes Current) that disperse eggs and larvae could influence the patterns of juvenile recruitment along the west coast.

Tailor spawn within a restricted range of temperatures and salinities, but these conditions occur at various times along much of the west coast, suggesting that recruits to the lower west coast could be spawned both locally and from distant sites, either north or south. Samples of tailor in spawning condition provided by recreational anglers have confirmed that spawning aggregations do occur within the Perth metropolitan region.

As part of the Research Angler Program, a recreational fisher daily log book was implemented in 2004. Log book anglers now provide important annual information about the size structure of

the recreational tailor catch and log book catch rates provide a relative index of abundance in various regions. These data will be used in future stock assessments, in conjunction with other data from recruitment surveys, biological studies and creel surveys.

Retained Species

Commercial landings (season 2006)

In 2006, the total state commercial catch of tailor was 23.9 t, down 2 t from 2005. The vast majority of landings occurred in the Gascoyne region (91.8% of total landings), with the west coast and south coast regions contributing 7.5% and 0.7%, respectively.

In the west coast region, 51.1% (0.92 t) of the total 2006 commercial catch was reported by wetline fishers in coastal areas between Kalbarri and Cape Naturaliste. The remainder was reported by the West Coast Estuarine Managed Fishery (47%) and the Cockburn Sound (Fish Net) Managed Fishery (1.9%).

Recreational catch: **76% of total state catch**
94% of total west coast catch

An estimate of the total state recreational tailor catch is not available for the current year (2006). The most recent state-wide estimate (all areas, all methods) is available from the National Recreational and Indigenous Fishing Survey conducted between May 2000 and April 2001 (Henry and Lyle 2003).

An estimated 587,000 tailor were caught in WA by recreational fishers during this 12-month survey. The average weight per tailor measured during the survey was 0.319 kg. Therefore, the recreational catch for the state was calculated to be 187 t during the survey period. This quantity was 76% of the total state-wide tailor catch (estimated recreational catch plus commercial catch) in 2000/01.

In 2000/01, the vast majority (182 t or 97%) of recreational landings of tailor were reported in the west coast region, with minor quantities taken in the Gascoyne and south coast regions. An estimated 88% of the west coast recreational catch during the survey was from shore-based fishing.

Preliminary estimates from the boat-based creel survey undertaken by the Department in 2005/06 suggest that the number of tailor retained by boat-based recreational fishers in the west coast region was 5,121 fish during the 12-month survey period. This was significantly less than the 26,627 fish that were estimated to have been retained by boat-based recreational fishers in 1996/97 during a similar creel survey by the Department.

The legal minimum length for tailor was raised from 250 to 300 mm between these 2 creel surveys and would have resulted in a higher proportion of fish being released in 2005/06 compared to 1996/97. Nonetheless, even if this proportion is assumed to be very high (say 50%), the boat-based catch rate of tailor on the west coast still appears to have declined significantly.

Fishing effort/access level

Commercial

In 2006, the majority (87%) of the state's commercial catch of tailor was caught in the Shark Bay Beach Seine and Mesh Net Managed Fishery (see elsewhere in this volume for the status report on this fishery).

In the west coast region, the West Coast Estuarine Managed Fishery, the Cockburn Sound (Fish Net) Managed Fishery and the wetline fishery in coastal waters take very minor quantities of tailor. Tailor is not a primary target species in these fisheries and landings are mostly bycatch.

Recreational

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and regions, provides the most comprehensive information on recent recreational fishing effort. The relevant data for the tailor fishery is the line fishing effort.

In inshore waters of the west coast region, where most recreational tailor landings occur, the estimated line fishing effort (either bait or lure) totalled 946,841 shore-based and 308,673 boat-based 'fishing events' during the 12-month survey period.

2 12-month creel surveys undertaken by the Department in 1996/97 and in 2005/06 estimated that the total fishing effort expended by boat-based recreational fishers in the west coast. However, no recent estimates of shore-base recreational effort, which accounts for the majority of tailor landings, are available for the west coast region.

Stock Assessment

Assessment complete: **Preliminary**

Breeding stock levels: **Uncertain**

Tailor become susceptible to capture by line fishing at 150 – 200 mm total length (TL) and around 1 year of age, but do not attain the legal minimum length of 300 mm until ~3 years (Ayvazian *et al.* 2001, K. Smith unpublished data).

Tagging studies have found that these sub-legal sized fish are subject to high fishing pressure, especially in the Perth metropolitan region (Young *et al.* 1999). Fortunately, survival rates by small tailor after hooking appear to be relatively high (≥90%), except if fish have suffered deep (gut) hooking or undergone excessive handling (Ayvazian *et al.* 2001, 2002). These results indicate that size limits and bag limits are effective tools for managing this species.

Juvenile tailor tagged in the Perth metropolitan area have been recaptured as adults at locations northwards or immediately offshore, suggesting that at least some fish spawn locally and contribute to local recruitment (Young *et al.* 1999).

About 21% of the west coast stock is thought to occur offshore (i.e. >500 m from shore) and this component of the stock is dominated by large breeding fish (Ayvazian *et al.* 2001). If local spawners are a major source of recruitment to the Perth metropolitan fishery, then high levels of targeting of offshore fish by recreational fishers is likely to result in local depletion. Recent creel surveys of boat-based fishing indicate that the recreational catch levels of tailor in west coast offshore waters declined significantly between 1996/97 and 2005/06.

The recruitment indices from the Swan River estuary and lower west coast, which now span 13 continuous years, indicate quite variable levels of annual recruitment to the lower west coast tailor population. Relatively high recruitment occurred in 1995, 1996, 1997 and 2005, but was low in other years.

Log book data and anecdotal evidence from recreational fishers suggest poor catches of mature fish in the Perth metropolitan region over recent years, which is consistent with low recruitment from 1998 to 2004. Slightly higher recreational catch rates were reported in 2006, probably as a result of higher recruitment in 2005. However, recruitment in 2006 returned to low levels.

The longer-term status of the tailor stock remains of concern due to continuing high fishing pressure and lack of data that would enable a more formal stock assessment.

On the west coast, where tailor are subject to relatively heavy fishing pressure, adults are caught predominantly on offshore reefs. Anecdotal evidence suggests that boat-based recreational fishers have been increasingly targeting large breeding individuals along the lower west coast in recent years.

A decline in the catch of tailor by boat-based fishers suggests that the abundance of offshore tailor on the west coast has declined significantly in the last 10 years. It is important to note, however, that the boat-based share of the recreational tailor catch is minor.

Therefore, the recent boat-based catch estimates cannot be used with confidence to infer anything about the recent catch of shore-based fishers, who account for the vast majority of recreational tailor landings in the west coast region. A survey of shore-based recreational catch levels in the west coast is urgently required to estimate the total catch of tailor.

Whilst the breeding stock on the west coast appears to have declined, it is not known whether the breeding stock is above or below 30% of virgin biomass, which is the minimum level generally accepted for this type of fish. Further research to better understand stock structure, spawning activity and recruitment dynamics is needed in order to estimate the size of the breeding stock on the lower west coast.

Non-Retained Species

Bycatch species impact: **Low**

The line fishing methods used to fish for tailor result in catches of other finfish species that are generally sought after by recreational fishers. Very limited discarding of unwanted species occurs.

Protected species interaction: **Negligible**

Recreational fishers angling for tailor are unlikely to capture any protected species.

Ecosystem Effects

Food chain effects: **Low**

Excessive removal of tailor from the food chain could potentially allow for some increase in the numbers of its prey species.

Habitat effects: **Negligible**

The line fishing methods used to fish for tailor have a negligible impact on the bottom substrate of estuaries or the ocean.

Social Effects

The annual spring–summer appearance of tailor along Perth metropolitan beaches has historically been targeted by thousands of shoreline anglers each year. However, recent low catch rates have resulted in fewer fishers participating in this activity.

Fishery Governance

Current fishing level: **Unacceptable**

Shore-based recreational fishers catch the vast majority of tailor in the west coast region. The current recreational fishing level in the west coast region is uncertain, due the lack of recent estimates of shore-based catch and effort levels.

Control of the recreational exploitation rate is managed through a daily bag limit and a legal minimum size limit. However, there is effectively no limit on the overall catch taken by this sector.

Available evidence (anecdotal reports of low shore-based catch rates, a significant decline in boat-based catch, ongoing low annual recruitment) suggests that, despite recent changes to bag and size limits, the recreational exploitation rate of tailor in the west coast region remains at an unacceptable level.

Commercial fishing levels are considered acceptable. The commercial catch of tailor in the west coast region is minor. Landings are essentially limited to south-west estuaries, Cockburn Sound and inshore wetline fisheries, which are subject to strict licence and gear limits.

New management initiatives (2006/07)

A review of recreational fishing in the south coast bioregion was completed and new rules implemented on 1 January 2006. As one of the outcomes of this review, the Minister for Fisheries determined that the ‘slot limit’ of only 2 fish over 600 mm should apply to the south coast.

In late 2005, the Metropolitan Region Recreational Fishing Advisory Committee proposed a further reduction in the upper slot limit from 600 mm to 500 mm and that the slot limit be introduced to the Gascoyne region. This proposal was considered by the state Recreational Fishing Advisory Committee (RFAC) who supported further consultation. The RFAC recommended that the proposal be referred to the next regional review of recreational fishing on the west coast, which is due to commence in 2007.

External Factors

It is likely that annual variation in coastal currents influences the settlement patterns of juvenile tailor and thus their subsequent recruitment into the fishery.

AQUACULTURE

Regional Research and Development Overview

Aquaculture production statistics are compiled at the Western Australian Fisheries and Marine Research Laboratories (WAFMRL) at Hillarys.

In 2005/06, the value of aquaculture decreased slightly and aquaculture tonnage decreased by 5% compared to equivalent data for 2004/05 (excluding marine algae and all pearl oysters). This is the second consecutive annual period during which aquaculture production has dropped, from a peak in 2003/04.

A Fisheries Research and Development Corporation (FRDC)-funded rock lobster project, completed in 2005/06, assessed the potential for on-growing wild-caught puerulus (post-larvae). Outcomes of this project highlighted the high survival and growth rates that can be obtained in aquaculture systems at acceptable stocking densities, indicating that puerulus on-growing may be one possibility for expanding rock lobster production in the future.

The Department of Fisheries has completed a scoping paper that considers the allocation of western rock lobster puerulus for commercial grow-out purposes. A western rock lobster puerulus aquaculture working group has been appointed to consider the issues raised in the scoping paper and develop a framework for the management of a puerulus grow-out industry.

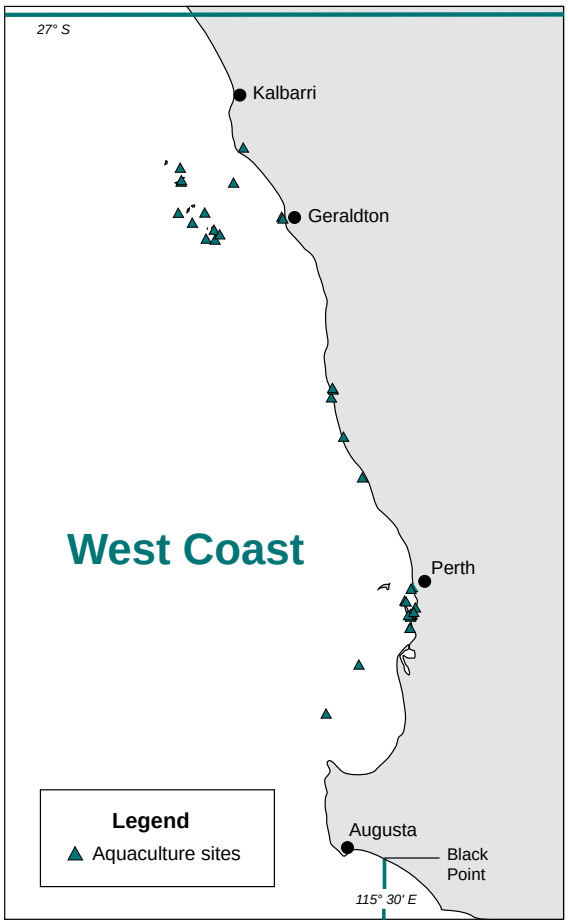
Negotiations with the Fremantle Port Authority regarding securing future leases for mussel farmers in Cockburn Sound continued and the final 'head lease' has been signed. The implementation of new leases under section 97 of the *Fish Resources Management Act 1994* is expected to occur in 2006/07.

The Department has also commenced a review of aquaculture licence conditions. The outcome of the review will see more consistent, streamlined and meaningful licensing and enforcement arrangements across all aquaculture industry sectors.

The Western Australian Shellfish Quality Assurance Program, which ensures that mussels are harvested only when water quality is appropriate for safe consumption of the product, continued to operate effectively. Arrangements with the Department of Health regarding the ongoing management of the program and its links to the new Food Bill are progressing.

The Department of Fisheries' marine finfish aquaculture research team continued its work on the development of microdiets for larval fish nutrition. The automated feeding system (patent pending) developed in an earlier stage of the project is being manufactured by the Department, with several systems already sold overseas, and was promoted by the team at the World Aquaculture Society Conference 2006. The control box for the automated feeding system has now been contracted to an external company.

With financial support from the FRDC, the current microdiet research is focusing on easily-digested proteins, feed attractants, and



WEST COAST AQUACULTURE FIGURE 1
Map showing the major licensed aquaculture sites of the West Coast bioregion.

the physical and chemical properties of the particles. The research team is collaborating with research and development centres in Tasmania, the Northern Territory, Spain, Portugal, Japan and Malaysia. Visiting scientists from Nagasaki University, Japan and the University of the Algarve, Portugal spent time in Perth during 2005/06, conducting collaborative research on larval fish nutrition.

Work also continued on the commercialisation of *Artemia* (brine shrimp) production at Hutt Lagoon, Port Gregory, with background research undertaken at the Artemia Reference Centre in Belgium. This project, also supported by the FRDC, is a collaboration between the Department of Fisheries and a multi-national industry partner that farms red algae at Hutt Lagoon.

Current work is building on the outcomes of previous research which tested the commercial viability of *Artemia* cysts and biomass through a pilot-scale system. The system is now being developed into a commercial-scale system, including developing new rearing protocols. It is anticipated that 'home-grown' *Artemia* products will be available commercially during 2007/08, reducing the reliance on unpredictable supplies of imported product for aquaculture feeds.

Mussel Farming Status Report

C. Lawrence and S. How

Industry Description

Production method

Mussels (*Mytilus edulis*) are farmed by collecting spat from the wild. These wild-caught juvenile mussels are then attached to vertical ropes called longlines for grow-out to market size.

Longlines consist of a rope with buoys to provide flotation, to which droppers are attached every 3 to 4 m upon which the mussels are seeded. This submerged structure maintains the mussels at least 2 m above the seabed. As mussels are filter feeders, commercial farms rely upon natural feed (algae, detritus and bacteria) rather than artificial diets or pellets.

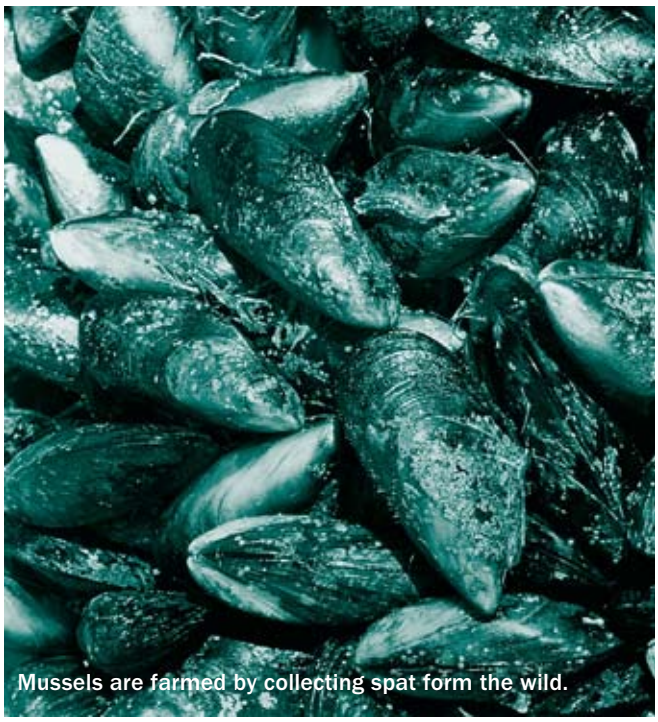
Production areas

Mussel farms require sheltered sites with adequate natural feed. Farms are found mainly in Cockburn Sound and Warnbro Sound, as well as in the Albany harbours and Wilson Inlet on the south coast.

Commercial production continues in the Southern Flats area of Cockburn Sound where mussel farmers now have more secure access to growing areas. Future growth of this industry is constrained by resource-sharing issues that limit access to additional sites in protected and productive areas.

Management arrangements

Licence approvals are required and regular site inspections are carried out to ensure farmers are operating within their site coordinates and that their sites are clearly marked for marine safety compliance.



Mussels are farmed by collecting spat form the wild.

The mussel industry must also meet the requirements of the WA Shellfish Quality Assurance Program. This program contributes significantly to the overall monitoring of the water quality of waterways such as Cockburn Sound. It also provides the mussel industry with a mechanism whereby harvesting and processing can be stopped when water quality declines.

Aquaculture Production

Production current year (2005/06): 765 tonnes

Number of producers for year 2005/06: 20

Production projection next year (2006/07): 800 tonnes

Mussel production increased by 6% in 2005/06 (Mussel Farming Figure 1).

Ecosystem Effects

Mussel farms present a low risk to the environment because there is no addition of feeds. In general, mussel farms can be considered as significant removers of excess nutrients from waterways. The algae that utilise these nutrients are consumed by mussels and are subsequently removed when harvested as mussel biomass.

While faecal wastes from the farms may occur, these are far less likely to cause high organic loadings on the sea bed in Western Australia than in mussel industries elsewhere in the world because the local mussel lines are more widely separated in response to the low local food (plankton) levels. Previous monitoring of potential impact on seagrass beds below mussel lines at Albany indicated negligible impact.

In Cockburn Sound, large pink snapper that aggregate in the area to spawn are attracted to the mussel farms in some years and are thought to consume significant amounts of mussels.

Social Effects

The industry provides direct employment to 40 to 50 people and adds valuable diversity to the Western Australian seafood industry.

Economic Effects

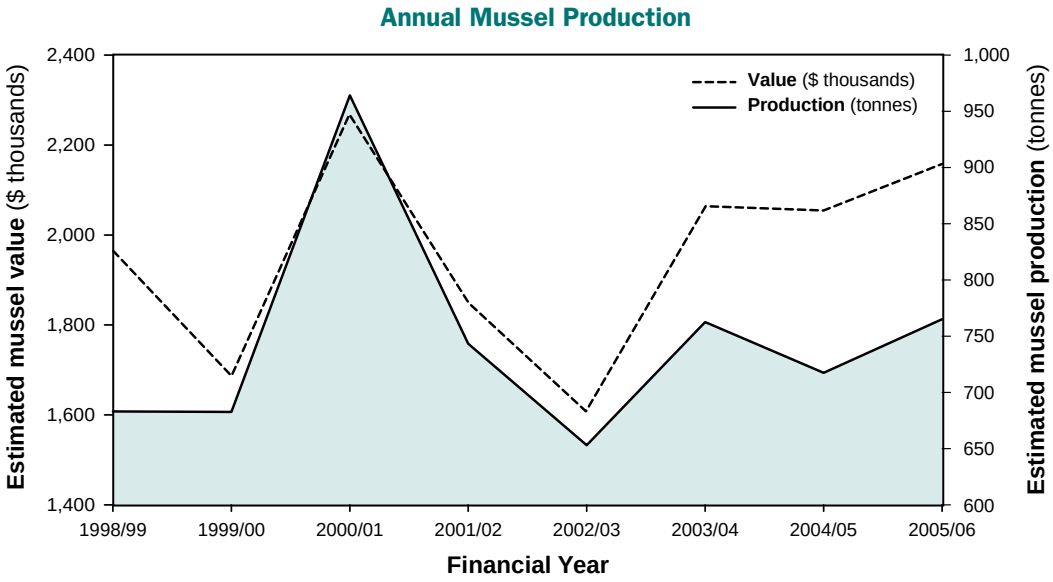
Estimated annual value (to producers) for year 2005/06: $2.2 million

The value of mussel production increased by 5% in 2005/06.

External Factors

Productive areas are generally in protected waters, where nutrients from terrestrial sources raise the food levels above those in coastal waters which are dominated by the low-nutrient, tropical Leeuwin Current. Changes in effluent levels entering the region can affect mussel farm productivity.

It is possible that the proposed increased use of Cockburn Sound for ports, desalination and power generation may increase resource-sharing issues within this area.



MUSSEL FARMING FIGURE 1
Estimated mussel production and value from 1998/99 to 2005/06.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education in commercial and recreational fisheries in the West Coast bioregion is undertaken by Fisheries and Marine Officers (FMOs) based at the Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton offices, as well as aboard the large ocean-going patrol vessels *Hamelin*, *McLaughlan*, and *Walcott*.

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols utilising vessels ranging in size from 5 m to 12 m. They also provide support to seagoing personnel and provide a wide variety of educational and extension services through formal and informal media to commercial fishers, fishing operations, other resource management agencies and community members.

The Department of Fisheries also delivers at-sea marine safety compliance services on behalf of the Department for Planning and Infrastructure in the Perth metropolitan region, extending from Mandurah to Lancelin (excluding the Swan/Canning Rivers).

Activities during 2005/06

During 2005/06, FMOs delivered a total of 22,060 hours of compliance and community education services in the field – almost unchanged in level from the previous year (West Coast Compliance Figure 1). A major component of this time was focused on the West Coast Rock Lobster Managed Fishery.

A continuing emphasis was placed on employing risk- and intelligence-based approaches to compliance planning and prioritisation.

Compliance planning for the West Coast Rock Lobster Managed Fishery focused on the Compliance Risk Assessment conducted with industry members in 2004. Compliance operations targeted one of the major risks – that of fishers interfering with other fishers' gear – which resulted in a number of apprehensions.

Targeted operations were also conducted to address other issues including illegal fish sales, over-potting, failing to release totally protected rock lobsters, and pulling rock lobster pots prior to the prescribed starting time each day.

Compliance in commercial fisheries was similar to previous years, although the 25 prosecutions instigated represented a significant drop on the previous year (from 49 in 2004/05). A total of 374 infringement warnings and 90 infringement notices were issued.

Within the West Coast Rock Lobster Managed Fishery, each vessel had its catch inspected by FMOs on at least one occasion, with an average of 6 checks per vessel throughout the fishery (West Coast Compliance Table 2). On average, 21 baskets were inspected per vessel, which is similar to the number in 2004/05 of 22 baskets.

The percentage of total catch inspected rose slightly, with approximately 2.4 to 3.1% of the catch inspected (compared to 2.3 to 2.9% in 2004/05). The observed per-animal non-compliance rate for the catch decreased significantly, to an estimated range of 0.0012 – 0.0019.

The Department of Fisheries' rock lobster compliance coordinator continued the education and liaison program through attendance at association and Rock Lobster Industry Advisory Committee tour meetings, educating fishers about rule changes, providing information and feedback on local compliance issues and receiving complaints from industry members. Feedback and advice was also provided on recent compliance operations conducted by FMOs. Twelve rock lobster fishermen's association meetings were attended. 3 major rock lobster compliance operations were carried out, using staff from throughout the West Coast bioregion.

In addition to the rock lobster fishery, the activity of the FMOs in the bioregion was focused on ensuring high levels of compliance in other commercial fisheries such as the estuarine and wetline ones and those for abalone, crab, shark, scallop and pilchards.

Considerable compliance activity was directed towards recreational fisheries within the West Coast bioregion, with FMOs achieving 39,836 field contacts with recreational fishers – a slight increase on the previous year. The majority of the compliance effort focused on rock lobster, abalone, net fishing, marine finfish and crabs.

Throughout the bioregion a total of 461 infringement warnings, 187 infringement notices and 81 prosecutions were instigated for recreational offences during 2005/06. This represents a significant decrease in warnings and infringement notices, (from 676 and 235 respectively in 2004/05 – a decrease of 29%) and a similar drop in prosecutions on the previous year (from 103 in 2004/05 – a decrease of 21%). This decrease was most likely due to the continuing high presence of FMOs at boat ramps, which has helped recreational fishers to become more educated about fishing regulations.

The Department of Fisheries' at-sea compliance capability was enhanced with a new 8.5 m, high-speed, rigid-hulled inflatable patrol vessel commencing service from the Fremantle District Office to patrol metropolitan waters, predominantly around Rottnest Island.

The Jurien Bay Marine Park was gazetted in conjunction with the Department of Environment and Conservation. As a result, the Department of Fisheries embarked on an education campaign to educate stakeholders about the new regulations within the Marine Park and 2 additional FMOs were stationed at Jurien for this purpose.

The Department began cross-authorisation training of rangers and wildlife officers operating within the Jurien, Marmion, Swan River and Shoalwater Marine Parks. Cooperation with other government departments was excellent, with FMOs conducting joint patrols with officers from the Department of Environment and Conservation, Department for Planning and Infrastructure, Australian Customs Service and the WA Police Service.

The Volunteer Fisheries Liaison Officer (VFLO) program continued to play a vital role in educating fishers about fishing rules, catch care and fishing techniques, as well as in other education and research activities. Volunteers in the West Coast bioregion conducted beach patrols, school talks, fishing workshops, and attended various boat shows and festivals.

The Mandurah VFLOs continued the successful 'Learning Circles for Fishers' program, visiting schools throughout Mandurah and surrounding areas. This program aims to improve participant understanding of fishing techniques, ethics and knowledge of fishing bag and size limits amongst school-aged children.

VFLOs, together with FMOs, attended the Geraldton Boat Show to provide advice regarding fishing regulations to the large number of boating enthusiasts and recreational fishers attending the show.

Initiatives in 2006/07

Drawing on an improved intelligence capacity, a number of targeted rock lobster compliance operations are planned for the 2006/07 rock lobster season, including a number of major operations at the Abrolhos Islands.

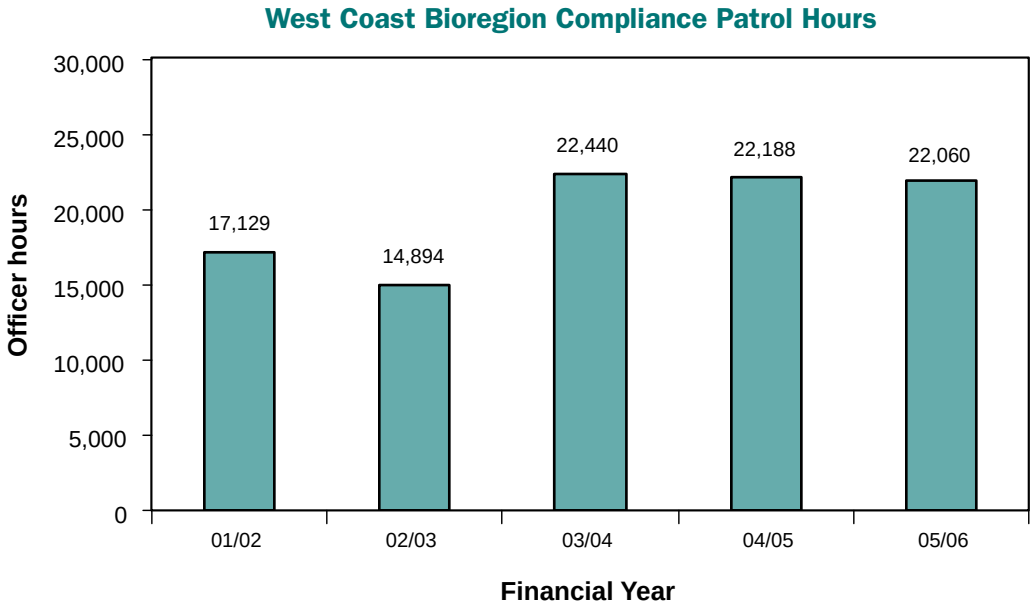
The Department of Fisheries is continuing to improve its at-sea patrol capability and 3 new patrol vessels will commence operation in districts throughout the bioregion. These vessels include a 6.5 m aluminium patrol vessel in Dongara, the 13 m aluminium-hulled *PV Chalmers* (launched to patrol the waters of the Abrolhos Islands), and a 6.8 m high-speed rigid-hulled inflatable (delivered to patrol the Mandurah District).

The *PV Abrolhos Piper* has been transferred to the Jurien District where it will be utilised on patrols of the extensive Jurien Bay Marine Park, and other fisheries compliance operations.

A new VFLO trailer is being located in Geraldton to deliver fishing clinics to school and community groups throughout the Mid West region.

VFLOs will attend the Abrolhos Islands during the rock lobster season, conducting school talks and patrols of the islands and assist with a clean-up of Big Rat Island.

The approval process is well underway for the construction of a new multi-agency Marine Operations Centre for the Mandurah District. This building will house over fifty staff from the Department of Fisheries, Water Police and the Department of Environment and Conservation. Approval is expected to be granted early in the 2007/08 year. This facility will provide further capacity to increase compliance services in the Peel Region in future years.



WEST COAST COMPLIANCE FIGURE 1

The figure gives 'On Patrol' Officer Hours showing the level of compliance patrol activity delivered to the West Coast bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

Fisheries and Marine Officers achieved 39,386 contacts with recreational fishers during 2005/06. Photo: Sandy Clarke

WEST COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the West Coast bioregion during the 2005/06 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	22,060 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries & Marine Officers	478
District Office contacts	1,839
Infringement warnings	374
Infringement notices	90
Prosecutions	25
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	39,836
District Office contacts	12,028
Infringement warnings	461
Infringement notices	187
Prosecutions	81
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY***	
Field contacts by Fisheries & Marine Officers	2,724
District Office contacts	8,766
Fishwatch reports***	247

Notes:

* Commercial West Coast Rock Lobster contacts are excluded from these totals and detailed in West Coast Compliance Table 2.

** Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by *PVs Hamelin and MacLaughlan*. Contacts made by *PV Walcott* are included in North Coast Compliance Table 1.

*** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the Southern Inland bioregion that were referred to Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillarys, Lancelin, Jurien, Dongara and Geraldton district staff.

WEST COAST COMPLIANCE TABLE 2

This table gives the summary statistics for commercial West Coast Rock Lobster Fishery compliance in all bioregions in the 2005/06 fishing season.

Total compliance hours*	21,703 Officer Hours
Field contacts by Fisheries & Marine Officers	3,998
District Office contacts	2,281
FACTORY INSPECTIONS OF CONSIGNMENTS	
Number of unique vessels checked	Entire fleet at least once
Average number of inspections per vessel	6
Average number of baskets checked per vessel **	21
Proportion of total commercial catch inspected	2.4 – 3.1%
Non-compliance rate (per-animal basis) ***	0.0012 – 0.0019
Total consigned commercial catch ('000 kg)	10,390
Estimated total illegal catch consigned ('000 kg)	12.6 –19.5

Notes:

* Includes all time spent on compliance related tasks, e.g. investigations and prosecutions.

** Calculated as the total baskets checked per vessel divided by total inspections per vessel.

*** A rate of 0.001 indicates 1 illegal animal detected in every 1,000 animals checked.

Gascoyne Coast Bioregion

Fisheries and Marine Officers patrol some quite remote areas of WA's Gascoyne Coast. Photo: Kieth Van Dongen

Gascoyne Coast Bioregion

ABOUT THE BIOREGION

The marine environment of the Gascoyne Coast bioregion represents a transition between the fully tropical waters of the North West Shelf and the temperate waters of the west coast. Under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) scheme, published in 1998 by the Australian and New Zealand Environment and Conservation Council, the bioregion has been divided into 4 meso-scale regions: Zuytdorp, Shark Bay, Ningaloo, and Exmouth Gulf (which in the IMCRA system is characterised as part of the Pilbara inshore and offshore regions).

Offshore ocean temperatures range from about 22°C to 28°C, while the inner areas of Shark Bay regularly fall to 15°C in winter. The major fish stocks are generally tropical in nature, with the exceptions of pink snapper and tailor which are at the northern end of their range off Shark Bay.

The coastline is characterised by high cliffs in the southern half changing to fringing coral reefs in the north. Coastal waters are generally high-energy in terms of wave action due to the strong trade wind system.

The Exmouth Gulf section of the Gascoyne Coast bioregion is seasonally influenced by extreme tropical summer cyclones, while the Shark Bay end of the bioregion receives very infrequent cyclones, but is affected at times by river outflows from inland cyclone-based summer rainfall. The limited local rainfall comes mostly from the northern edge of winter storm fronts.

The waters off the Gascoyne coast are also strongly influenced by the unusual southward-flowing Leeuwin Current, generated by flow from the Pacific through the Indonesian archipelago. This tropical current becomes evident in the North West Cape area and flows along the edge of the narrow continental shelf where, coupled with low rainfall and run-off, it has created the highly diverse Ningaloo Reef system and fish fauna associated with the latter.

The outer area of the large marine embayment of Shark Bay is also influenced by the warm winter current. The inner waters of the embayment are hypersaline, owing to the high evaporation and low rainfall of the adjacent desert areas. The World Heritage-listed Shark Bay is unusual for its extreme hypersalinity at the bay heads, the extensive Wooramel seagrass bank, and associated banks and channels.

The sea floor of both Shark Bay and the continental shelf is typically sandy compared to Exmouth Gulf, which has more mud areas and turbidity.

In February 2002, an article in *Science* magazine (Roberts et al. 2002) identified the 18 world 'hotspots' in terms of tropical reef endemism and the threats facing them. The article ranks the west coast of Western Australia as the second most diverse marine environment in the world in terms of tropical reef species, and indicates that it is subject to the second lowest level of environmental threat of the 18 areas that were investigated.

Commercial fishing is a very significant industry in the region, with 3 of the State's more valuable managed fisheries – the Shark Bay Prawn, Exmouth Gulf Prawn and Shark Bay Scallop Fisheries – landing combined catches valued in the range of $40 – $50 million annually. These fisheries have operated sustainably in the region since the mid-1960s and are internationally recognised as 'best practice' in terms of management and research.

The Gascoyne Coast bioregion has also supported since the 1960s an offshore snapper fishery and the Denham-based beach seine fishery, which respectively provide most of the pink snapper and whiting catch for the state. A developing fishery for blue swimmer crabs, based primarily in Carnarvon but operating throughout the waters of Shark Bay, is currently the largest Western Australian fishery for this important species.

A small 'wetline' fishing sector takes demersal species including emperors, baldchin groper/tuskfish and, more recently, the deep-water-dwelling goldband snapper (jobfish). Formal management arrangements for the mackerel fishery were introduced in August 2004.

The special features of the Gascoyne coast, coupled with the warm, dry winter climate and productive fish stocks, have made it a focal point for winter recreation by the Western Australian community. Fishing is a key component of many tourist visits. A full range of angling activities is available, including beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo).

Recreational fishing is predominantly for tropical species such as emperors, lutjanid snappers, groupers, mackerels, trevallies and other game fish. Some temperate species at the northern end of their ranges, such as pink snapper, tailor and whiting, provide significant catches, particularly in Shark Bay.

In addition, the Gascoyne Coast bioregion supports extensive scuba diving and snorkelling activities, particularly inside the coral lagoons of the Ningaloo reef system. Specialised 'eco-tourism' activities include whale shark and manta ray observation at Ningaloo and dolphin and dugong viewing in Shark Bay.

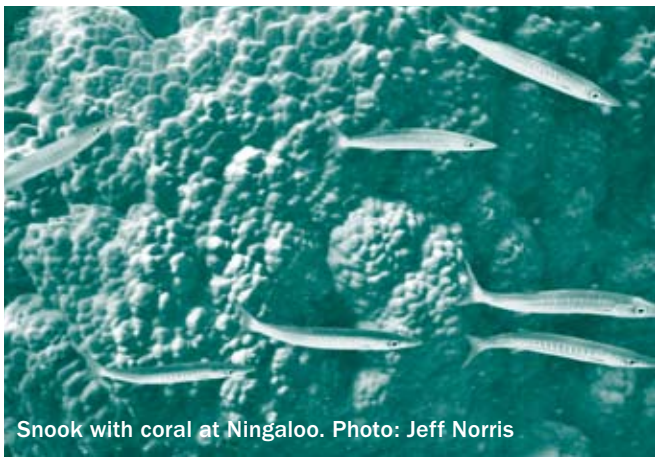
Aquaculture development in the Gascoyne is dominated by the production of pearls and pearl oysters in the major embayments. Hatchery production of oysters is of critical importance in this region, driven by the irregular and therefore unreliable recruitment of both large species of pearl oysters in the wild. Hatcheries in Carnarvon and Exmouth supply significant quantities of *Pinctada maxima* spat to pearl farms in Exmouth Gulf and the Montebello Islands, while several hatcheries supply juveniles of the blacklip pearl oyster *Pinctada margaritifera* to the bioregion's developing black pearl farms.

The Department of Fisheries' Research Division's newly formed Biodiversity Branch has recently commenced a state-wide project aimed at evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise

further introductions. One of the objectives of the project is to determine the risk of different vessel types introducing marine species to WA waters, based on shipping patterns and the species that are likely to be translocated through those movements.

Other objectives are the establishment of a centralised introduced marine species monitoring framework that:

- uses the national monitoring approach;
- determines locations where monitoring should occur, recognising both ports and high value areas; and
- provides information for the developing national database. The project will also analyse potential future changes to threats due to increased shipping movements and changes in vessel origins.



Snook with coral at Ningaloo. Photo: Jeff Norris

ENVIRONMENTAL MANAGEMENT

Regional Overview (Gascoyne Coast)

Western Australia's earliest marine habitat protection areas, in the form of extensive prawn nursery trawl closures over the sand flats and seagrass beds, were introduced in the 1960s in both Shark Bay and Exmouth Gulf.

This system of fisheries closures, later expanded to cover all significant coral areas, has provided long-standing protection to virtually all fragile marine habitats in the bioregion (Gascoyne Coast Habitat Protection Figure 1). Further complementary protection (Gascoyne Coast Habitat Protection Figure 2) has been subsequently added to these highly valued areas by:

- proclamation of marine conservation reserves under the *Conservation and Land Management Act 1984* at Ningaloo Reef, Shark Bay and, most recently, the Murion Islands;
- Fish Habitat Protection Areas under the *Fish Resources Management Act 1994* at Point Quobba and Miaboolya Beach; and
- s. 43 closures to fishing at South Murion Island and surrounding the the wreck of the *Gudern* (Shark Bay).

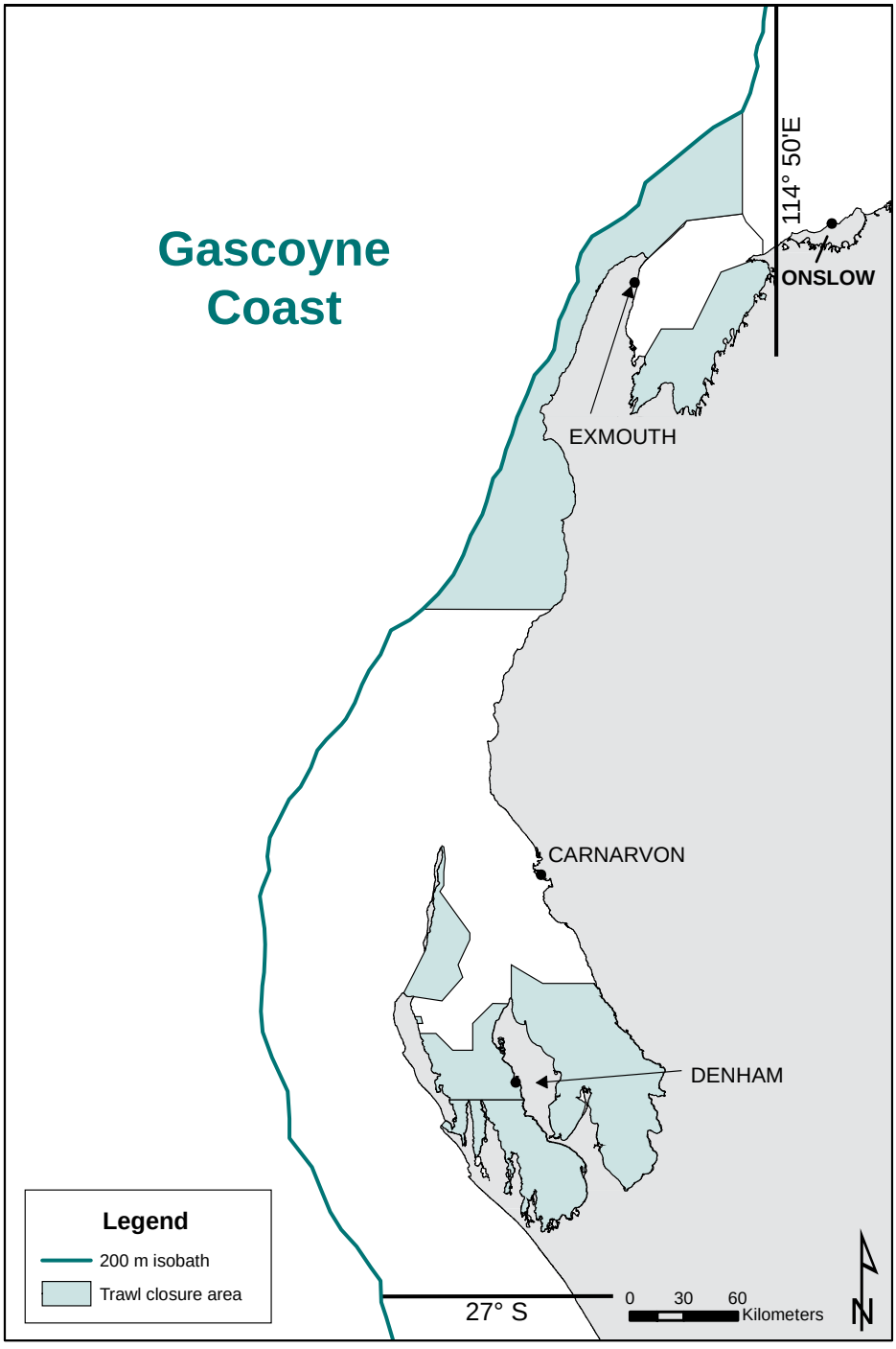
The Australian Government Department of Environment and Water Resources is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with a view to finalizing a North West Marine Bioregional Plan (MBP) which will contain individual marine protected areas.

Specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and longlines throughout the Gascoyne, to prevent the incidental entanglement of dugongs and turtles which inhabit the region. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in trawl nets have increased the protection for sharks, rays and the occasional loggerhead turtle encountered on the trawl grounds.

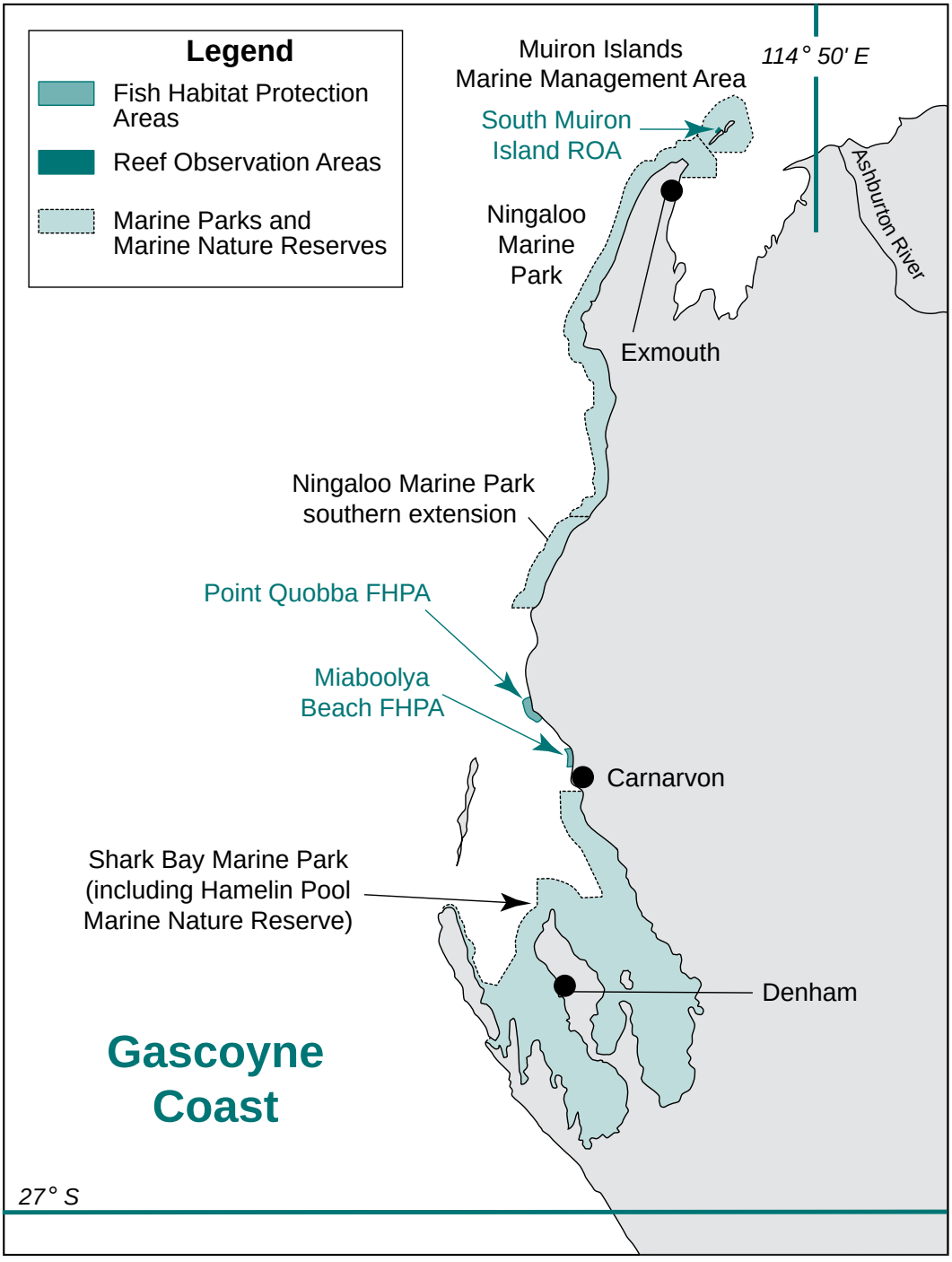
In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has initiated Ecosystem Based Fisheries Management (EBFM) principles, which involve a more holistic approach to traditional fisheries management and will guide fisheries management arrangements in the future. EBFM will thus encompass Integrated Fisheries Management and embrace broader ecosystem issues, as information becomes available, so that both exploited fish stocks and the ecosystems that support them can be sustainably managed in the future. The West Coast and Gascoyne Bioregions have been selected to trial this process.

Finally, the Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals which have the potential to impact on the aquatic environment, including the current proposal by Straits Resources Yannarie Solar Salt at Exmouth Gulf. The Department continues to actively engage with natural resource management coordinating groups to promote sustainable use of the aquatic environment.

Preparing trap at Ningaloo.
Photo: Jeff Norris



GASCOYNE COAST HABITAT PROTECTION FIGURE 1
Map showing areas permanently closed to trawling in the Gascoyne Coast bioregion.



GASCOYNE COAST HABITAT PROTECTION FIGURE 2
Map showing current and proposed areas of protected fish habitat in the Gascoyne Coast bioregion.

FISHERIES

Shark Bay Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from S. O'Donoghue

Fishery Description

The Shark Bay Prawn Managed Fishery targets western king prawns *(Penaeus latisulcatus)* and brown tiger prawns *(Penaeus esculentus)* and takes a variety of smaller prawn species, including coral prawns (various species) and endeavour prawns (*Metapenaeus* spp.). King prawns are the dominant species, comprising about 70% of the catch. Tiger prawns make up most of the remaining 30%.

Fishing is undertaken using otter trawls, with 'bison' otter boards (under exemption) and standard flat wooden otter boards.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993
Shark Bay Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Joint Trawl Management Advisory Committee
Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this managed fishery are the waters of the Indian Ocean between latitudes 23°34′ S and 26°30′ S and adjacent to Western Australia on the landward side of the 200 m isobath (Shark Bay Prawn Figure 1).

Management arrangements

Management of the fishery is based on input controls which include limited entry, seasonal and area openings and closures, moon closures and gear controls. These management arrangements are designed to keep effort at levels that will maintain sufficient spawning stocks and achieve optimal yields.

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year depending on environmental conditions, moon phase and the results of surveys, which predict recruitment dynamics. The timing of the opening of the season allows the harvesting of the current season's recruits and the large residual prawns not caught in the previous season.

Permanently closed nursery areas within the fishery prevent the fishing of small prawns and provide habitat preservation, while spatio-temporal closures serve to maintain tiger prawn breeding stocks above the threshold abundance level. Within the main fishing period, there are various subsidiary openings and closures designed to increase size, quality and market value while protecting the stocks from recruitment over fishing. Moon closures run for 7 days around each full moon during the season, though on occasions the industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate. In addition, since 1996 the fishing arrangements in Denham Sound have incorporated industry closures aimed at preventing the take of small prawns early in the season and controlling fishing in the southern part of the 'Sound' where there may be juvenile snapper aggregations.

The 2006 season fishing arrangements provided a season opening date of 18 March and closing on 1 November for a total of 173 nights. Fishing patterns during the season involved flexible fishing arrangements and voluntary industry closures, based on assessment of both king and tiger prawn size through fishery-independent surveys. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats.

The fishery as a whole is subject to a maximum headrope allocation. However, the basis on which the total allocation may be divided among the fleet is under review. For the past few seasons, all boats have operated under an exemption from the '375 boat unit rule' currently provided for in the management plan. In 2005, vessels commenced trialing quad gear, which continued in 2006.

Bycatch reduction devices (BRDs) are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a 'grid' and a secondary BRD or fish escapement device (FED) in each net.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target prawn species, bycatch species impacts, protected species interactions, habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research activities continue to focus on stock assessment and annual monitoring of the prawn stocks, particularly tiger prawns. All boats complete detailed research log books, and these, together with pre-season recruitment surveys and in-season surveys of size composition and spawning stock, provide the information sources for monitoring the status of the stocks.

In-season surveys have proved to be valuable in ensuring that the prawns are targeted at an optimal market size.

A Fisheries Research and Development Corporation (FRDC)-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay will be completed in 2007.

A second FRDC project with Edith Cowan University has been examining the spatial distribution of catch by size category and effort during the fishing season. This project will also be completed in 2007.

A new FRDC-funded project focussing on minimising gear conflict and resource sharing issuess in the Shark Bay trawl fisheries will commence in 2008. This will include hydrographic modelling of prawn and scallop larval movement within Shark Bay.

Retained Species

Commercial production (season 2006): 1,559 tonnes

Landings

The total landings of major penaeids for the 2006 season were 1,559 t, comprising 1,091 t of king prawns, 467 t of tiger prawns and less than 1 t of endeavour prawns (Shark Bay Prawn Figure 2). In addition, there were also 115 t of minor penaeids (coral prawns) landed.

The total landings were within the target catch range (1,501 – 2,330 t). Tiger prawn landings were also within the target range for that species (400 – 700 t). King prawn landings were slightly below the acceptable catch range (1,100 – 1,600 t).

For the 2006 season, the king prawn effort levels affected catches, as the fleet targeted larger king prawns for economic value.

Scallop landings by the prawn fleet in 2006 totalled 432 t whole weight. For a more detailed description, refer to the Shark Bay Scallop Managed Fishery section elsewhere in this volume.

By-product landings included 114 t of blue swimmer crab (*Portunus pelagicus*), 48t of squid, 22 t of tuna (wetlining), 6 t of cuttlefish, 1 t of bugs (*Thenus orientalis*) and 1 t of mulloway (*Argyrosomus hololepidotus*).

Fishing effort/access level

Twenty-seven boats are licensed for prawn trawling in this managed fishery, but as a result of changes in gear configuration only 25 boats operated in 2006.

During 2005, trials were undertaken to assess the viability for fishing with quad gear. 4 boats operated using quad gear configuration (4 x 5.5 fathom nets) compared to the remainder of the fleet towing twin gear (2 x 8 fathom nets), giving a total net headrope length of 424 fathoms compared to 432 in past years.

For 2006, 5 boats towed quad gear (4 x 5.5 fathom nets) with the remainder of the fleet towing twin gear, giving a total net headrope length of 430 fathoms.

Previous status reports have documented effort as nominal effort, for twin gear (27 boats towing 2 8-fathom standard nets). Due to some boats using different size nets since 2005, the catch rates and effort is adjusted to take into account each boat's net size. The effort and catch rate information stated in this status report will be the adjusted standardised twin gear equivalent effort.

Total nominal effort recorded by the prawn fleet in 2006 was 37,066 hours. The adjusted effort was 40,005 hours, which is lower than the 2005 season's adjusted effort. The effort in 2006 is the lowest recorded in 36 years.

At the commencement of the 2006 season, the prawns were small in size but the industry aim was to target larger-size prawns. Therefore the 3 area openings within the Carnarvon/Peron area were based on surveys prior to each opening.

The size composition of prawns over the area determined the extent of area to be opened to optimise the take of large-size prawns. In addition, closures were put in place north west of Cape Peron North and west of the nursery line during the season to prevent the take of small king prawns.

Recreational component: Nil

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The catch per unit of effort for the fishery can be used as an indicator to monitor changes in stock levels from year-to-year. The catch rate of 27.3 kg/hr (equivalent to twin gear units) for king prawns observed in 2006 remains high compared to past years, given the total landings of king prawns were just below the lower end of the target catch range.

The 2006 tiger prawn catch rate of 11.7 kg/hr was lower compared to that in 2005 (13.8 kg/hr) but comparable to the high catch rates (mean 12.0 kg/hr) during the 1970s and a significant increase compared to the low catch rates during the 1980s (mean 4.9 kg/hr).

The overall 2006 daily catch rates were maintained at relatively high levels for the season by the extended full moon closures, which are designed to reduce the period of inefficient fishing.

Spawning stock and recruitment indices are derived from log book and survey data and are compared to the accepted spawning stock–recruitment relationship (SRR) for tiger prawns in Shark Bay.

Voluntary log books provide information on the daily catch (kg) of target species and effort (hours trawled) expended in each fishing area by each boat, based on trawl duration and catch of every trawl. From these data, catch and effort is obtained for each fishing area.

Fishery-independent surveys are undertaken for king and tiger prawn stock levels, which are monitored and assessed using catch and effort information from recruit surveys (March and April), surveys in Denham Sound and breeding stock surveys in June and August. The number of surveys undertaken each year may be 2 or 3, depending on the timing of the moon phase.

To maintain adequate breeding stock levels for tiger prawns, the tiger prawn spawning area (TPSA) is closed at a catch rate threshold level between the range of 18 to 22 kg/hr. Since a survey regime to monitor catch rates of tiger prawns has been established (2001), the catch rate has steadily increased from the initial level of 10 kg/hr to the present range.

King prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys.

Fishery-independent survey data allow fishing to target appropriate prawn sizes for market value each season and have a longer-term aim of providing catch predictions. Environmental factors, in particular the variation in the strength of the Leeuwin Current, are being examined to improve the understanding of variations in the annual catch and hence SRR for the king prawn stock.

The standardised tiger prawn spawning index of Area B in August and Area D in July has been used historically to assess tiger prawn spawning stock and is based on the catch and effort rate of the fishing fleet. This standardised assessment (catch and effective effort) cannot be undertaken in 2006 due to substantial changes in boat gear configuration and efficiencies and fleet fishing dynamics.

In addition, trawl closures are triggered annually by a tiger prawn catch rate threshold derived from daily log book catch and effort data prior to the key spawning period (July and August and remains in place for the rest of the season) and therefore commercial catch rate information is not available in the area.

Estimations of catch rates from adjacent areas were used in previous years but this method is now replaced by the use of fishery-independent survey-based catch rates within the TPSA for July and August.

The multi-species nature of this fishery requires the levels of harvest for both king and tiger prawn stocks to be carefully monitored to simultaneously achieve the optimum sustainable catches.

Current stock and recruitment studies indicate that at current exploitation levels, the king prawn stock remains above the level where recruitment is not affected by spawning stock levels. Thus, at the current level of exploitation, fluctuations in the annual king prawn harvest are most likely to have resulted from varying effort levels and environmental effects on recruitment, not from the spawning stock abundance.

In contrast, the recruitment levels of tiger prawns during the 1980s were demonstrably affected by reduced spawning stock biomass. Management practices have subsequently been improved to increase the level of the spawning stock. This included the implementation of a temporal closure of the Carnarvon/Peron line, aimed at reducing effort on tiger prawns early in the season, as well as the introduction of a tiger prawn spawning area (TPSA) closure in 1996.

In addition, commencing in 2005 the raising of the catch rate threshold level for the TPSA from 10 kg/hr to 18 – 22 kg/hr provided added protection to the spawning stock. These measures have had a favourable impact on the tiger prawn stock, with relatively stable catches over the last 10 years.

3 standardised research surveys (to confirm commercial catch rates derived from log book information) were carried out in the TPSA (Shark Bay Prawn Figure 1) in June, July and August to obtain the catch rate of tiger prawns.

The average catch rate of tiger prawns from the surveys was 21 kg/hr for all 3 surveys and within the target range. The mean catch rate of king prawns was 29.9 kg/hr.

The levels of harvest for both tiger and king prawns in the Shark Bay Prawn Managed Fishery are carefully monitored.

This regime of surveys and closures will continue to allow an analysis of its usefulness in the protection of spawning stock. The threshold catch rate level will be monitored to ensure that it is set at the desirable level.

Variable quantities of minor penaeids (predominantly coral prawns) are retained, depending on the catch of the target species. Owing to the small size of these species, it is likely that the majority of the stock is able to pass through the mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006, the breeding stock indicators for tiger prawns and coral prawns were met. The king prawns were slightly below the catch range but this was due to reduced effort, targeting of larger size prawns and a small shift of effort away from king prawns. Endeavour prawns were also below the catch range, but this is not of concern as this species is not targeted in this fishery.

Non-Retained Species

Bycatch species impact: **Moderate**

Bycatch composition is dominated by dead wire weed, which breaks off the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small fish species, mostly not taken by other sectors.

Small blue swimmer crabs and other crustacean species are also taken in significant quantities but are generally released alive. Overall bycatch levels are moderate relative to other subtropical trawl fisheries, at about 4 to 8 times the prawn catch.

Field sampling for a study on the composition and abundance of bycatch of trawled and untrawled areas of Shark Bay was completed in 2004, with data analysis and report writing to be completed by 2007.

Secondary bycatch reduction devices (square mesh panels in cod ends) are now fully implemented and should further reduce the quantity of small fish retained in trawls.

The 2 performance measures for the fishery relate to (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed, with the final report underway. Preliminary analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of Bycatch Reduction Devices (BRDs) in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Protected species interaction: **Low**

Although protected species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay generally, only sea snakes are seen regularly in the trawl catches in certain areas, and these are mostly returned to the sea alive.

The full implementation of BRDs ('grids') in the fishery since 2002 has generally eliminated the occasional capture of turtles in trawl nets. However, there is a short period of time in a specific area that is grid-exempt due to excessive weed. This area generally has low occurrence of turtles, minimising captures during this time, and the short trawl duration (maximum 60 minutes) required in Shark Bay to accommodate the high prawn catch rates and the clogging effects of dead wire weed means that any turtles caught can be returned to the sea alive.

One performance measure for the fishery is for 90% of turtles from non-BRD nets to be returned alive. For the 2006 season, 13 turtles were recorded (6 loggerhead turtles and 7 unidentified) as being caught in nets and were returned alive. 8 were caught during the short, grid-exempt period and 5 were caught when grids were fitted in the nets.

Ecosystem Effects

Food chain effects: **Low**

Although the harvest rates of the retained target species are high, such species have very high natural mortality rates and make up a relatively small proportion of the 'fish' biomass on the trawl grounds. Thus, most prawn predators are opportunistic, due to these natural variations in prawn populations.

Consequently, it is not likely that the commercial take of prawns impacts significantly on the upper trophic levels within the Shark Bay ecosystem. The reduced levels of effort now used by the fishery, combined with the modifications to gear to reduce unwanted catch, will have further reduced the potential for indirect impacts to occur.

Habitat effects: **Moderate**

As a result of the extensive permanent and temporary closures first introduced via the management plan in the 1960s and 1970s respectively (Shark Bay Prawn Figure 1), the fleet operates in approximately 5% of the overall licensed area of the fishery.

Inside Shark Bay, trawl fishing is focused in the deeper areas (predominantly sand/shell habitats) of the central bay, north of Cape Peron and in the northern area of Denham Sound. The majority of sponge/coral habitats are contained within specific trawl closures to protect these areas.

Performance measures for habitat impact relate to the spatial extent of trawling within Shark Bay's sand/shell and coral/sponge habitats. In 2006, the performance measure was met as the total area trawled within Shark Bay, at approximately 862 square nautical miles or ~18% of inner Shark Bay, was below the 40% level and focused only in areas of sand/shell habitat. Most sponge/coral habitats in Shark Bay are now protected by fishery closures, and in 2006 no trawling occurred on the few known sponge/coral habitats areas within the designated trawlable area of the fishery.

Social Effects

The estimated employment for the year 2006 was 110 skippers and crew. There are also prawn processing and support staff employed at Carnarvon and Fremantle.

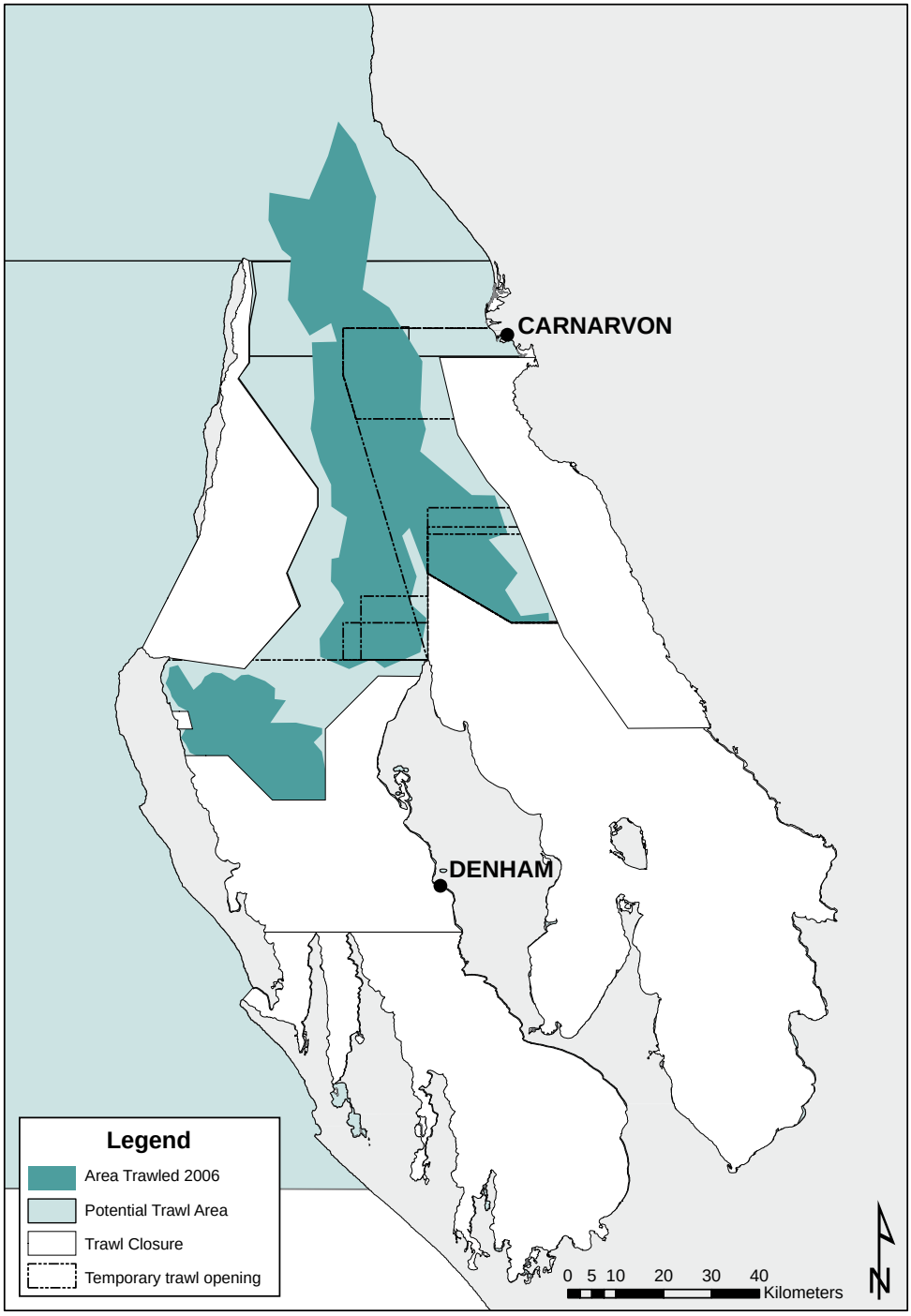
This industry, in conjuction with the other trawl fisheries for prawns and scallops in the Gascoyne bioregion, is a major contributor to regional employment.

Economic Effects

Estimated annual value (to fishers) for year 2006: $20.2 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. Generally, the price of prawns was similar to those in 2004 and 2003 and average ex-boat prices were as follows:

King prawns	$12.00/kg
Tiger prawns	$14.60/kg
Coral prawns	$2.50/kg



SHARK BAY PRAWN FIGURE 1
Boundaries of the Shark Bay Prawn Managed Fishery and area trawled in 2006.

Fishery Governance

Target catch range: 1,501 – 2,330 tonnes

Under current effort levels and normal environmental conditions, and based on catches in the 1990s following the restructuring of the fishery to 27 licences, the target catch range for major penaeids is 1,501 – 2,330 t.

Target catch ranges for individual species are king prawns 1,100 – 1,600 t, tiger prawns 400 – 700 t and endeavour prawns 1 t to 30 t. King and endeavour prawn catches during 2006 were just below the target ranges set, while tiger prawn catches were within the target range.

New management initiatives (2006/07)

Due to rising costs of fishing and lower prawn prices, trials were undertaken to facilitate a fleet restructure by removing boats whilst permitting the remaining boats to tow larger gear; 4 5.5 fathom nets. The overall fleet net allocation is to be reduced to account for a gear efficiency increase of between 8 to 10%.

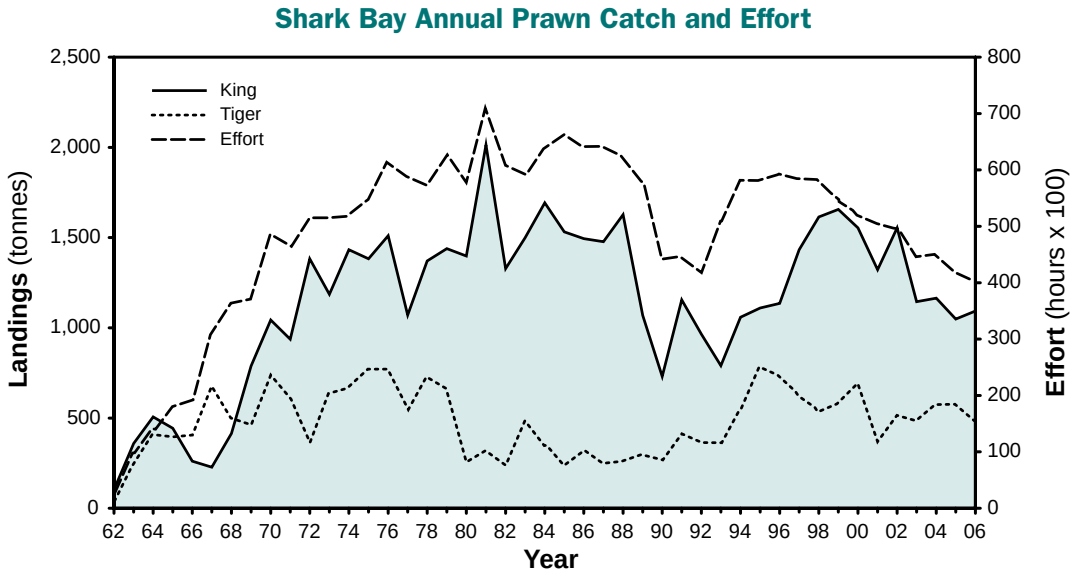
Legislative changes to permit greater flexibility in the distribution of gear units among the fleet are currently in the drafting stage.

External Factors

The catches of prawns in Shark Bay are relatively stable compared with other penaeid fisheries. The major environmental factor influencing these stocks appears to be the flow of the Leeuwin Current along the outside of the embayment.

A relationship between current strength (as measured by Fremantle sea level) and king prawn catches has been identified and may be used to indicate broad catch trends. The mechanism proposed is that higher current flows increase water temperatures and catch rates of the prawns.

The Leeuwin Current also appears to affect scallop recruitment, which can cause a redirection in fishing effort away from prawn areas and artificially lower prawn catches when scallops are very abundant due to a shift in effort/targeting.



SHARK BAY PRAWN FIGURE 2

Shark Bay Prawn Managed Fishery annual landings and effort, 1962 – 2006.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer and M. Kangas
Management input from S. O'Donoghue

Fishery Description

The Exmouth Gulf Prawn Managed Fishery targets western king prawns *(Penaeus latisulcatus)*, brown tiger prawns *(Penaeus esculentus)*, endeavour prawns (*Metapenaeus* spp.) and banana prawns *(Penaeus merguiensis)*. Fishing is undertaken using otter trawls.

Governing legislation/fishing authority

Exmouth Gulf Prawn Management Plan 1989
Exmouth Gulf Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Joint Trawl Management Advisory Committee
Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of the Exmouth Gulf Prawn Managed Fishery are 'the waters of the Indian Ocean and Exmouth Gulf below high water mark lying south of a line starting at Point Murat and extending northeasterly to the southern extremity of South Muiron Island; thence generally northeasterly along the southeastern shore of that island to its easternmost extremity; thence northeasterly to the southern extremity of North Muiron Island; thence northeasterly and northerly along the southeastern and eastern shores of that island to its northern extremity; thence easterly to the northern extremity of Serrurier Island; thence generally southerly along the western shores of that island to its southern extremity; thence southeasterly to the southern extremity of Locker Island and then due south to the mainland' (Exmouth Gulf Figure 2).

Management arrangements

Management of this fishery is based on input controls which include limited entry, seasonal and area openings and closures, moon closures and gear controls. These management arrangements are designed to keep fishing effort at levels that will maintain sufficient spawning biomass of prawns (particularly tiger prawns).

The yearly cycle of operation for the fishery is dynamic and multi-faceted. Opening and closing dates vary each year, depending on environmental conditions, moon phase and the results of fishery-independent surveys, which estimate tiger prawn recruitment and spawning stock and a prediction of catch.

Management arrangements in recent seasons have provided for 200 fishing nights with a minimum of 28 non-fishing nights for moon closures (i.e. 4 nights each full moon). For the 2006 season, official opening and closing dates were set at 17 April and 1 December 2006 respectively, providing the maximum 200 nights for fishing. However, this is a flexible arrangement and the season actually commenced on 24 April, based on results from pre-season surveys, and closed at 0800 hrs on 24 November for a total of 157 days fished. There were also spatio-temporal closures during the early part of the season (April–July) to avoid fishing on small prawns.

Stringent measures are in place to ensure that spawning stock levels are adequate and that the prospect of both recruit and growth over fishing is avoided. These measures will continue to be applied while incorporating a flexible fishing regime to optimise size and value of tiger prawns.

There is a consultative process in operation whereby the Department of Fisheries' Research Division and industry jointly decide on the timing and extent of areas to be fished or closed, according to size and abundance of prawns. This process allows industry to undertake supervised research surveys to determine changes in prawn distribution, abundance and size composition during the season, thus enabling a rapid response to resource fluctuations to maximise tiger and king prawn size (and hence market value) while still providing a sustainable approach to stock management.

Management guidelines season prescribe a mandatory closure of the tiger prawn spawning area when the tiger prawn catch rate falls to 19 kg/hr (based upon quad gear catch rate, 4 – 4.5 fathom nets) or on 1 August, whichever is the sooner. From 1 November, after the main spawning period, the catch rate threshold level is reduced from 19 kg/hr to 14 kg/hr.

The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats. The fishery as a whole is subject to a maximum headrope allocation. However, the gear configuration package (net and board sizes) permitted within this total allocation are under review, with vessels operating for the past few seasons under an exemption allowing the use of 'quad gear' (4 smaller nets) rather than the standard twin 7.5-fathom nets. This has resulted in a reduction in the number of boats, with a reduced headrope allocation redistributed among the remaining boats. The reduction of boat numbers and overall net allocation is ongoing, with the aim of maximizing economic efficiency but still maintaining overall catch in this fishery as well as sustainability.

Bycatch reduction devices are implemented in this fishery, with all vessels required by way of a condition on the managed fishery licence to fish with a 'grid' and a secondary bycatch reduction device ('BRD') or fish escapement device in each net. Industry, in association with the Department of Fisheries, has successfully gained certification from the US Department of State that the fishery is BRD-compliant in terms of potential turtle captures. This allows licensees to export product to the US market. The certification is due to be reviewed in the 2007 season. Industry also installed 'hopper' in-water sorting systems in 2002, which provides an improved quality of prawns and reduces mortality for some bycatch species.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any

potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target prawn species, bycatch species impacts, habitat effects and provisioning effects. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research activities continue to focus on stock assessment and surveys to monitor annual recruitment of tiger prawns and the residual spawning stock levels, and a pre-season survey of king prawns to assist with harvesting strategies.

Monitoring of fleet fishing activity is undertaken to determine the timing of the closure of the tiger prawn spawning area. All boats complete detailed research log books, which, together with survey data and factory catch unload records, provide the information sources for managing the fishery. The calibration of catch rates between twin and quad gear has been undertaken to measure changes in fishing efficiency.

The Department of Fisheries and industry will continue the monitoring of juvenile tiger prawn habitats (seagrass/algal communities) and their regeneration after being depleted by the effects of Cyclone Vance in 1999 (which resulted in a very poor recruitment in 2000).

The project funded by the Fisheries Research and Development Corporation examining the biodiversity of bycatch species in trawled and untrawled areas of Exmouth Gulf and the associated report will be completed in 2007.

Retained Species

Commercial production (season 2006): 899 tonnes

Landings

The total landings of major penaeids for the 2006 season were 899 t, comprising 442 t of king prawns, 258 t of tiger prawns and 199 t of endeavour prawns. The total landings were lower than in the last 2 seasons, but within the target catch range.

The tiger prawn landings were at the low end, but within the normal catch range of 250 – 550 t (Exmouth Gulf Prawn Figure 1). King prawn and endeavour prawn landings were within the target catch range of 350 – 500 t and 120 – 300 t respectively.

Recorded landings of by-product included 32 t of coral prawns, 18 t of blue swimmer crab *(Portunus pelagicus)*, 10 t of squid, 2 t of bugs *(Thenus orientalis)* and 1.5 t of cuttlefish.

Fishing effort/access level

There are 16 boat licences in this managed fishery, but as a result of changes in gear configuration only 12 boats operated in 2006, towing a total of 229 fathoms of net headrope.

Since 1990 the total allocation of net headrope for this fishery has been set at 240 fathoms, based on 16 boats each towing 15 fathoms. During 1998, trials were undertaken to asses the viability for fishing with quad gear. In 2000, the entire fleet towed 4.5 fathom nets in quad gear configuration and the fleet was reduced to 13 boats utilising 234 fathoms.

In order to improve upon the economic efficiency achieved while maintaining sustainable catch levels, in 2006 there was trialing of larger-size nets in quad configuration. One other boat in the fleet towed 3.75 fathom quad gear (this boat is a single licensee with a maximum net headrope allocation of 15 fathoms).

Previous status reports have documented effort as nominal effort which was adjusted to twin gear (16 boats towing 2 7.5 fathom standard nets). This year (as well as 2005), due to some boats using different size nets since 1998, the catch rates and effort has been further adjusted to take into account each boat's net size rather than an average for the fleet. The effort and catch rate information stated in this report – and future status reports – will be the newly adjusted effort which is standardised to twin gear.

Total nominal effort for the 2006 season was 21,184 hours. The adjusted effort was 27,511 hours, which was 12% lower than 2005 (31,097 hours adjusted).

Effort peaked in this fishery during the late 1970s at 52,710 hours. Due to a combined reduction of boats, overall net headrope and nights fished has seen a significant decrease in fishing effort.

Of the 200 nights allocated to fishing, the fleet fished 157 nights during the 2006 season. This was less than the 173 nights fished in 2005 and 183 nights fished in 2004. The 2006 adjusted fishing effort level was the lowest since 1969.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected catch next season (2007): 260 – 390 tonnes tiger prawns

The standardised catch per unit of effort data from the fishery is an indicator of abundance, which can be used to monitor changes in stock levels from year-to-year. The average catch and catch rate is compared to a 10 year reference point (1989 to 1998) for each species.

The adjusted catch rate, 16.1 kg/hr, for king prawns is the highest on record and well above the average catch rate of 11.7 kg/hr. The catch rate of 9.4 kg/hr for tiger prawns is lower than the average catch rate of 10.0 kg/hr. The endeavour prawn catch rate of 6.3 kg/hr was slightly above the average catch rate of 5.6 kg/hr.

The tiger and king prawn stocks are assessed each year using regular surveys, which permit variations to the management arrangements within the season to optimise catch and size grades.

For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock, which are assessed against the spawning stock – recruitment relationship. For the 2006 season, the total landings were low but within the catch prediction, based on recruitment survey indices, for this season (225 – 340 t).

The spawning stock levels in 2005 were in excess (25.1 kg/hr) of the threshold of 19 kg/hr. Environmental conditions may

Prawn trawler. Photo: Cliff Young

not have been favourable for high survival of tiger prawn juveniles/recruits.

Tiger prawn breeding stock levels are maintained at adequate levels by monitoring the tiger prawn catches to determine when fishing should cease in the main tiger prawn grounds. This strategy maintains the spawning biomass of tiger prawns above the historically-determined biological reference point of 8 to 10 kg/hr (twin gear-15 fathoms) adjusted for effective effort.

Adjustments to the catch rate threshold level over time have occurred to account for gear efficiency. Prior to 2002, the catch rate threshold level had been raised from 12 kg/hr to 16 kg/hr nominal effort for twin gear (7.5 fathom nets). It was then further re-adjusted to the present cut-off threshold catch rate of 19 kg/hr, based on 4.5 fathom quad gear boats.

During 2006, tiger prawn catch rates were monitored from May to August and the tiger prawn grounds closed on 1 August. 3 standardised tiger prawn breeding stock surveys carried out from August to October showed an average catch per unit effort (CPUE) of 17.2 kg/hr in the main spawning area (Q1) – slightly lower than the threshold level. The August, September and October surveys showed a CPUE of 17.7kg/hr, 18.6 kg/hr and 15.3 kg/hr respectively, therefore the tiger prawn spawning area (Area B) was not re-opened for fishing.

The catch prediction for tiger prawns is based on the relationship between recruitment survey indices (early and late March and early April) and the season's landings (April – November of the same year). For 2007, the projected tiger prawn catch range is 260 – 390 t under normal environmental conditions.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort and the extended breeding period and lower catchability of the species compared to tiger prawns. The variability in the abundance of the king prawn stock has been assessed since 2002 by a pre-season recruitment survey. This additional survey was included to investigate the cause of the run of low catches following Cyclone Vance in 1999.

Although there has not yet been sufficient survey data collected for a detailed stock assessment, the return to a normal range catch in 2004 to 2006, without any significant change to fishing practice, indicates that the low recruitment was unlikely to be related to the breeding stock levels. Further years of catch data will be required to both confirm this recovery and assess the spawning stock–recruitment relationship for this king prawn stock.

There is no formal assessment for endeavour prawns – a secondary target species whose distribution overlaps that of tiger prawns – and they are fished to varying levels, depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns.

The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the tiger prawns and the tiger prawn closures also protect a significant portion of the endeavour prawn breeding stock each year. In addition, endeavour prawns are also considered to be more resilient to fishing pressure due to their smaller size and lower catchability, which is similar to king prawns.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006, the breeding stock indicators (catches within specified ranges) for king, endeavour, banana and coral prawns were all met. The spawning catch rate indictor for tiger prawns was slightly below the threshold level and therefore no further fishing took place after the spawning period. The zero catch recorded for banana prawns corresponded to a low rainfall year when the catch of banana prawns is negligible and individual prawns are not separately recorded and processed.

Non-Retained Species

Bycatch species impact: **Low**

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken.

Secondary bycatch reduction devices are now mandatory in this fishery and will further reduce the volume of overall bycatch species retained in the trawls while improving the quality of the prawn catch. In addition, 9 boats during 2006 and 2005 (compared to 8 in 2004 and 7 during 2003) used 'hoppers' (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality. Also, fishing effort in 2006 was the lowest in over 36 years, reducing trawl impacts.

The 2 performance measures for the fishery relate to (i) its impact on biodiversity through the take of non-target (bycatch) species, and (ii) its impact on associated species, e.g. dolphins, through the discarding of bycatch (provisioning). In the case of biodiversity, a major project surveying bycatch species on and off the trawl grounds has been completed, with the final report to be completed in 2007. Preliminary analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort and implementation of Bycatch Reduction Devices (BRDS) in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Protected species interaction: **Low**

While protected species including dugongs, turtles and sea snakes occur in the general area, only sea snakes and occasionally turtles are encountered in the trawl catches. Both species are typically returned to the sea alive.

BRDs ('grids') are now compulsory, which has largely eliminated the capture of any turtles or other large animals. In addition, secondary bycatch reduction devices (square mesh panels) were implemented in all nets in 2005. One turtle was reported as being caught in nets during 2006.

Ecosystem Effects

Food chain effects: **Low**

Although the prawn species are managed at relatively high levels of annual harvest, the impact of the catch on local food chains is unlikely to be significant in view of the high natural mortality, extent of non-trawled nursery areas and variable biomass levels of prawns resulting from variable environmental conditions such as cyclone events.

Habitat effects: **Low**

Historically the fishery impacted on some shallow water areas (less than 12 m in depth) containing sponge habitats, but the refocusing of the fishery into deeper waters to take larger prawns since the early 1980s has reduced this interaction. The trawling effort is now focused in the deeper central and north-western sectors of Exmouth Gulf.

Owing to the predominantly mud and sand habitats of the trawl grounds, the trawl gear has relatively little physical impact. Overall, the nature of this particular trawl fishery and the very tight controls on effort indicate that its environmental effect is now likely to be low.

Performance measures for habitat impact relate to the spatial extent of trawling within the licensed area of the Exmouth Gulf fishery. In 2006 the performance measure was met as the total area trawled, at approximately 316 square nautical miles or ~26% of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2006 was 37 skippers and crew. Additional processing and support staff are also based in Exmouth Gulf and Fremantle. Within the Exmouth area, the fishery is one of the major regional employers and contributes to the economic viability of the Exmouth township.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$10 million**

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. In this fishery there is a high degree of vertical integration, with the fishing companies which own the boats undertaking direct marketing of the product into overseas markets. For this reason, the product prices quoted can only be estimates. Estimated prices were as follows:

King prawns	$11.80/kg
Tiger prawns	$13.70/kg
Endeavour prawns	$7.60/kg
Coral prawns	$2.00/kg

Fishery Governance

Target catch range: 771 – 1,276 tonnes

Under current fishing effort levels, the target catch range for major penaeids is 771 – 1,276 t. The long-term target catch ranges for individual species are king prawns 350 – 500 t, tiger prawns 250 – 550 t, and endeavour prawns 120 – 300 t (noting that maximum or minimum catches do not occur for all species simultaneously).

These overall and individual figures are for normal environmental conditions and generally based on a 10-year average (1989-1998). The target catch ranges for all species were met for the 2006 season.

Current fishing (or effort) level: Acceptable

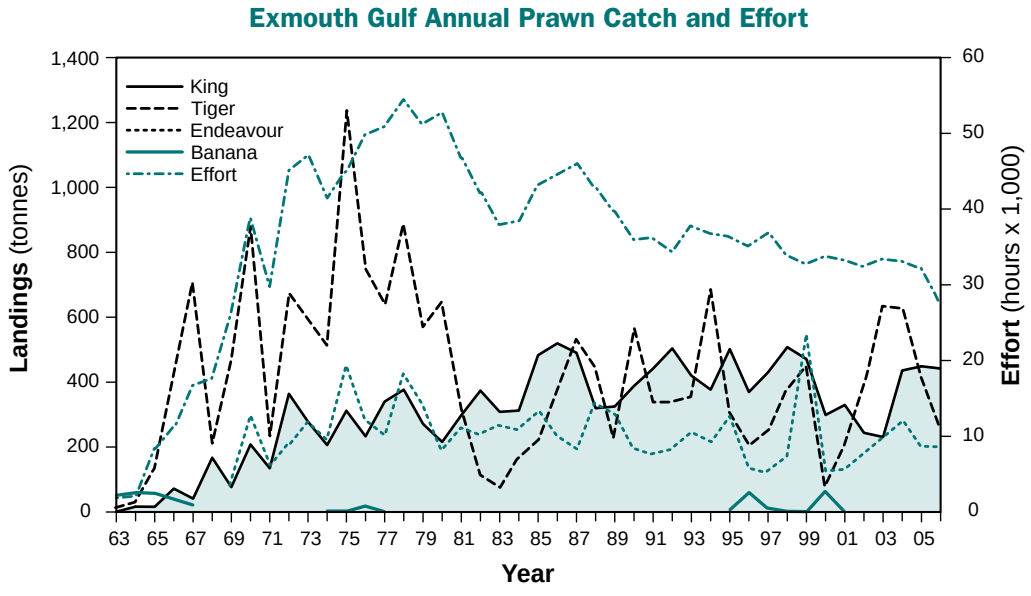
The 2006 fishing effort level was the lowest since 1969.

New management initiatives (2007)

For the 2007 season it is intended to have less boats towing larger nets incorporating a further overall headrope reduction of 18 fathoms, with a total of 211 fathoms of overall net being towed.

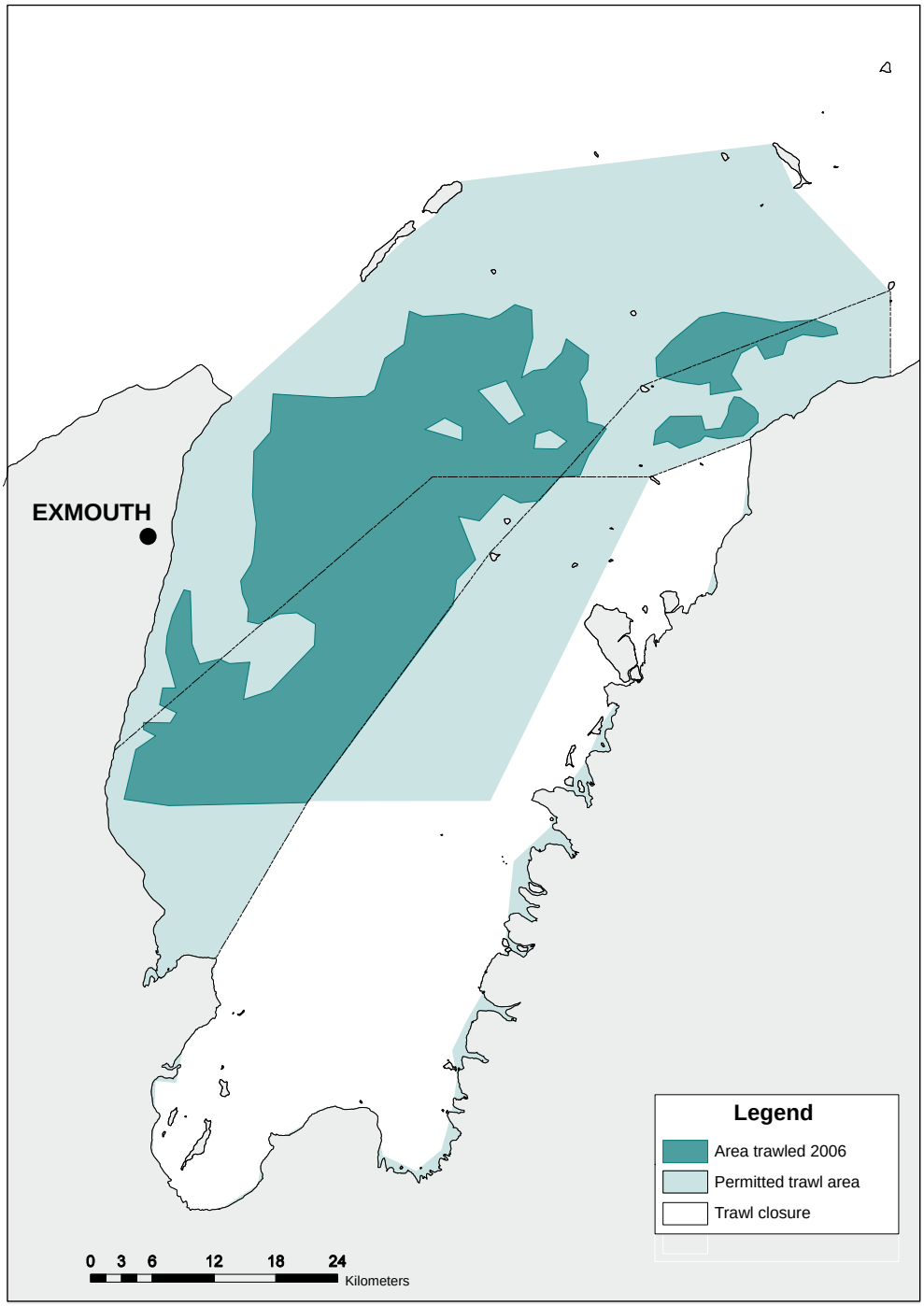
External Factors

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Their impacts can be either positive or negative. Cyclone Vance in 1999 showed positive impacts, with high prawn catches due to a later timing of the cyclone pushing prawns out onto trawl grounds. However, the damage caused to nursery habitats were subsequently seen, with very low tiger prawn catches for 2 years after. Early (December – February) cyclones can have a negative impact (high mortality) on small-size prawns in the shallow nursery areas.



EXMOUTH GULF PRAWN FIGURE 1

Exmouth Gulf Prawn Managed Fishery annual landings and effort, 1963 – 2006.



EXMOUTH GULF PRAWN FIGURE 2
Boundaries and area trawled of the Exmouth Gulf Prawn Fishery.

Shark Bay Scallop Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from S. O'Donoghue

Fishery Description

The Shark Bay Scallop Managed Fishery catches the southern saucer scallop (*Amusium balloti*), and is usually Western Australia's most valuable scallop fishery. The catch is taken using otter trawl by boats licensed to take only scallops (14 Class A licences) and boats that also fish for prawns in the Shark Bay Prawn Managed Fishery (27 Class B licences).

Catch in this fishery varies widely depending on the strength of recruitment, which is thought to be influenced by the strength of the Leeuwin Current. Most of the catch is marketed to south-east Asia as frozen scallop meat ('roe-off').

Governing legislation/fishing authority

Shark Bay Scallop Management Plan 1994
Shark Bay Scallop Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption).

Consultation process

Joint Trawl Management Advisory Committee
Meetings between the Department of Fisheries and industry

Boundaries

The outer boundaries of the fishery encompass 'the waters of the Indian Ocean and Shark Bay between 23°34′ south latitude and 26°30′ south latitude and adjacent to Western Australia on the landward side of the 200 m isobath, together with those waters of Shark Bay south of 26°30' south latitude'.

Within these general areas, scallop trawling only occurs in waters east of the outer islands of Shark Bay, in depths between 16 m and 40 m. In addition to the outer shelf region, a reef area eastward of the Naturaliste Channel, between the northern end of Dirk Hartog Island and the southern end of Bernier Island, is also closed to scallop (and prawn) trawling; and no scallop trawling is allowed east of a line extending northward from Cape Peron to the mainland.

The boundaries for Class A boats are the waters of Shark Bay and Denham Sound west of longitude 113°30′36″ E and north of a line running due east from the northern extremity of Cape Bellefin to Peron Peninsula (Shark Bay Scallop Figure 1).

Management arrangements

Management of the fishery is based on input controls, which include limited entry, seasonal and area closures, gear controls including bycatch reduction devices ('grids'), and crew limits. This management is aimed at catching scallops at the best size and condition for the market, thereby maximising the economic return, while maintaining breeding stock levels. The scallop stock in Shark Bay commences spawning in mid-April (continuing through until the end of November) and meat condition declines as spawning continues. Therefore, the opening date of the season is a compromise between maintaining breeding stock levels (measured by a pre-season survey of stock abundance and commercial catch rates during the fishing season) and the seasonal decline in meat condition associated with spawning.

The 2006 scallop season commenced on 1 March in Denham Sound (compared to 10 March in 2005), with all 14 Class A scallop boats fishing. This was an earlier season opening than normal, with the aim of increasing the total weight of scallops caught by taking them at a time when the meat size is large prior to spawning. However, to ensure that sufficient stock remained for spawning, the fishing arrangements provided a threshold catch limit for the scallop fleet to cease fishing for the fishing period (0530 to 1830 hrs, each day). This was the second season that fishing for scallops was restricted to day-time hours in Denham Sound.

On 18 March the dedicated scallop boats moved into the northern part of Shark Bay to commence fishing in North West Peron area and the Red Cliff area, together with the B class scallop boats (north of 25°30.20′ S latitude). Part of the Red Cliff ground was set aside for closure when the catch rate threshold level was reached. This area closed at 0800hrs on 13 April after 3 days fishing, however, fishing continued outside the closed part of Red Cliff for one day and then the dedicated scallop boats left Shark Bay to fish in the Abrolhos Islands and Mid West Trawl Fishery.

The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats.

The Department's Research Division carries out daily monitoring of the fleet for catch and effort and provides the advice when to close areas. This, together with the vessel monitoring system, is part of the fisheries management strategy for the control of spatial and temporal closures.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were breeding stock levels of target scallop species and interactions with protected species (loggerhead turtles). Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Research for monitoring the status of the scallop stock in Shark Bay is based on detailed research log book records and factory receivals provided by industry. In addition, an annual research survey is carried out in November, which, together with existing detailed biological knowledge, enables an annual catch forecast to be provided. These survey data are also used as the basis for the management arrangements in the following year.

A Fisheries Research and Development Corporation (FRDC)-funded project examining the biodiversity of bycatch in trawled and untrawled areas of Shark Bay will be completed in 2007. A second FRDC project with Edith Cowan University has been examining the spatial distribution of abundance of the recruitment survey and

the spatial distribution of catch during the fishing season to improve catch forecasting. This project will be completed in 2007.

A new FRDC-funded project focusing on minimising gear conflict and resource sharing issues in the Shark Bay trawl fisheries will commence in 2008. This will include hydrographic modeling of scallop larval movement within Shark Bay.

Retained Species

Commercial production (season 2006):
1,068 tonnes whole weight

The total scallop landings for this fishery, for both A and B Class scallop boats, were 1,068 t whole weight, of which the A Class boats landed 636 t (59.5%) and the B Class boats landed 432 t. The total landings were below the predicted catch.

The November 2005 scallop survey provided a catch forecast of 1,550 – 2,330 t for the entire Shark Bay scallop fishery for 2006. The projection may have been affected by the change in fishing pattern (daylight fishing in Denham Sound) and the use of catch threshold limits.

The total scallop landings (including prawn boats landings) from Denham Sound (592 t) were at the lower end of the catch range forecast (575 to 850 t). This area provided the majority of scallop catches in Shark Bay for the 2006 season.

The total scallop landings from Red Cliff and North West Peron areas were 476 t – well below the catch prediction range (975 to 1,450 t). The lower scallop landings may have been influenced by the closure to part of the Red Cliff area at the threshold catch rate level.

Fishing effort/access level

The total effort recorded by the Class A boats in 2006 was 5,406 hours – a slight increase from 2005 (4,887 hours). For the past 2 years, effort has been restricted because fishing ceased at catch rate thresholds.

In 2005, for the first time, fishing for scallops in Denham Sound was restricted to daylight hours (6 am – 6.30 pm), in order to reduce interaction with prawn stocks. For the 2006 season the fishing time was extended slightly (5.30 am – 6.30 pm).

To ensure that sufficient stock remained for spawning, the fishing arrangements provided a threshold catch limit whereby the scallop fleet would cease fishing when the catch rate of scallops reached between 280 to 300 kg meat weight per day fished (daylight fishing in Denham Sound) and 400 kg meat weight per 24-hour fishing in part of the Red Cliff area.

In 2005, the threshold catch rate level to cease fishing was 125 kg/hr. Fishing ceased in Denham Sound when the catch rate level was approximately 300 kg meat weight/day. The use of a catch rate threshold is experimental for at least 3 years to establish the level of subsequent recruitment from the remaining measured stock under normal environmental conditions.

Recreational component: **Nil**

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Projected catch next season (2007):
4,360 – 6,530 tonnes whole weight

A mean catch per unit effort of 117.5 kg/hr (whole weight) was recorded for the Class A fleet in 2006. This catch rate was close to the 10-year average (1995 to 2004) of 116 kg/hr.

The status of the stock is determined from a pre-season survey of recruitment and residual stock carried out in November – December on the main fishing grounds and in Denham Sound. This survey enables management arrangements for the fishery to be determined that take into account fishing scallops at optimal size and condition, while at the same time conserving appropriate levels of spawning stock.

The survey design and analysis of the data provides separate catch forecasts for the northern Shark Bay (Red Cliff and North West Peron) and Denham Sound areas, allowing separate opening dates to be determined for each area to optimise scallop catches each season.

The 2005 November annual scallop survey showed acceptable scallop recruitment in Denham Sound and fishing ceased at the upper end of the threshold limit, i.e. 300 kg/hr level for the 2006 season, the level at which fishing ceased in 2005. In addition, fishing for scallops ceased for a period of 2 months (May and June) by the B class fleet in the northern Shark Bay area to allow the remaining scallop stock to spawn during the key spawning period.

Research has shown that scallops mature at about 1 year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the spawning season, particularly winter which is the critical period for generating future recruits.

During the November 2004 scallop survey, a patch of scallops was located in an area named ‘the Leads’, which lies just south of the Denham Sound permitted trawl area, within the snapper/trawl closure. The November 2005 annual scallop survey trawls were undertaken and the catch prediction was 20 – 40 t meat weight, leaving 40% stock for spawning.

Therefore, fishing for scallops in the ‘Leads’ area in 2006 was not warranted because of low scallop abundance (less than 50 t meat weight as acceptable total catch).

The performance measure for the fishery was used to set the start date for the season, which is adjusted annually. It used the pre-season survey information, to ensure adequate breeding stock levels. In 2006 the fishing season was opened prior to the start of spawning, but with catch rate thresholds applied to all areas to maintain adequate breeding stock levels.

The catch projection for the 2007 season is based on the 2006 survey results. On the main fishing grounds (North West Peron and Red Cliff) in Shark Bay, recruitment was higher than in 2005 and will form the broodstock in 2007.

The predicted catch forecast for this area is 4,460 t with a range of 3,570 – 5,350 t whole weight. A similar pattern with higher recruitment levels and lower abundance of residuals was observed in the Denham Sound area, giving a predicted catches of 985 t with a range of 790 – 1,180 t whole weight. The catch projection for the fishery as a whole is therefore 5,445 t, with a range of 4,360 – 6,530 t whole weight.

As discussed above, there have been a number of management changes and surveys in the fishery that have affected the catch prediction relationship and have resulted in the catch not reaching the projected catch. A review of this relationship is underway.

Non-Retained Species

Bycatch species impact: **Low**

Owing to the legislated mesh size of the nets (100 mm) and the relatively short time spent by boats in this fishery, the total bycatch of fish is minimal.

Protected species interaction: **Low**

Protected species are occasionally captured but are released alive, due to the relatively short duration of trawls. Grids have been fully implemented to minimise the capture of large animals on Class A scallop boats and the capture risk to these animals is negligible.

The performance measure for this fishery is for 90% of turtles from non-BRD nets to be returned alive. BRDs are now compulsory in all nets, and no turtles were reported as being caught by scallop boats in 2006.

Ecosystem Effects

Food chain effects: **Low**

The ecosystem impacts of saucer scallop fisheries are unlikely to be significant, taking into account the typically high annual variation in abundance of the species and the high natural mortality associated with short life cycles and natural mortality in the third year of life.

Habitat effects: **Low**

The scallop fleet operates over a limited portion of the licensed fishing area, primarily in the oceanic centre section of Shark Bay. Fishing is concentrated on a small sector of the typically bare sand habitat associated with concentrations of this species.

In 2006, 19% of the area available for trawling was fished. As a result of the small area impacted and the short-term impact of the gear on sand habitats, the overall effect of fishing on benthic habitats is low.

Social Effects

The estimated employment for the year 2006 was approximately 130 skippers and crew. There are also processing and support staff employed at Carnarvon, Fremantle and Geraldton. This fishery – and other trawl fisheries in the Gascoyne - generate a major component of employment in the region.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$3.7million**

The wholesale price of scallops varies, depending on the type of product (grade and meat condition) and the market forces operating at any one time. The average wholesale price across all grades of scallops was $3.50/kg whole weight or $17.50/kg meat weight. Meat weight is 20% of whole weight.

Fishery Governance

Target catch range: **1,250 – 3,000 tonnes whole weight**

The target catch range is approximately 1,250 – 3,000 t whole weight, based on catches over the 5-year period 1995 – 1999. This period excludes the high catches of the early 1990s (Shark Bay Scallop Figure 1), apparently created by an unprecedented 4 years of El Niño conditions.

The projected catch for next season, based on a pre-season survey, is higher than the target catch range as a result of good recruitment.

New management initiatives (2006/07)

A review of the season opening process was carried out for 2004 and 2005, with selected areas opened to fishing earlier than previous years to maximise the size and therefore value of scallop meat. As a counter-measure to fishing earlier, all fishing for scallops ceased at a conservative catch rate threshold in these areas, thereby providing adequate spawning stock protection.

These arrangements will continue for the 2007 season and in addition, after the cut-off catch rate (350 kg/24-hr catch by A class boats) is reached, the Red Cliff and North West Peron area will remain closed until August, over the key spawning period to both A and B class boats.

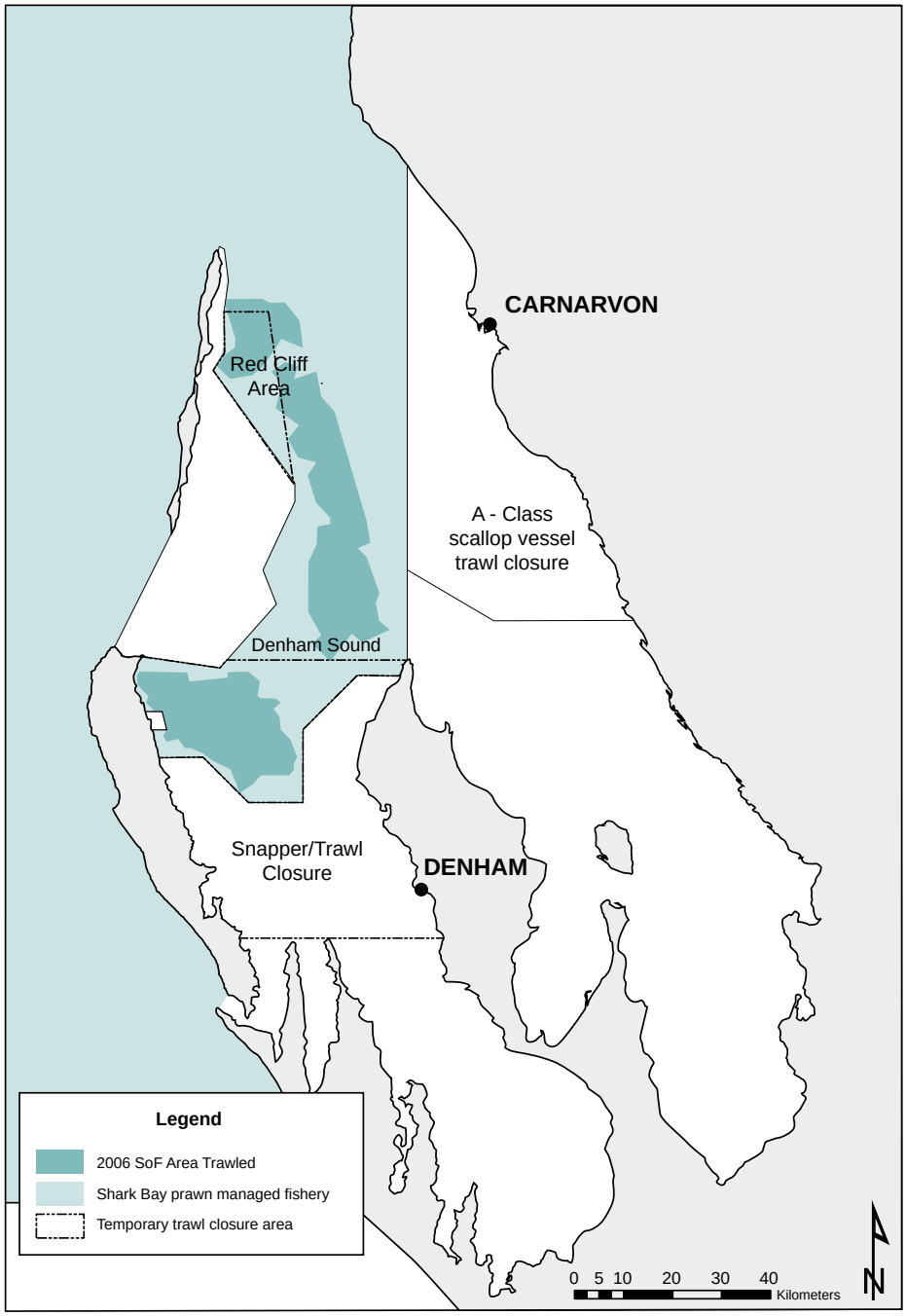
Overlaying the threshold catch cut-off level is a catch share agreement of 72% and 28% for the A and B class boats respectively to be averaged over a number of years. This initiative is to provide a method to maintain historical catch share (on which the catch share ratio is based) between these 2 fleets and to reduce conflict for the take of scallops between the 2 fleets.

The threshold catch rate for Denham Sound in 2007 was set by Department of Fisheries' research/industry agreement at 300 kg meat weight/day. This threshold rate is set to ensure that sufficient stock remains for spawning and aims to maintain equity by leaving stock available for fishing by the Class B (prawn) boats later in the season after the Class A boats leave the area.

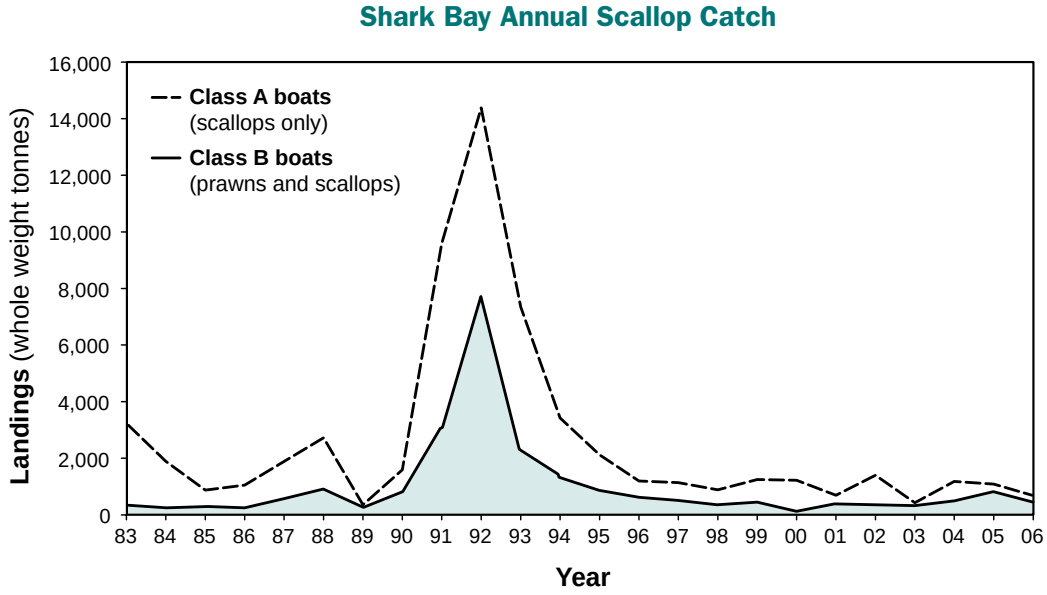
External Factors

A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels (corresponding to strong Leeuwin Current) correlate with poor recruitment.

The Department of Fisheries is currently examining the mechanisms that control recruitment success in greater detail, in order to explain more of the inter-annual variation that occurs.



SHARK BAY SCALLOP FIGURE 1
Boundaries of the Shark Bay Scallop Fishery.



SHARK BAY SCALLOP FIGURE 2
Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983 – 2006.

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson, R. Marriot and E. Lai
Management input from L. Caporn

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses the commercial and recreational fishing activities that target demersal scalefish species in the continental shelf waters of the Gascoyne bioregion between 114°50′ E and 27° S, (Gascoyne Demersal Scalefish Fishery Figure 1). These include the activities of the Shark Bay Snapper Managed Fishery, Wetline Fishing (Gascoyne) and recreational line fishing (both from licensed charter and private vessels).

Commercial line fishing within these waters is now principally undertaken by Shark Bay Snapper Managed Fishery (SBSF) licensed vessels that have historically targeted the oceanic stock of pink snapper (*Pagrus auratus*) in waters off Shark Bay. Stock identification studies have shown that this stock is quite distinct from pink snapper stocks found in the inner gulfs of southern Shark Bay (see Inner Shark Bay Fishery). Pink snapper in the Kalbarri region directly to the south of the SBSF waters are currently treated as a separate population (see West Coast Demersal Scalefish Fishery).

SBSF licensed vessels use mechanised handlines and, in addition to pink snapper, catch a range of other species including goldband snapper (*Pristipomoides* spp., mainly *P. multidens*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae; includes spangled emperor, *Lethrinus nebulosus*), cods (Serranidae), ruby snapper (*Etelis carbunculus*) and pearl perch (*Glaucosoma burgeri*).

Commercial 'open-access' wetline vessels without SBSF-quota use similar line-fishing gear and operate in Gascoyne waters outside of the SBSF management zone (see 'Boundaries'). These vessels catch a similar variety of species, as do a limited number of licensed charter vessels and recreational vessels fishing out of Denham, Carnarvon and the Ningaloo area (Coral Bay, Tantabiddi, Exmouth).

Integrated Fisheries Management (IFM) is scheduled for implementation in the Gascoyne in 2009. 4 IFM indicator species have been identified, 3 of which are the focus of this status report, i.e. pink snapper, goldband snapper and spangled emperor. A fourth species, Spanish mackerel, is reported elsewhere (Mackerel (Interim) Managed Fishery).

Governing legislation/fishing authority

Commercial

Shark Bay Snapper Management Plan 1994
Shark Bay Snapper Managed Fishery License
Prohibition on line fishing from trawlers (Shark Bay) Order 2000
Prohibition on commercial line fishing in waters of Shark Bay Snapper Managed Fishery Order 2004
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994, Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)

Regional Recreational Fishing Advisory Committees (Denham, Carnarvon, Exmouth)

Boundaries

The SBSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°34′ S and 26°30′ S. SBSF licensed vessels are not permitted to fish in the inner gulfs of Shark Bay.

Open-access wetline vessels are only permitted to fish in the following Gascoyne waters: (i) north of 21° 56′ S; (ii) between 23°07′ and 23°34′ S; and (iii) south of 26°30′ S. No commercial fishing is permitted between 21°56′ and 23°07′ S ('Point Maud – Tantabiddi Well' closure).

The recreational fishery that includes licensed charter vessels operates in all Gascoyne waters (Gascoyne Demersal Scalefish Figure 1).

Management arrangements

Commercial line fishing in the Gascoyne, for pink snapper in particular, dates back to the early 1900s. The SBSF came under formal management for the first time in May 1987. Between then and 2000, pink snapper catches taken during the peak season (May – August) were subject to individual quotas, while gear controls applied in the off-peak season. From 2001, the fishery has been quota-managed on a year-round basis. A minimum holding of 100 quota units applies and all units are transferable. These units operate from 1 September to 31 August, with a total of 5,125 units in the fishery.

In 2004, the total allowable commercial catch was reduced to 338,250 kg (from 563,750 kg), with the value of each unit at 66 kg. In the same year, Shark Bay Scallop and Prawn Managed Fishery licensees volunteered to not take any pink snapper, effectively reducing the commercial quota further and resulted in an 'effective' total allowable commercial catch (TACC) of 313,000 kg in 2004. The TACC has remained effectively at this level to 2006.

Currently there are no direct catch limits in place for any of the other key target species taken by SBSF vessels. A comprehensive Ecologically Sustainable Development (ESD) assessment of the SBSF fishery was undertaken in 2003. The only issue identified through this process related to the level of the oceanic pink snapper breeding stock at that time (see boxed text for the annual assessment of performance for this issue).

'Open-access' commercial wetline fishing outside of the SBSF is scheduled to come under formal management as an outcome of the 'Wetline review' with the creation of a Gascoyne Demersal Scalefish Fishery and Gascoyne Inshore Net Fishery (see Fisheries Management Paper No. 224 for further details).

Many of the commercial (line-fishing) target species are subject to mimimum legal sizes (emperors, pink snapper, Spanish mackerel, red emperor, cods). The recreational fishery (includes charter vessels) is principally managed using daily bag, possession and size limits, coupled with prohibitions on the use of 'commercial' fishing gear (e.g. longlines).

Research summary

Pink snapper: Detailed research on the oceanic pink snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. An age-structured model, developed as part of a Fisheries Research and Development Corporation (FRDC)-funded project (2000 – 2003) was used to assess the status of the oceanic snapper stock for the first time in 2003.

The size and age composition of commercial catches have been closely monitored since the SBSF quota was reduced by 40% in 2004. Catch and effort data and the results from the most recent age-based stock assessment modeling were used to provide the status report for this species here.

Goldband snapper: An FRDC-funded project (1997 – 2000) provided important biological information on goldband snapper in the Kimberley region. While detailed information for this species in the Gascoyne is currently lacking, limited biological sampling has been underway since 2005. This will form the basis for more comprehensive research including a stock assessment that is currently underway as part of the Gascoyne IFM process. A more detailed status report for the species will be presented next year.

Spangled emperor: An FRDC-funded project (1989 – 1991) provided preliminary biological information on several emperor species in north-west Western Australia. Comprehensive research on this IFM indicator species commenced in March 2007. A more detailed status report for the species will be presented next year.

In previous *State of the Fisheries* reports, the commercial catch and effort data reported only included information for SBSF licensed vessels fishing between latitudes 23°34′ S and 26°30′ S. However, data reported in this edition generally covers commercial fishing in all Gascoyne waters between 114° 50′ E and 27° S for the first time.

Commercial catches and fishing effort previously were reported by calendar year. Because most of the Gascoyne commercial catch of the key demersal species is now taken by SBSF vessels, catches reported here are for period of SBSF quota year, e.g. September 1 2005 – August 31 2006. Catches exclude mackerels, sharks and tunas (reported elsewhere).

Recreational catches (estimated) and charter catches (reported) are those for period January – December 2006.

Retained Species

Commercial landings (season 2006):

Pink snapper 334 tonnes
Goldband snapper 104 tonnes
Spangled emperor 18 tonnes
Other emperors 19 tonnes
Other species 94 tonnes

The total commercial catch of pink snapper in the Gascoyne in 2006 was 334 t. Of this, 318 t was taken by SBSF licensed vessels fishing within the SBSF management zone (TACC was 338 t). In addition, these SBSF vessels also caught a total of 222 t of other species in 2006 which included 96 t of goldband snapper, 24 t of red emperor, and 15 t of spangled emperor (Gascoyne Demersal Scalefish Fishery Table 1).

Wetline vessels (no SBSF–quota) fishing outside of the SBSF caught approximately 16 t of pink snapper, 8 t of goldband snapper, 3 t of spangled emperor, and 16 t of other various species.

While the overall catches of emperor and cod species taken by commercial vessels in the Gascoyne have historically been relatively small and stable, catches of goldband snapper increased sharply from less than 10 t in 2001, peaked at around 300 t in 2003 and are now in sharp decline (Gascoyne Demersal Scalefish Fishery Figure 3).

Recreational catch:

Pink snapper 11 %
Goldband snapper 2 %

In 2006, the recreational catch of oceanic pink snapper landed at Denham was estimated at 12 t (8 t in 2005) with at least a similar catch assumed to have been landed at Carnarvon (no recent data available).

The recreational catch of oceanic pink snapper taken from charter boats in 2006 was 18 t (21 t in 2005, 25 t in 2004). The decrease in pink snapper catch can be partly explained by the reduction in the daily bag limit introduced in January 2006 (from 6 to 4 fish per person). Based on these data, the recreational catch of oceanic pink snapper was estimated at approximately 11% of the total catch in 2006 (similar to that in 2005).

In the inner gulfs, pink snapper are mostly taken by recreational boats and are subject to separate management arrangements (see Inner Shark Bay Fishery).

Most of the recreational catch of goldband snapper in the Gascoyne is taken by charter boats with approximately 2 t taken in 2006 (3 t in 2005). Based on these limited data, the recreational catch of goldband snapper was estimated at approximately 2% of the total Gascoyne catch in 2006 (3% in 2005).

Data on recreational catches of spangled emperor are not available at this time. Detailed information obtained from the Gascoyne recreational fishing survey currently underway will be reported in next year's *State of the Fisheries.*

Fishing effort/access level

Commercial

As a consequence of the requirement introduced in 2004 that all wetline vessels operating within the waters of the SBSF need to possess a minimum holding of pink snapper quota, commercial line fishing between 23°34′ S and 26°30′ S is now entirely conducted by SBSF licensed vessels.

Following the introduction of these arrangements, a dramatic decline in 'open-access' wetline effort across the Gascoyne has been observed. In 2006, SBSF vessels landed 90% of the entire Gascoyne commercial catch of the key demersal species.

In 2006 there were 53 licences in the SBSF. A total of 18 vessels actively participated in fishing in 2006 (decreased from 23 in 2005).

The effectiveness of fishing effort has varied markedly on a seasonal basis, historically peaking in June – July when pink snapper are aggregated to spawn.

SBSF catch and effort data are therefore assessed using 'standard boat days' only, i.e. days fished by vessels that caught more than 4 t each of pink snapper by line during the period June – July. Fishing effort in the SBSF was 518 standard boat days in 2006 (616 in 2005).

Recreational

Data on recreational fishing effort (excluding charter vessels) are not available at this time but will be reported in detail in next year's *State of the Fisheries.*

In 2006, of the 83 fishing tour and 14 restricted fishing tour/eco-tour operators licensed to operate within the Gascoyne, only 42 licenses were active.

Stock Assessment

Assessment complete

Pink snapper: Yes
Goldband snapper: Not assessed
Spangled emperor: Not assessed

Breeding stock levels

Pink snapper: Increasing

Pink snapper: Based on the results of stock assessment modeling in 2003 that indicated that the spawning biomass of the oceanic snapper stock was depleted, the TACC was reduced by 40% for the 2003/04 season. The stock assessment was updated in 2005 (incorporating data obtained from monitoring the commercial fishery in 2004) and again in April 2006 (incorporating data from the 2005 commercial fishing season).

This assessment was externally reviewed in July 2006. Most recently, a stock assessment was undertaken in February 2007 using data obtained from the 2006 commercial season.

Based on the results of this assessment, the spawning biomass of the oceanic pink snapper stock was estimated at 27 – 28% of the unexploited level, i.e. below both the 'target' (40% of the

unexploited spawning biomass) and 'threshold' level (30% of the unexploited spawning biomass).

While there had been some recovery of the spawning biomass since the quota reduction in 2004, at current harvest levels it was estimated that the target level would not be reached within the maximum permissible (10-year) timeframe, i.e. by 2014, under the current quota. As a consequence, further reductions in the overall catch have been implemented for the 2006/07 and next 2 fishing seasons (2007/08 and 2008/09).

The use of catch rates as an index of abundance for pink snapper must be treated with some caution in this fishery, due to the aggregating behaviour of the species during the winter (spawning) period. There are also difficulties associated with determining a pink snapper (targeted) catch rate from the multi-species monthly catch and effort data, and in recent years, possible changes in fishers' behaviour following the 2004 quota reduction.

The pink snapper catch per boat day in 2006 for SBSF licensed vessels for the peak months (June – July) was 614 kg snapper/boat day – significantly higher than the catch rate calculated for 2005 and 2004 (491 and 465 kg snapper/boat day, respectively) (Gascoyne Demersal Scalefish Fishery Figure 2).

The performance measure for the Shark Bay Managed Snapper Fishery is that the catch rate for the peak months (June – July) should not fall below 500 kg/standard boat day. Catch rates in 2006 have increased significantly, to 614 kg/standard boat day, which is above the fishery's spawning stock indicator.

Non-Retained Species

Bycatch species impact: **Negligible**

Virtually all the commercial catch consists of demersal scalefish with a medium-to-high market value, therefore the catch of non-retained species is insignificant.

Protected species interaction: **Negligible**

The line fishing methods used do not catch any protected species.

Ecosystem Effects

Food chain effects: **Low**

Pink snapper are generalist feeders and are just one of a number of such species inhabiting the continental shelf waters in this region.

Food chain effects are considered to be low because the quota system restricts SBSF catches to a small percentage of the total biomass. While the spawning biomass for the oceanic stock remains depleted, management action has again (as in 2004) been taken to facilitate stock recovery to at least 40% of the unexploited level by 2014.

The juvenile and sub-adult components of the stock are likely subject to large, environmentally-driven fluctuations in abundance even in the absence of fishing, due to significant variability in recruitment.

Habitat effects: **Negligible**

The nature of the fishery, targeting aggregations of adult pink snapper and other demersal scalefish using hooks and lines, means that the commercial fishery has virtually no direct impact on the habitat.

Social Effects

The pattern of commercial fishing by SBSF vessels in 2006 was similar to that seen in previous years and reflects the shift from the traditional complete focus on pink snapper during the peak season to a fishery more targeted at outer-shelf species throughout the whole year.

In 2006, 17 vessels fished for more than 10 days during the peak season (May – August) with an average crew of 2.

Fishing and associated fish processing is one of the major sources of local employment in Denham and Carnarvon.

Shark Bay and Ningaloo are very popular tourist destinations, especially during the winter months and school holidays. Much of this tourism is recreational-fishing related. While data are currently lacking, research is underway to assess levels of recreational fishing activity and human usage in the Ningaloo area.

Economic Effects

Estimated annual value (commercial fishers) for year 2006: $3.4 million

The overall value of the SBSF fishery increased slightly in 2006 to around $3.4 million ($3 million in 2005), with $2 million from pink snapper and $1.4 million from all other scalefish species. This increase in value is related to increased prices paid to fishers rather than any increase in catches landed.

While an actual dollar value cannot be assigned to recreational catches in the Gascoyne, the availability of quality target demersal species underpins the local tourism industry and generates significant income for the regional economy.

Fishery Governance

Target catch (or effort) range: **425 – 558 days**

In recent years, since the pink snapper quota was reduced in 2004, the number of boat days of fishing effort required to obtain the landed catch have been calculated to be well above the target effort range of 425 – 558 boat days (616 boat days in 2005, 620 boat days in 2004). However, in 2006, an estimated 518 boat days of fishing effort were used to obtain the reported catch of 318 t, i.e. well within the target effort range.

The average catch per unit effort (CPUE) has increased sharply each year since the quota was reduced in 2004, to an estimated 614 kg/June – July boat day for the 2006 season (it was 491 kg/June – July boat day in 2005, 465 kg/June – July boat day in 2004). This was significantly above the ESD performance measure of 500 kg/standard boat day.

Given the issues raised in relation to pink snapper catch rates in this fishery (see 'Stock Assessment') and the unknown effect of the most recent quota reductions on fishers behaviour in the future, there is a need to review the current ESD trigger level of 500 kg/standard boat day.

New management initiatives (2006/07)

The most recent stock assessment (February 2007) estimated that in 2006 the spawning biomass of the oceanic pink snapper stock was still below both the 'target' and 'threshold' levels. While the spawning biomass is recovering, at current harvest levels it was estimated that the 40% target level would not be reached within the agreed timeframe (i.e. by 2014).

Based on this assessment and following a series of discussions with industry since July 2006, the Department of Fisheries introduced further reductions in the TACC (reduced by approximately 12%) for the 2006/07 season and a further 7% for the following 2 seasons (2007/08 and 2008/09). These arrangements will be reviewed prior to start of the 2009/10 season.

Concerns around sustainability of the more vulnerable deeper-water species (e.g. goldband snapper, ruby snapper, pearl perch) remain. Management arrangements for the proposed Gascoyne Demersal Wetline Managed Fishery and Gascoyne Inshore Net Fishery (which will operate in coastal waters north of the Shark Bay Beach Seine and Mesh Net Managed Fishery to take scalefish including mullet and whiting species) are still being finalised.

Integrated Fisheries Management (IFM) is scheduled for implementation in the Gascoyne in 2009. IFM involves determining sustainable harvest levels for the key species; allocating explicit catch shares between commercial, recreational and indigenous sectors; and then managing the respective sectors within these allocations.

Research is currently underway that will provide information on existing catch shares and stock assessments for the key indicator species by late 2008.

External Factors

Under the Offshore Constitutional Settlement, commercial trawlers licensed by the Commonwealth may operate in the region outside the 200 m isobath as part of the Western Deepwater Trawl Fishery (WDWTF). In 2006, WDWTF licensed vessels reported a total catch of less than half a tonne of pink snapper. The quantity of pink snapper returned to the water is unknown.

Research on pink snapper in the Shark Bay region, and elsewhere in Australia and New Zealand, has demonstrated high variability in recruitment between years. In most cases, this appears to be caused by environmental (probably oceanographic) variation affecting survival at the pre-settlement and possibly early post-settlement phases.

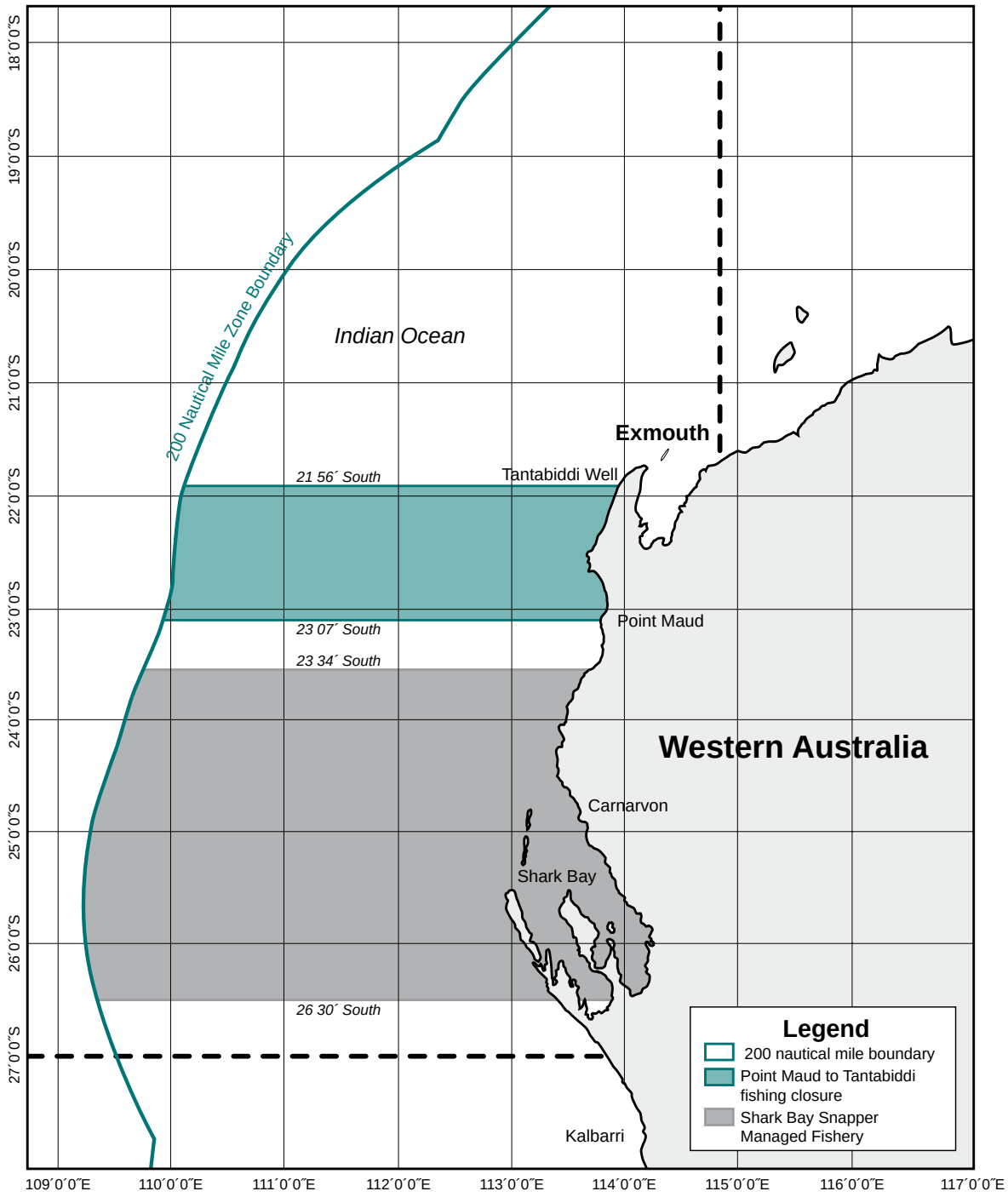
Variation in Leeuwin Current strength may play some role in affecting pink snapper recruitment processes. Because Shark Bay is at the northern limit of pink snapper distribution on the west coast of Australia, some sensitivity to environmental variation between years (e.g. sea temperature) would be expected.

There is an urgent need to better understand relationships between pink snapper populations on the west coast of Australia between Shark Bay and Cockburn Sound. In particular, sources of recruitment for pink snapper in waters off Kalbarri need to be investigated.

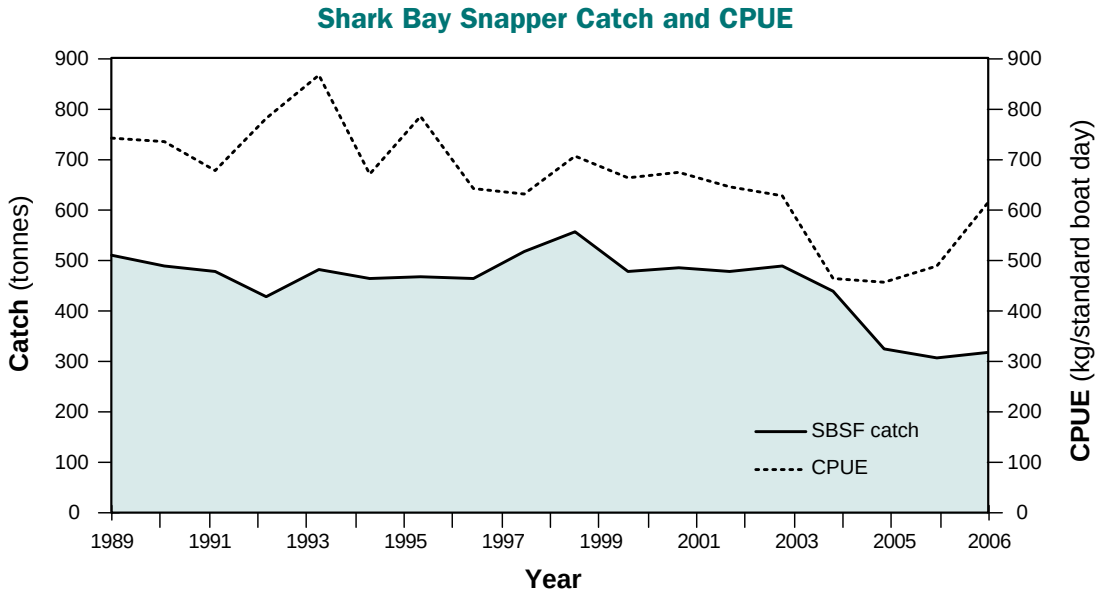
GASCOYNE DEMERSAL SCALEFISH TABLE 1

Catches of species other than pink snapper taken in the years 2001 – 2006 by SBSF licensed boats in the area between 114° 50′ E and 27° S. This list excludes mackerels and sharks, which are reported on elsewhere in this volume, and tunas which are reported to the Commonwealth Government.

Species		2001 (tonnes)	2002 (tonnes)	2003 (tonnes)	2004 (tonnes)	2005 (tonnes)	2006 (tonnes)
Goldband snapper	*Pristipomoides* spp.	3.4	6.2	109.1	202.8	204.3	95.8
Red emperor	*Lutjanus sebae*	6.4	16.1	15.5	30.1	27.4	23.7
Spangled emperor	*Lethrinus nebulosus*	13.3	16.5	17.4	10.6	10.1	14.9
Other emperors	Lethrinidae	13.6	12.0	11.3	17.7	16.0	17.9
Cods	Serranidae	9.8	19.4	21.5	29.2	23.0	17.6
Other		46.8	56.1	55.8	56.2	50.9	52.4
Total		**93.3**	**126.3**	**230.5**	**346.5**	**331.7**	**222.3**

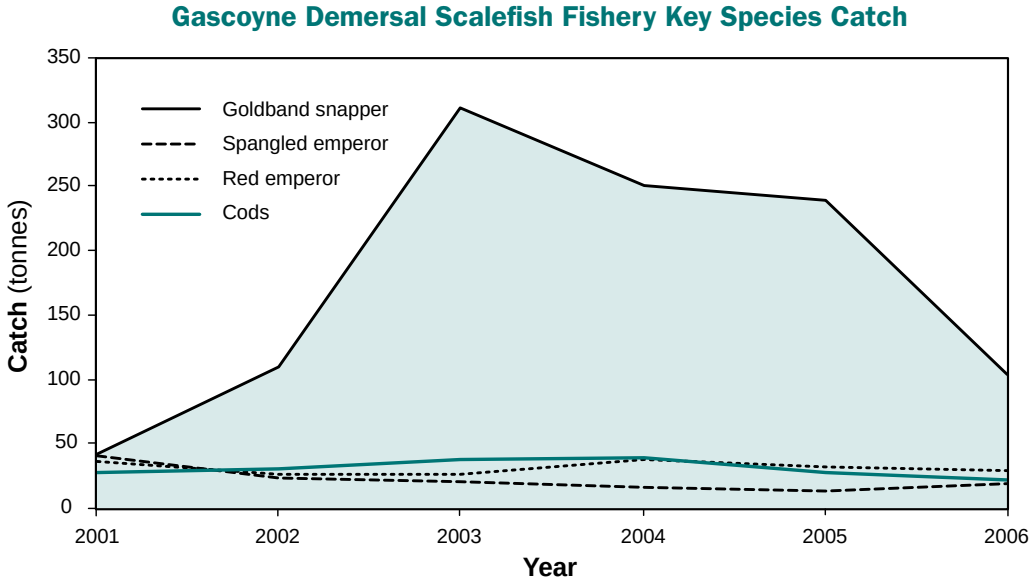


GASCOYNE DEMERSAL SCALEFISH FIGURE 1
Waters of the Gascoyne bioregion including Shark Bay Snapper Managed Fishery management zone and 'Point Maud to Tantabiddi Well' fishing closure. Hatched lines indicate boundaries of the Gascoyne Coast bioregion.



GASCOYNE DEMERSAL SCALEFISH FIGURE 2

Catch and catch per unit effort (CPUE) by year from 1989 to 2006 for the SBSF. Units are kg whole weight of pink snapper per standard boat day. The CPUE for line fishing by dedicated snapper vessels in June – July (peak season) is used as one index of abundance in the stock assessment model used for this stock.



GASCOYNE DEMERSAL SCALEFISH FIGURE 3

Catches of key demersal scalefish species taken by both the SBSF and 'open access' wetline fishery in the Gascoyne Coast bioregion (between 114° 50′ E and 27° S) for period 2001 – 2006

Inner Shark Bay Scalefish Fishery Status Report

G. Jackson, J. Norriss and E. Lai
Management input from M. Stadler

Fishery Description

The Inner Shark Bay Scalefish Fishery encompasses the commercial and recreational fishing activities that target scalefish species within the waters of the Shark Bay Marine Park, Denham Sound and the Eastern Gulf (Inner Shark Bay Fishery Figure 1). This includes the Shark Bay Beach Seine and Mesh Net Managed Fishery (SBBSMNF) and Inner Shark Bay Recreational Fishery.

The SBBSMNF operates from Denham and uses a combination of beach seine and haul net gears to take 4 main species/groups – whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and western yellowfin bream (*Acanthopagrus latus*). Small quantities of other assorted species (e.g. garfish and trevallies) are also caught.

One of the SBBSMNF fishers also holds 1 of the 2 commercial permits in the Shark Bay Crab Interim Managed Fishery and can trap blue swimmer crabs (*Portunus pelagicus*) in waters of Shark Bay south of Cape Inscription (reported elsewhere in West Coast Blue Swimmer Crab Fishery Status Report).

Most recreational fishing is boat-based (rod and line, handline) with some limited fishing from the shore (rod and line). The main recreational scalefish species are black snapper (grass or blue-lined emperor, *Lethrinus laticaudis*), pink snapper (*Pagrus auratus*), whiting (*Sillago* spp.), tailor, western butterfish (*Pentapodus vitta*) and blackspot tuskfish (bluebone, *Choerodon schoenleinii*). Recreational fishers take large numbers of blue swimmer crabs, mostly in the Eastern Gulf.

A limited number of fishing charter vessels operate out of Monkey Mia and Denham.

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Management Plan 1994
Shark Bay Beach Seine and Mesh Net Managed Fishery Licence

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)
Regional Recreational Fishing Advisory Committees (Denham, Carnarvon)
Direct consultation with local community on specific issues (e.g. Shark Bay Snapper Ministerial Working Group)

Boundaries

The areas covered by this report are shown in Inner Shark Bay Scalefish Fishery Figure 1. Fishing is not permitted in the Hamelin Pool Marine Nature Reserve.

The boundaries of the SBBSMNF are 'the waters of Shark Bay from high water mark lying

(a) south of a line drawn from the northernmost point of Cape Inscription on Dirk Hartog Island due east to the mainland; and

(b) east of a line drawn from Surf Point on Dirk Hartog Island to Steep Point on the mainland; but excluding the waters of Shark Bay due south of a line drawn west of the highwater mark of Kopke Point on the mainland to the highwater mark on the mainland south of Petit Point on Peron Peninsula'.

Management arrangements

Commercial

The SBBSMNF is managed through input controls in the form of limited entry and gear restrictions. A unit in the fishery comprises 1 primary vessel, a maximum of 3 netting dinghies and a maximum team size of 3 individual fishers.

Most of the catch is marketed through the 'Shark Bay Fish Factory' in Denham, which sets weekly delivery quotas and commercially-acceptable size limits that are often set above the minimum legal size for the species concerned.

Under the current management plan, licensed operators are subject to net length and mesh size controls which require that:

- the mesh not be less than 48 mm for taking whiting;
- the mesh not be less than 86 mm for taking mullet; and
- the mesh not be greater than 38 mm and not less than 26 mm throughout and the net shall not be more than 200 m in total length and have a pocket no more than 30 m in length when used to take garfish.

Recreational

The recreational fishery is principally managed using daily bag, possession, size and gear limits. More complex arrangements are used for pink snapper – historically the most important recreational target species.

Pink snapper inhabiting the inner gulfs comprise several essentially reproductively isolated populations. Management recognises separate fishable stocks in the Eastern Gulf, Denham Sound and the Freycinet Estuary (Inner Shark Bay Fishery Figure 1). Research advice for this species is provided on the basis of these divisions.

Prior to 2003, recreational catches of pink snapper in inner Shark Bay were managed using a combination of size and bag limits and fishery closures. In 2003, a total allowable catch (TAC) was set for each pink snapper stock for the first time which included explicit allocations of the available catch for the recreational and

commercial sectors. The recreational sector (includes charter vessels) was allocated 75% and the commercial sector 25% of the available catch in each management area.

In 2006, these TACs were set as follows:

- Eastern Gulf – 15 t (12 t recreational, 3 t commercial);
- Denham Sound – 15 t (12 t recreational, 3 t commercial); and
- Freycinet Estuary – 5 t (approximately 1,400 fish – 1,050 recreational, 350 commercial).

To manage the recreational pink snapper catch in each area, the fishing regulations in 2006 were as follows:

- Daily bag limit of 1 pink snapper per person;
- Minimum size of 50 cm;
- Maximum size of 70 cm;
- Closed season from 1 May – 31 July (Eastern Gulf only);
- Closed season from 15 August – 30 September (Freycinet Estuary only); and
- Freycinet Estuary only – limited number (1,050) of single-use 'management quota tags' available, with each 'tag' entitling the fisher to retain 1 pink snapper only per tag.

These arrangements were designed to keep the recreational catch of pink snapper in each management area to a sustainable level, so as to allow breeding stocks to recover to, and then be maintained, at or above the 'target' level (40% of the unexploited level).

Recreational catches of other 'Category 1' (highest risk) demersal species (e.g. black snapper, estuary cod, tuskfishes) in the inner gulfs of Shark Bay, and elsewhere in the Gascoyne bioregion, are managed using a combination of size, bag and possession limits.

Research summary

Research to support the management of pink snapper has been undertaken by the Department of Fisheries since 1996/97. Scientific assessments of the status of the 3 pink snapper stocks have been provided each year since 1998.

A review of the research 1997 – 2001 and the results of preliminary model-based stock assessments were used in 2002 to determine appropriate levels of TAC for each pink snapper stock for the period 2003 – 2005. In June 2005, results of updated stock assessments and recreational fishing surveys were used to determine management arrangements for pink snapper and other 'Category 1' species for the period 2006 – 2008. Arrangements for pink snapper are scheduled to be reviewed in mid-2008.

A project funded by the Fisheries Research and Development Corporation (FRDC) and conducted by the Department of Fisheries (1999 – 2002) provided important biological information on black snapper in inner Shark Bay. Black snapper inside Shark Bay are managed as a single unit stock.

An FRDC-funded project conducted by Murdoch University (2000 – 2003) provided important biological information on tuskfish species in inner Shark Bay. Blackspot tuskfish inside Shark Bay are managed as a single unit stock.

The first survey of recreational fishing in Shark Bay was undertaken in 1983. More recently, estimates of recreational catch and effort in the inner gulfs have been derived from the results of recreational fishing surveys undertaken by the Department of Fisheries, initially as part of a broader survey of the Gascoyne region in 1998/99. Results showed that 99% of both the pink and black snapper recreational catch was taken by boat-based fishers. Since then, recreational fishing surveys in inner Shark Bay have focused on boat-based fishing, with interviews conducted with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps each year since 2000 (on-going).

Catches of the key species taken by licensed commercial and charter fishing vessels was estimated from data provided via compulsory catch returns. They have been available for the charter sector only since 2002.

Monitoring of the status of the SBBSMNF target species (whiting, sea mullet, tailor and yellowfin bream) is undertaken annually, using data provided via compulsory catch returns coupled with the extensive scientific knowledge gained from previous research. FRDC-funded research has recently been undertaken on whiting species (2001 – 2003) and yellowfin bream (1999 – 2001) by Murdoch University.

Performance indicators based on catch and catch rates were determined for whiting, sea mullet, tailor and yellowfin bream by the Department of Fisheries as part of drafting a Ecologically Sustainable Development report for the SBBSMNF.

Retained Species

Commercial catches (season 2006): Whiting 113.4 tonnes
Mullet 62.0 tonnes
Tailor 20.7 tonnes
Yellowfin bream 23.1 tonnes
Pink snapper 1.9 tonnes

The total commercial catch (all species combined) taken by SBBSMNF licensed vessels in 2006 was 229 t – 34 t lower than in 2005 and the lowest since 1976.

The total catch in 2006 comprised 113.4 t of whiting, 62.0 t of sea mullet, 20.7 t of tailor, 23.1 t of yellowfin bream and 10.2 t of other mixed scalefish species, including 1.9 t of pink snapper (Inner Shark Bay Scalefish Table 1, Figures 2 – 6). Black snapper and blackspot tuskfish are not caught by SBBSMNF vessels.

Recreational catch estimates:

Pink snapper:	**Eastern Gulf 3.4 tonnes**
	Denham Sound 5.4 tonnes
	Freycinet 2 tonnes
Black snapper:	**9.3 tonnes**
Blackspot tuskfish:	**2.3 tonnes**

Pink snapper: As a direct result of management intervention, including the introduction of TAC-based management in 2003,

recreational catches of pink snapper overall have decreased significantly since 1998 (Inner Shark Bay Scalefish Figure 7).

In 2006, the recreational pink snapper catch was estimated to have increased by more than 100% to 3.4 t in the Eastern Gulf and by 17% to 5.4 t in Denham Sound, compared with 2005. In contrast, the recreational catch in Freycinet Estuary had declined by 16% to 2 t in 2006 compared with 2005.

In all 3 areas, pink snapper catches remained well within the TAC (Inner Shark Bay Scalefish Table 4). Numbers of pink snapper released by recreational fishers in 2006 were significantly lower than in previous years (decreased by approximately 25% to 15,000 in the Eastern Gulf, by 48% to 19,000 in Denham Sound and by 15% to 6,000 in the Freycinet Estuary).

The above catches include 100 kg of pink snapper taken in the Eastern Gulf by licensed charter vessels in 2006 (nil catch in Denham Sound and Freycinet Estuary).

Black snapper: Black snapper remain the most common species landed (in order of number kept) by recreational boats in inner Shark Bay, mostly as a consequence of the restrictive management arrangements introduced for pink snapper. The annual catch of black snapper taken by recreational boats is estimated to have varied between 7 and 17 t since 1998.

In 2006 the recreational catch of black snapper was estimated to have declined by approximately 25% to 9.3 t compared with 2005 (12 t) (Inner Shark Bay Scalefish Table 2). The number of black snapper released by recreational fishers was 41% lower than in 2005.

A total of 100 kg of black snapper was taken by licensed charter vessels in the inner gulfs in 2006 (100 kg in 2005, 300 kg in 2004).

Whiting: Whiting (mostly yellow-finned, *Sillago schomburgkii*) are the next most common species landed (by number kept) by recreational boats after black snapper and pink snapper. In 2006 the recreational catch was estimated at 0.2 t – a 40% decrease compared with the catch in 2005 (Inner Shark Bay Scalefish Table 2).

Tailor: Catches of tailor landed by recreational boats in 2006 are estimated at 0.8 t – approximately double that in 2005 (Inner Shark Bay Scalefish Table 2).

Blackspot tuskfish: In 2006 the recreational catch of blackspot tuskfish was estimated at 2.3 t (4.5 t in 2005). This represents a 46% decline compared with 2005, with numbers released higher at 6,472 compared with 5,205 in 2005 (Inner Shark Bay Scalefish Table 2). No catch of this species was reported by licensed charter vessels in 2006.

Fishing effort/access level

Commercial

In 2006, of the 10 SBBSMNF licences, 7 vessels were actively involved in fishing. Since 1990, total fishing effort has averaged 1,228 boat days per year, with a peak of 1,760 in 1991 and a low of 979 in 1995 (Inner Shark Bay Scalefish Figure 2).

In 2006, there was a total of 1,034 boat days of fishing effort expended in the fishery. The fishery is an all-year-round one, with an average of 5.3 boats fishing per month. Fishing effort has been at historically low levels during the last decade, partly due to a reduction in the number of licensees.

Recreational

In 2006, boat-based recreational fishing effort was estimated to have declined overall to approximately 35,000 fisher days (38,000 in 2005) with the effort shared equally between both gulfs (Inner Shark Bay Scalefish Table 3).

Compared with 2005, recreational fishing effort decreased in the Eastern Gulf and Denham Sound, by 8% and 21% respectively, but approximately doubled in the Freycinet Estuary.

Stock Assessment

Assessment complete

Whiting:	**Yes**
Mullet:	**Yes**
Tailor:	**Yes**
Yellowfin bream:	**Yes**
Pink snapper:	**Yes**
Black snapper:	**Preliminary**
Blackspot tuskfish:	**Not assessed**

Breeding stock levels

Whiting:	**Adequate**
Mullet:	**Adequate**
Tailor:	**Adequate**
Yellowfin bream:	**Adequate**
Pink snapper:	**(Eastern Gulf) Adequate**
	(Denham Sound) Adequate
	(Freycinet) Inadequate
	Black snapper: Adequate

Whiting, mullet, tailor, yellowfin bream: Assessment of the 4 main target species taken by SBBSMNF is based primarily on analysis of the catch and effort data from statutory monthly returns. A target range of annual catch and a CPUE trigger level have been determined for each species (Inner Shark Bay Scalefish Table 1).

In the event that catch is outside the acceptable range or CPUE is below the trigger level, a review is initiated, and the results used to determine whether further investigation or management action is required.

The 2006 total catch (all species combined) at 229 t was below the target range of 235 – 335 t (Inner Shark Bay Scalefish Figure 2). The overall CPUE in 2006 was 221.9 kg/boat day (all species combined), slightly below the average since 1990 of 229.7 kg/boat day. The significant decrease in CPUE since the record high of 309.6 kg/boat day in 2004 was primarily due to a decline in the mullet catch rate.

The 2006 whiting catch of 113.4 t was within the target range (93 – 127 t) and the CPUE of 109.6 kg/boat day – the second highest on record – was above the trigger level (75 kg/boat day) (Inner Shark Bay Scalefish Figure 3).

The 2006 mullet catch of 62 t was below the target range (77 – 144 t) for only the second year since 1971 (Inner Shark Bay Scalefish Figure 4). In addition, the 2006 mullet CPUE of 60 kg/boat day, had significantly declined from the all-time-high of 136.8 kg/boat day in 2004, and was below the required trigger (62 kg/boat day).

While this calls for a review, data recently provided by the Denham Fish Factory suggest that the level of catch in 2006 had been surpassed in 2007 by May. Moreover, commercial fishers reported that poor weather conditions at the time of year when mullet are mostly targeted contributed to the low catch in 2006.

The 2006 tailor catch was 20.7 t and below the target range (25 – 40 t) for the third consecutive year (Inner Shark Bay Scalefish Figure 5). CPUE was 20.1 kg/boat day, just above the minimum required trigger level of 20.0 kg/boat day. Low tailor catches in recent years can be partly attributed to processing and quota restrictions self-imposed by the fishery and introduced between 2002 – 2004.

While some reduction in natural abundance cannot be discounted, it should be noted that for 8 out of the 12 years between 1976 – 1987, the annual tailor catch was also below the more recently determined target range. A review will be undertaken by the Department of Fisheries.

The 2006 yellowfin bream catch of 23.1 t was above the target range (7 – 15 t), and the CPUE of 22.3 kg/boat day was well above the minimum required trigger of 5 kilograms/boat day (Inner Shark Bay Scalefish Figure 6). Catches and catch rates have been very high since 2002. An investigation by the Department of Fisheries has established that increased catches and catch rates were due to an increase in abundance related to an exceptionally strong recruitment of the 1999 year class.

The legal requirement that a net of mesh size not less than 48 mm be used for whiting ensures that virtually all of the catch is made up of mature fish. Consistent levels of catch of whiting and sea mullet over recent years suggest that the breeding stocks are being maintained.

Breeding stock levels of tailor are unknown. The higher catches and CPUE of yellowfin bream, due to strong natural recruitment, indicate that breeding stock levels are healthy.

Pink snapper: Daily egg production method surveys, to directly estimate pink snapper spawning biomass in the Eastern Gulf, Denham Sound and Freycinet Estuary, have been conducted by the Department of Fisheries since 1997. Research trawl surveys, to provide information on the abundance of 0+ age snapper, have been conducted each year since 1996. Between 1998 and 2001 these data, combined with reported commercial catches (from CAES) and estimates of recreational catch (from boat ramp surveys), were used to determine the status of each inner gulf pink snapper stock.

Since 2002, age-based stock assessment models have been used to assess the status of the 3 pink snapper stocks in relation to the management target (40% of the unexploited spawning biomass). These assessment models are now updated every 3 years to suit a 3-year-cycle of fishery review (the next review is scheduled for mid-2008).

At the time of the last stock assessments (June 2005), spawning biomass was estimated at approximately 64% and 59% of the unfished levels in the Eastern Gulf and Denham Sound respectively, i.e. above the management target in both areas.

Although the spawning biomass in the Freycinet Estuary was estimated at only 31% of the unfished level, i.e. below the management target, the breeding stock is rebuilding and it is estimated that the 40% level will be reached by 2007 – 2008.

Black snapper: A preliminary yield-per-recruit model was developed based on biological data for black snapper collected between 1999 and 2002. No further stock assessment has been undertaken since then. Breeding stock levels are currently believed to be adequate.

Blackspot tuskfish: No stock assessment has been undertaken for the species. Breeding stock levels are unknown.

Non-Retained Species

Bycatch species impact: **Low**

The methods used in the commercial fishery sees fishers targeting specific schools of fish. Bycatch is likely to be minimal because seine netting is a highly selective method of fishing. Based on experience, fishers can determine the species and size of the school, and the size of individual fish within the school, before shooting the net.

Fish are easily observed in the very shallow near-shore waters of Shark Bay, so schools of non-target species and undersized fish are avoided in most cases.

Protected species interaction: **Negligible**

As nets are actively set and hauled, if any protected species such as dugongs, dolphins or marine turtles are caught they are immediately released.

Ecosystem Effects

Food chain effects: **Low**

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that total finfish recruitment to Shark Bay has not been affected by removals. Therefore, the total biomass of key target species in the region appears sufficient to maintain trophic function.

Habitat effects: **Negligible**

Seine nets are set and hauled over shallow sand banks, including inter-tidal areas. Sand habitats are naturally dynamic environments with resident infauna adapted to cope with regular physical disturbances. Combined with the low frequency of fishing in any one location, this indicates that the fishery would have no lasting effect on the habitat.

Social Effects

Up to 30 fishers can be employed in the SBBSMNF, based on 10 managed fishery licences each operating with a maximum of 3 crew.

In 2006 there was a 29% decrease on the number of crew days (2,117) expended in the fishery compared with 2005. Fishing and associated fish processing is one of the major sources of local employment. The commercial fishery, although relatively small-scale, makes a significant contribution to the Denham economy and community.

In addition, Shark Bay is a very popular tourist destination, especially during the winter months and school holidays. Of the 150,000 tourists estimated to visit the region each year, approximately 30% (50,000) are thought to participate in recreational fishing.

Economic Effects

Estimated annual value (to commercial fishers) for year 2006: $734,000

Commercial:

The overall value of the SBBSMNF in 2006 was estimated at $734,000 and includes catch values of $453,000 for whiting, $105,000 for sea mullet, $92,000 for yellowfin bream and $46,000 for tailor.

Recreational:

While an actual dollar value cannot be assigned to the fish taken recreationally in inner Shark Bay at this time, the availability of fish underpins the tourism industry and generates significant income for the regional economy.

Fishery governance

Target (commercial) catch range: 235 – 335 tonnes

Under the current management arrangements, the acceptable range for total catch in the SBBSMNF is 235 – 335 t. Acceptable catch ranges for the individual target species are as follows: whiting 93 – 127 t, sea mullet 77 – 144 t, tailor 25 – 40 t and yellowfin bream 7 – 15 t.

These acceptable catch ranges were developed (based on catch data from 1990-2003) to allow annual catch levels to fluctuate in response to normal variations in stock abundance. If annual catches fall outside the acceptable ranges, an investigation is triggered which may lead to management changes.

In 2006, catches of both tailor and mullet were below the acceptable catch range, while catch rate for mullet was below the trigger CPUE. Further investigation of all 3 species will be conducted. However, 3 of the 4 key target species were considered to be fished at sustainable levels.

Catches of pink snapper taken by recreational boats and SBBSMNF vessels in 2006 remained significantly below the agreed TAC and within the catch allocation in each inner gulf area, indicating that the management arrangements continued to be successful (Inner Shark Bay Scalefish Table 4).

The decrease in estimated catch of blackspot tuskfish may be explained by the reduction in bag limit (from 4 to 2) from January 2006. However, despite a reduction in the bag limit for estuary cod (from 2 to 1), catches were estimated to have increased significantly on those in 2005, which is cause for some concern given that this species is highly residential and hermaphroditic.

Current fishing (or effort) level: Acceptable

Commercial

Total fishing effort in SBBSMNF in 2006 had declined by approximately 10% on level in 2005, in part due to a reduction in number of licences in the fishery.

Recreational

There was an estimated 8% reduction in overall recreational fishing effort (boat-fisher days) in 2006 compared with 2005.

New management initiatives (2006/07)

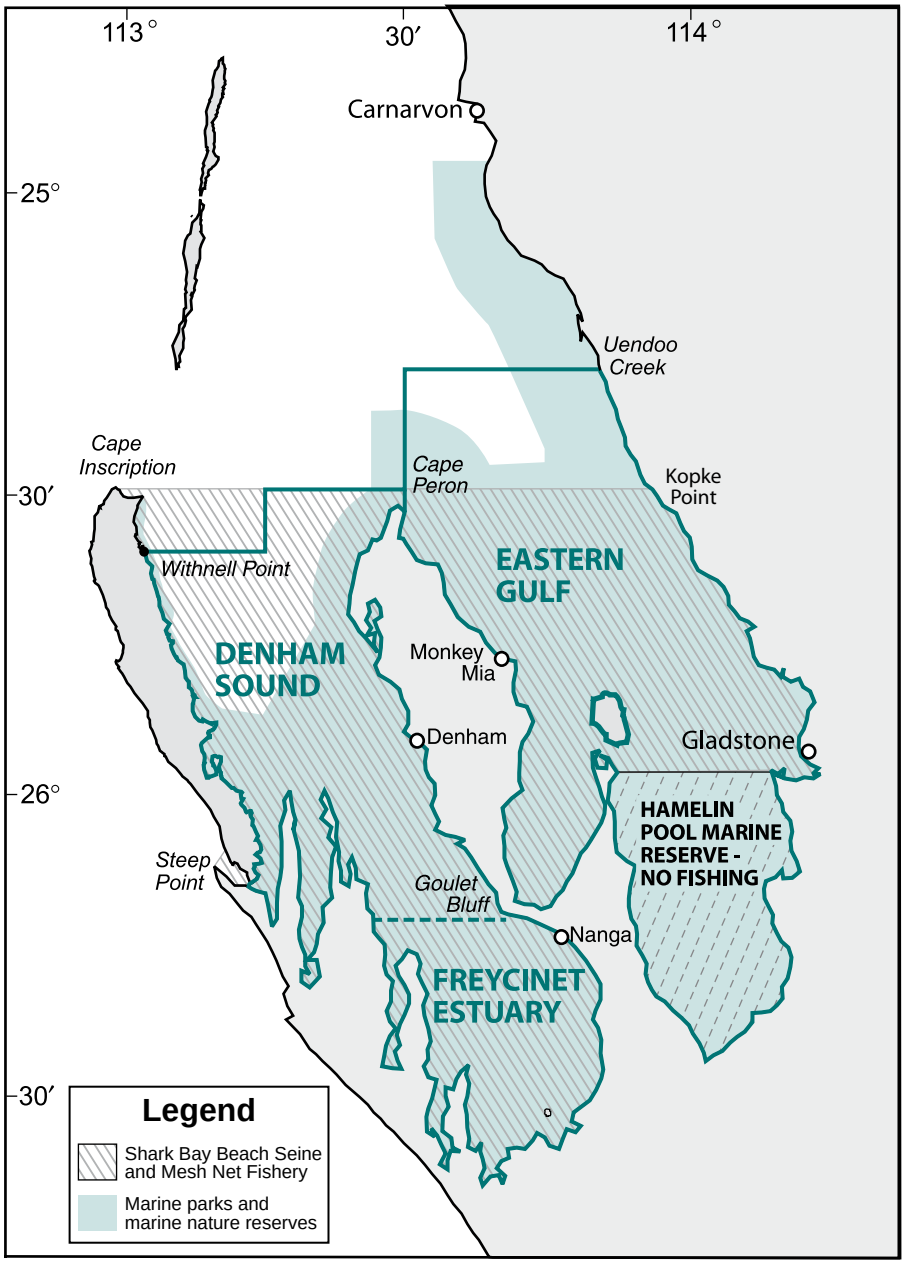
A comprehensive review of the SBBSMNF management plan was completed in 2005, following a series of meetings held in Denham between the Department of Fisheries and licensees. A series of 12 recommendations, including that all licences in the fishery become fully transferable and that owner-operator clauses are removed, were given 'in principle' support by the Minister and will form the basis of amendments to the management plan.

The minimum legal length for yellowfin bream was increased statewide from 250 mm to 350 mm on 1 January 2006, following a review of recreational fishing in the Pilbara and Kimberley. In an effort to protect breeding females, the minimum size increase was initiated following research undertaken by Murdoch University which showed the species to be a protandrous hermaphrodite, i.e. individuals change sex from male to female.

The study found that 50% of males were sexually mature at a total length of 245 mm, while 50% of females only reached sexual maturity at 348 mm. However, an exemption to the new 350 mm size limit has been issued until April 2008 pending further scientific consideration of other management options suggested by stakeholders for this species, including a slot limit and or spatial spawning closures.

External Factors

The inner Shark Bay environment is particularly stable as a result of its low-rainfall and arid environment. The abundances of some target species tend to be fairly stable and fishery production is mainly determined by the level of fishing effort. However, other species – including pink snapper, yellowfin bream and possibly tailor – appear to be influenced by environmentally-driven variations in recruitment.



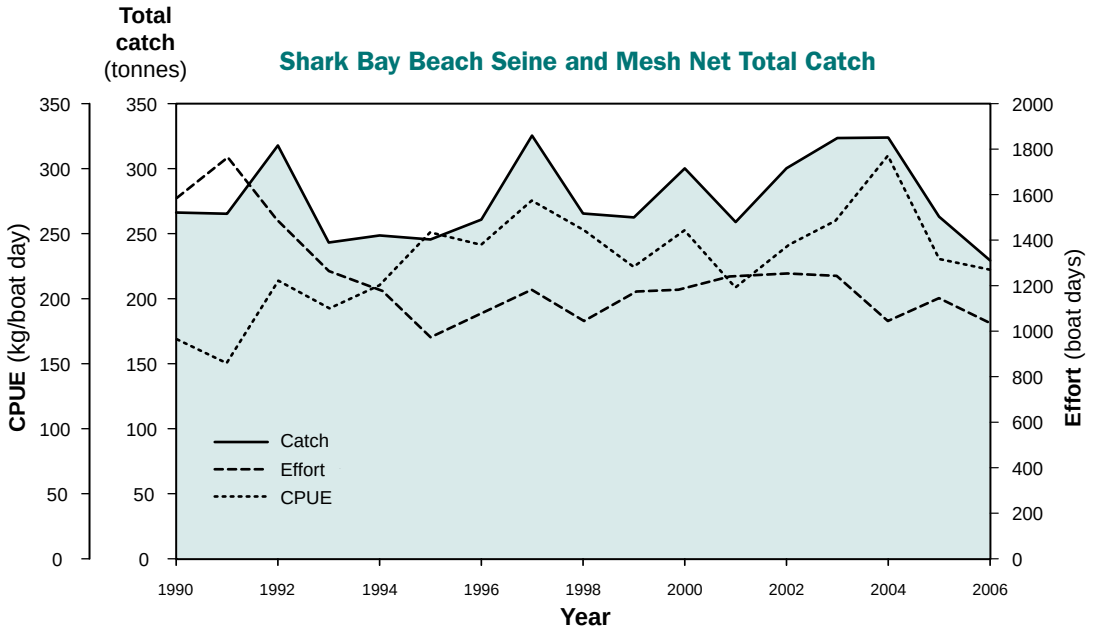
INNER SHARK BAY SCALEFISH FIGURE 1

The commercial and recreational scalefish fishing areas of inner Shark Bay. Waters to west of the Peron Peninsula, i.e. Denham Sound and Freycinet Estuary, are collectively known as the Western Gulf.

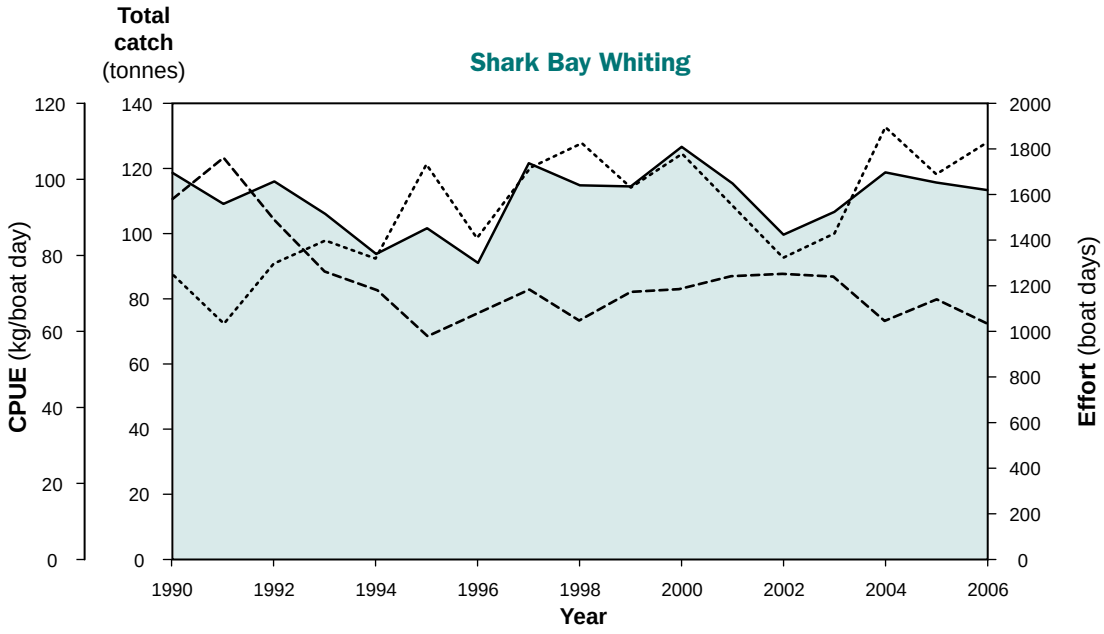
INNER SHARK BAY SCALEFISH TABLE 1

Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2000 – 2006.

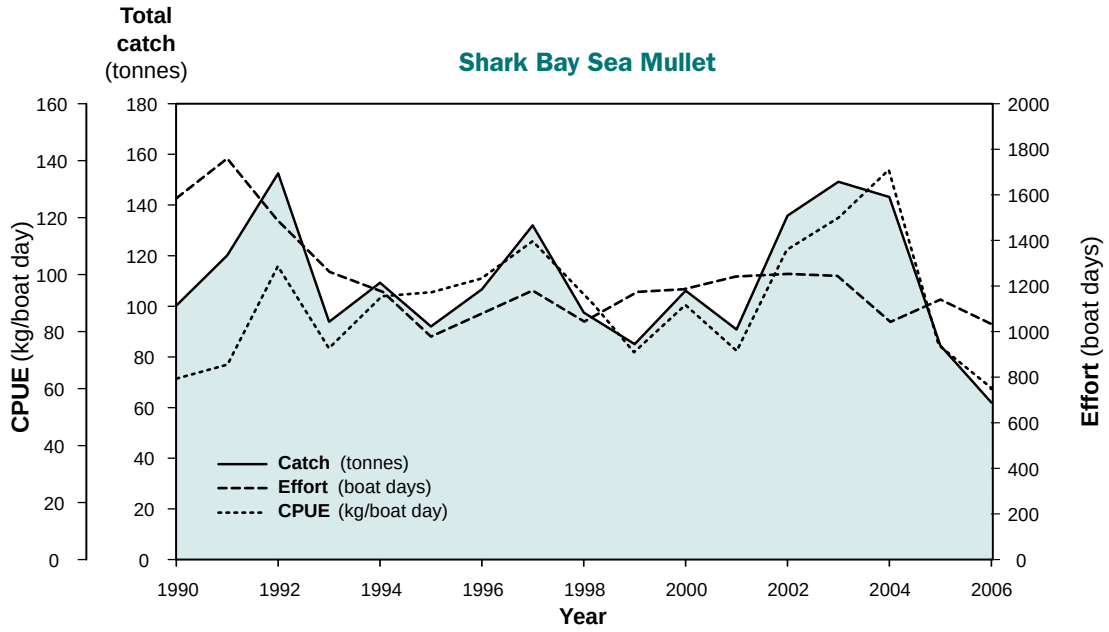
Species	Trigger Level	2000	2001	2002	2003	2004	2005	2006
Whiting	75	106	92	79	86	114	102	110
Mullet	62	107	93	80	120	137	74	60
Tailor	20	32	21	21	22	23	17	20
Bream	5	7.3	6.2	13	19	26	23	22



INNER SHARK BAY SCALEFISH FIGURE 2
The total scalefish annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990 – 2006.

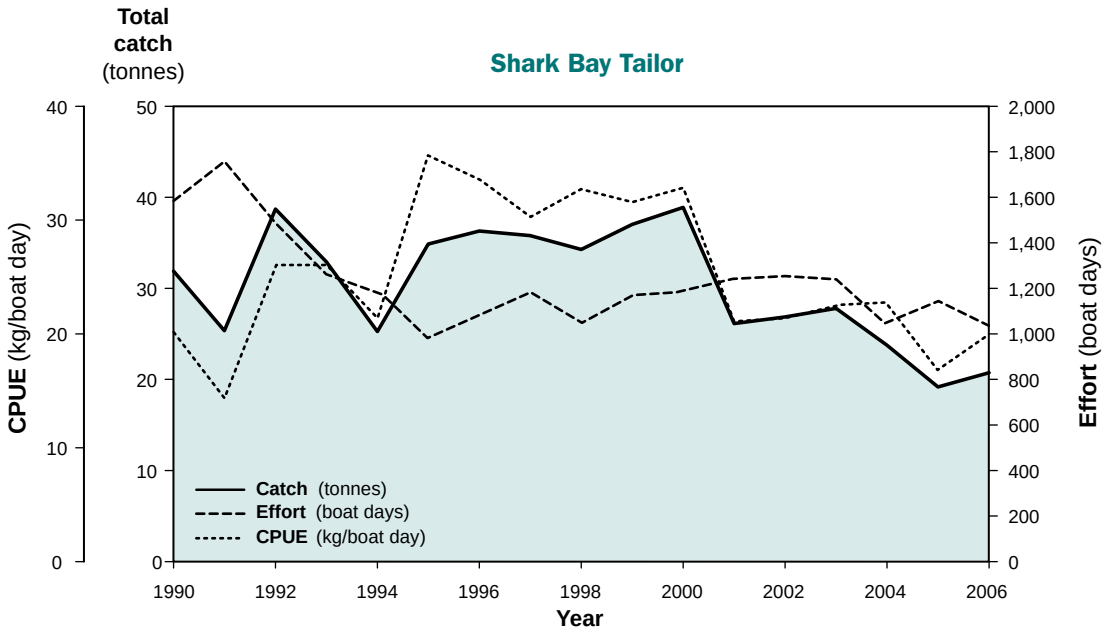


INNER SHARK BAY SCALEFISH FIGURE 3
The whiting annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990 – 2006.



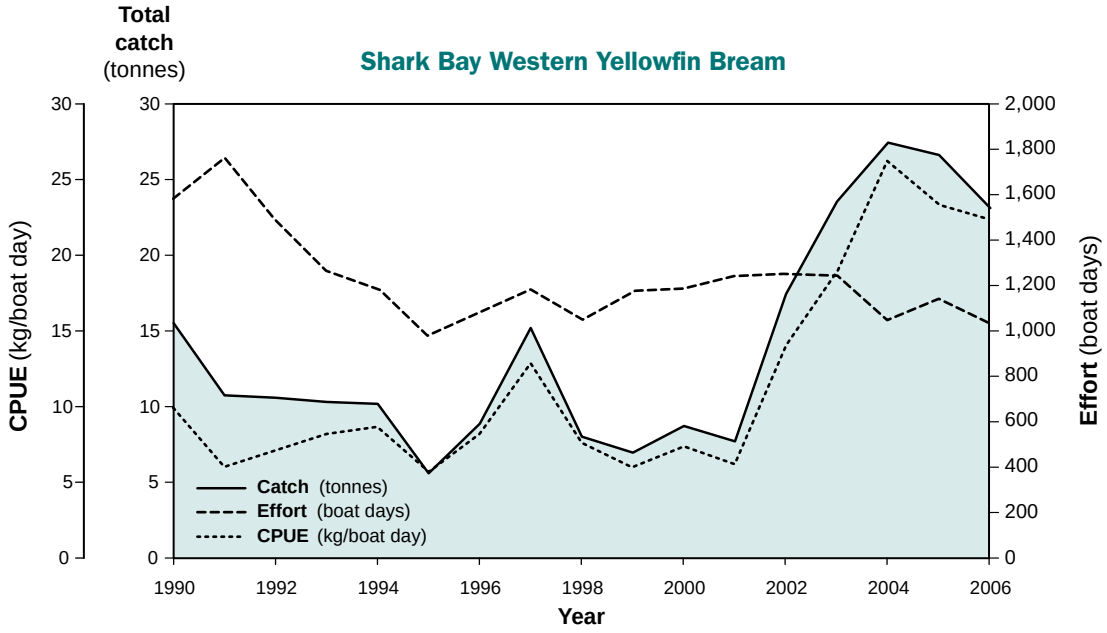
INNER SHARK BAY SCALEFISH FIGURE 4

The sea mullet annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990 – 2006.



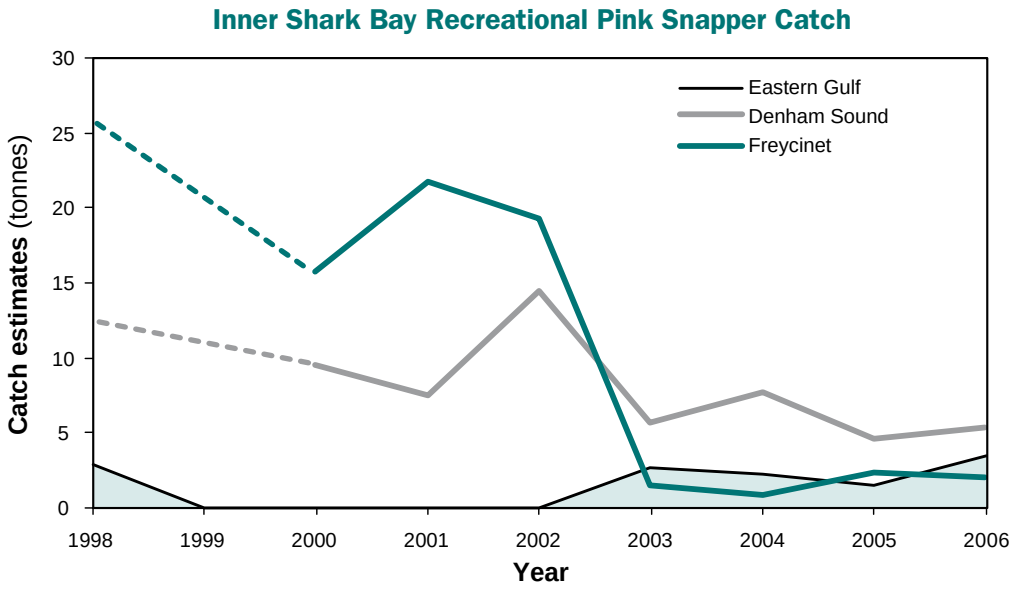
INNER SHARK BAY SCALEFISH FIGURE 5

The tailor annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990 – 2006.



INNER SHARK BAY SCALEFISH FIGURE 6

The yellowfin bream annual catch, effort and catch per unit effort (CPUE) for the Shark Bay Beach Seine and Mesh Net Managed Fishery over the period 1990 – 2006.



INNER SHARK BAY SCALEFISH FIGURE 7

Estimated catches of pink snapper taken by recreational boats in the 3 fishing areas of inner Shark Bay, 1998 – 2006 (does not include charter vessel catches). The Eastern Gulf was closed to the take of pink snapper from June 1998 to March 2003.

INNER SHARK BAY SCALEFISH TABLE 2

Estimated annual catch, in numbers, of key species taken by recreational boats in inner gulfs of Shark Bay (does not include charter catches). Numbers of fish released are shown in brackets.

Year	Pink snapper	Black snapper	Whiting	Butterfish	Tailor	Mullet	Blackspot tuskfish
1998	13,926 (88,020)	17,073					
1999	na	na	na	na	na	na	na
2000	8,387 (53,493)	10,042 (18,272)	3,105 (61)	3,452 (11,099)	1,128 (72)	901 (19)	
2001	8,319 (87,655)	7,357 (15,470)	5,071 (203)	2,605 (9,508)	1,774 (128)	550 (0)	260 (4,667)
2002	9,130 (95,920)	11,286 (21,417)	9,043 (6,152)	1,545 (8,067)	2,123 (362)	755 (0)	1,160 (4,583)
2003	3,803 (84,622)	9,982 (20,548)	3,281 (730)	868 (7,030)	924 (27)	51 (0)	1,967 (4,703)
2004	4,418 (97,780)	13,376 (21,382)	9,979 (1,635)	796 (9,396)	265 (590)	49 (0)	1,552 (5,201)
2005	3,311 (62,068)	9,987 (25,218)	5,142 (514)	662 (11,854)	455 (38)	1,303 (0)	1,771 (5,205)
2006	**3,904 (39,886)**	**7,542 (14,872)**	**3,064 (449)**	**1,035 (5,489)**	**1,285 (228)**	**475 (0)**	**955 (6,472)**

INNER SHARK BAY SCALEFISH TABLE 3

Estimates of recreational boat fishing effort (fisher days) and retained pink snapper catch (tonnes) in inner Shark Bay, 1998 – 2006 (does not include charter catches). Total catches are rounded to the nearest tonne.

Year	Eastern Gulf		Denham Sound		Freycinet			Total Catch
	Effort	Catch	Effort	Catch	Effort	Catch	Total Effort	
1998	11,066	2.9[1]	21,047	12.2	17,208[2]	25.7[2]	**49,321**	**38**
1999	na	na	na	na	na	na	**na**	**na**
2000	9,438	closed	15,753	9.5	9,625[2]	15.8[2]	**34,816**	**25**
2001	7,254	closed	11,958	7.5	15,452[3]	21.8[3]	**34,664**	**29**
2002	10,621	closed	18,530	14.5	14,747[3]	19.3[3]	**43,898**	**34**
2003	15,602	2.7[4]	22,338	5.7	4,130[3,5]	1.5[3,5]	**42,070**	**10**
2004	17,405	2.3[4]	13,976	7.7	2,556[2,5]	0.9[2,5]	**33,937**	**11**
2005	19,059	1.5[4]	15,713	4.6	3,624[2,5]	2.4[2,5]	**38,396**	**9**
2006	17,567	3.4[4]	12,432	5.4	5,432[2,5]	2.0[2,5]	**35,432**	**11**

1. For the period April – June only (fishery closed June 1998)
2. Estimates for Nanga only; surveys did not include Tamala
3. Estimates for all Freycinet Estuary; surveys included Tamala
4. Fishery closure (2003 – 2005, 1 April – 31 July inclusive; 2006, 1 May – 31 July inclusive)
5. Management tags required (2003 – 2005, 900 recreational tags/year; 2006 – 2008, 1,050 recreational tags/year)

INNER SHARK BAY SCALEFISH TABLE 4

Catches (tonnes) of inner Shark Bay pink snapper taken by each sector in 2006 and total catch relative to TAC for each stock. Recreational share includes catch estimated from survey results and catch reported by charter vessels.

	Eastern Gulf	Denham Sound	Freycinet
Recreational	3.4	5.4	2.0
Charter vessels	0.1	0.0	0.0
Commercial	0.2	1.7	0
Total Catch	**3.7**	**7.1**	**2.0**
TAC	15	15	5
Commercial share (%)	5	24	0
Recreational share (%)	95	76	100
Total Catch: TAC (%)	**25**	**47**	**40**

Gascoyne Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from C. Syers

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth.

The majority of the commercially and recreationally-fished stock, however, is concentrated in the coastal embayments between Geographe Bay in the south and Port Hedland in the north.

Crabbing activity in the Gascoyne Coast bioregion is centered in the embayments of Shark Bay and Exmouth Gulf, with the Shark Bay Crab (Interim) Managed Fishery having developed into the largest crab fishery in Western Australia.

Blue swimmer crabs are targeted using a variety of fishing gear. Originally, commercial crab fishers in WA used set (gill) nets or drop nets, but most have now converted to purpose-designed crab traps. The State's prawn and scallop trawl fisheries also retain crabs as a by-product.

Governing legislation/fishing authority

Shark Bay Crab Fishery (Interim) Management Plan 2005
Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994
Exemptions under Section 7 of the *Fish Resources Management Act 1994*
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order – Shark Bay fishery only)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

Separate licence conditions describing areas of operation for the commercial crab fishers in Shark Bay were replaced by the Shark Bay Crab Fishery (Interim) Management Plan on 1 December 2005. The fishery covers the waters of Shark Bay north of Cape Peron, to Bernier and Dorre Islands in the west and Quobba Point in the north.

In addition, 1 Shark Bay beach seine fisher and 1 Cockburn Sound crab fisher, both with long-standing histories of targeting crabs in these waters, are permitted to use traps to target blue swimmer crabs in other areas of Shark Bay. 1 fisher is endorsed to trap in the waters of Shark Bay south of Cape Peron, while the other may use 200 traps of his 300 trap Shark Bay Crab (Interim) Managed Fishery endorsement to fish the waters of the eastern gulf in Shark Bay.

In 2002, 2 exemptions were issued to explore the sustainability and commercial viability of fishing resident blue swimmer crab stocks in the waters of Exmouth Gulf, south of a line drawn between the northernmost point of North West Cape and Locker Point. A submission was received in 2005 to fish the coastline around the Ashburton River, along the north-east coast of Exmouth Gulf to Onslow. The north and eastern boundaries of the exemptions were then extended to 115°E longitude, which forms the western boundary of the Pilbara Experimental Crab Fishery.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994*. Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications, and seasonal and daily time restrictions.

The principal management tool employed to ensure adequate breeding stock in the commercial crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. Male blue swimmer crabs in Shark Bay become sexually mature at 115 mm carapace width (CW), while females become sexually mature below 100 mm CW.

The legal minimum sizes range of 135 mm CW in the Gascoyne fisheries is set well above the size at sexual maturity, and should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

A comprehensive Ecologically Sustainable Development assessment of the Shark Bay fishery has determined that performance should be reported annually against measures relating to the breeding stock of crabs.

Recreational fishing for blue swimmer crabs in Western Australia is managed through a series of input and output controls. As with commercial fishing, **t**he principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity.

During the 2005/06 financial year covered by this report, a minimum legal size limit of 127 mm CW applied in state waters, along with a bag limit of 20 crabs per person or 40 crabs per boat. Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures.

Research summary

Data for the assessment of blue swimmer crab stocks in the Gascoyne Coast bioregion are obtained from fishers' compulsory catch and effort returns, voluntary daily log books and on-board catch monitoring conducted by Department of Fisheries' research staff.

Additional information on the biology and ecology of blue swimmer crabs has been provided by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University. An FRDC project completed in early 2005 produced a comprehensive stock assessment of the Shark Bay blue swimmer crab fishery.

Retained Species

Commercial landings (season 2005/06): 678 tonnes

Total landings for the Gascoyne Coast Bioregion during 2005/06 was 678 t, which accounted for 76% of the state catch.

Annual catch from the Shark Bay Crab (Interim) Managed Fishery remained constant during 2005/06 with total landings of 559 t, similar to the 560 t landed the previous year that was the highest catch on record (Gascoyne Coast Blue Swimmer Crab Figure 2).

Landings from the Shark Bay trawl fleet fell considerably, however, with total landings for 2005/06 of 103 t – down 38% from the 166 t reported the previous year. Shark Bay trawlers tend to retain fewer crabs as a by-product of their fishing operations in years when their target prawn and scallop catches are higher. Market factors can also influence the quantity of crabs retained by the trawl fleet, with fewer crabs taken when demand from processors is low and the beach price is down.

A total of 16 t of blue swimmer crabs was landed from Exmouth Gulf during 2005/06, about half of the previous year's catch of 32 t (Gascoyne Coast Blue Swimmer Crab Figure 1). The 2 dedicated crab exemption holders undertook a modest amount of exploratory fishing, with their catch increasing from 4.9 t during 2004/05 to 6.6 t in 2005/06.

As in previous years, however, the Exmouth Gulf trawl fleet landed the majority of the catch in this area. After an increase in landings over the last 2 years (27 t and 28 t in 2003/04 and 2004/05 respectively), the catch retained by the trawl fleet fell significantly to just 9.7 t. As with the Shark Bay trawl fleet, Exmouth Gulf trawlers tend to retain fewer crabs as a by-product of their fishing operations in years when their target prawn catches are higher, demand from processors is low and the beach price is down.

Recreational catch: 1% of total catch

Most of the recreational fishing for blue swimmer crabs in Western Australia occurs in the West Coast bioregion, with minimal recreational effort in the Gascoyne Coast bioregion.

A creel survey monitoring recreational crabbing in the Gascoyne Coast bioregion was carried out during 1998/99. The survey provided a recreational blue swimmer catch estimate of 968 kg, representing less than 1% of the total catch.

Most of the catch was taken in inner Shark Bay. There has been no monitoring of recreational blue swimmer crab catch in the Gascoyne Coast bioregion since this survey.

Fishing effort/access level

Dedicated trap fishers accounted for 86% of the State's commercial catch in 2005/06, taken from 594,361 trap lifts. This represents a gradual increase from the 78% of the commercial catch taken from 642,015 trap lifts by trap fishers in 2004/05.

The remainder of the State's commercial catch was taken by trawlers (who retain crabs as a by-product species), with a small component (less than 1%) caught in gillnets.

Effort in the Shark Bay Crab (Interim) Managed Fishery increased marginally during 2005/06. The 5 dedicated Shark Bay crab trap fishermen achieved their highest fishing effort of 363,300 trap lifts over 1,215 days (Gascoyne Coast Blue Swimmer Crab Figure 2) – up from 347,940 trap lifts over 1,178 fishing days the previous year.

The 2 exemption holders in Exmouth Gulf again undertook a minimal amount of fishing during 2005/06, as they continue to explore the commercial viability of fishing blue swimmer crab stocks in the Gulf. Effort was identical to 2004/05, with a total of 5,800 pot lifts reported for 2005/06, with fishing occurring predominantly in the winter months.

Stock Assessment

Assessment complete: **Preliminary**

Length-frequency data gathered from ongoing monitoring programs in the Shark Bay Crab (Interim) Managed Fishery suggests that management controls currently in place provide adequate measures to maintain a sustainable level of catch and effort.

Monitoring of the commercial catch in Shark Bay has been conducted since 1998, with consistent size distributions being recorded between years within the fishery.

The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm CW) and significantly reduced the catch of crabs < 120 mm CW, without impacting on legal catches. Improved work practices have reduced the mortality of returned under-size and berried crabs caught in commercial traps to negligible levels.

Catch rates from each fishery provide an index of abundance which can be used to assess fishery performance from year-to-year. Trap catches in Shark Bay (Gascoyne Coast Blue Swimmer Crab Figure 2) showed an almost 5-fold increase since the commencement of the Carnarvon Experimental Crab Trap Fishery in 1998 until 2002/03, while effort and catch per unit effort increased just 3 and 0.5 times respectively within that period.

These increases in catch and CPUE reflect the more efficient fishing of blue swimmer stocks in Shark Bay, as the commercial operators' knowledge of the stocks increased over time and improvements were made to fishing gear and vessels.

The mean catch rate for the Shark Bay Crab (Interim) Managed Fishery during 2005/06 was 1.54 kg/trap lift (Gascoyne Coast Blue Swimmer Crab Figure 2), which is comparable to the catch rate of 1.61 in 2004/05 and is consistent with the range seen since significant fishing in Shark Bay commenced around 1999/2000.

The yearly catch rate from dedicated crab fishers in Exmouth Gulf improved slightly in 2005/06 to 1.1 kg/trap lift, up from 0.8kg/trap lift in 2004/05. This slight improvement reflects the increased knowledge of the commercial operators as they continue to explore and gain insight into the crab stocks within Exmouth Gulf, and develop solutions to the logistical problems associated with fishing the remote areas of the north-east coastline of the Gulf which appear to support the most commercially-viable quantities of blue swimmer crabs.

Breeding stock levels: **Adequate**

As the legal size at first capture (127 – 135 mm CW), which is reached within the first 12 to 18 months of age, is well above the size at maturity (85 – 115 mm CW for males and females) in all sectors of the Gascoyne Coast Bioregion fisheries, the breeding stock levels are expected to be adequate to maintain stocks in all current fishing areas under normal environmental conditions.

The industry voluntarily applies a higher minimum size for marketing purposes, further increasing the level of spawning prior to capture.

In addition, breeding stocks in the Gascoyne bioregion are further supported by the influence of the warmer water temperatures that occur at these latitudes, which extends the spawning period over several more months of the year than on the lower west coast, where spawning is restricted to the late spring and early summer months.

The performance measure for the export of crabs from the Shark Bay fishery requires that the breeding stocks are maintained, as demonstrated by adult crab abundance (catch per unit effort). In 2005/06 the CPUE in the main northern Shark Bay fishery, at 1.54 kg/trap lift, remained well above the historical minimum CPUE of approximately 1 kg/trap lift, which has proved adequate to support recruitment to the fishery.

Non-Retained Species

Bycatch species impact: **Negligible**

The shift from using gillnets to traps in most blue swimmer crab fisheries has resulted in a substantial reduction in bycatch from dedicated crab fishing. Pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled.

Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them. The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these breeding stocks.

Discarded crab bycatch from trawl fisheries taking crabs as a by-product is dealt with in those reports specific to the trawl fisheries.

Protected species interaction: **Negligible**

The crab trap longline system used in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.

Ecosystem Effects

Food chain effects: **Low**

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually, secondary food chain effects are likely to be minimal in these fisheries.

Habitat effects: **Negligible**

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macrobenthos.

Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Social Effects

During 2005/06, approximately 21 people were employed as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast bioregion. Additional employment for some 12 workers has also being created in Carnarvon through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: $2.8 million

The State's blue swimmer crab catch for the 2005/06 season was valued at approximately $4.0 million. This total represented a 13% decrease on the $4.6 million generated in 2004/05, but was similar to the $3.9 million the blue swimmer crab fishery generated in 2003/04.

Blue swimmer crab landings from the Gascoyne Coast bioregion during 2005/06 were worth $2.8 million – a decrease of 15% on the $3.3 million generated during 2004/05. This decrease was largely due to the significant reduction in blue swimmer crabs retained by the Shark Bay trawl fleet.

Despite the smaller State catch in 2005/06, beach prices for blue swimmer crabs remained between $4/kg and $6/kg live weight in the major fisheries, with the average price for the year around $4.50/kg. There were slight increases in the beach price paid for crabs caught in the West Coast bioregion following the reduction in catch over recent years from Cockburn Sound, however surplus stock from Shark Bay fed the gap in local supply.

While the majority of the product was sold through local and inter-state markets, several Shark Bay fishers have been exploring markets in south-east Asia and the value-adding of product on the domestic market.

Fishery Governance

Target catch (or effort) range

Catches from new and expanding fisheries (such as Shark Bay and the Pilbara Crab Fishery) have already taken the state-wide catch for the species in excess of 1,000 t. A review of these blue swimmer crab fisheries will be undertaken and target catch ranges set.

Current fishing (or effort) level: Acceptable

Following several years of rapid expansion as the fishery developed, current catch rates suggest that the catch rate in the Shark Bay Crab (Interim) Managed Fishery has stabilised at an acceptable level and this will be monitored, along with the trend in catch and effort.

With slightly reduced effort from the Exmouth Gulf trawl fleet and minimal fishing by the 2 dedicated crab fishers, the current level of effort in Exmouth Gulf is considered acceptable.

New management initiatives (2006/07)

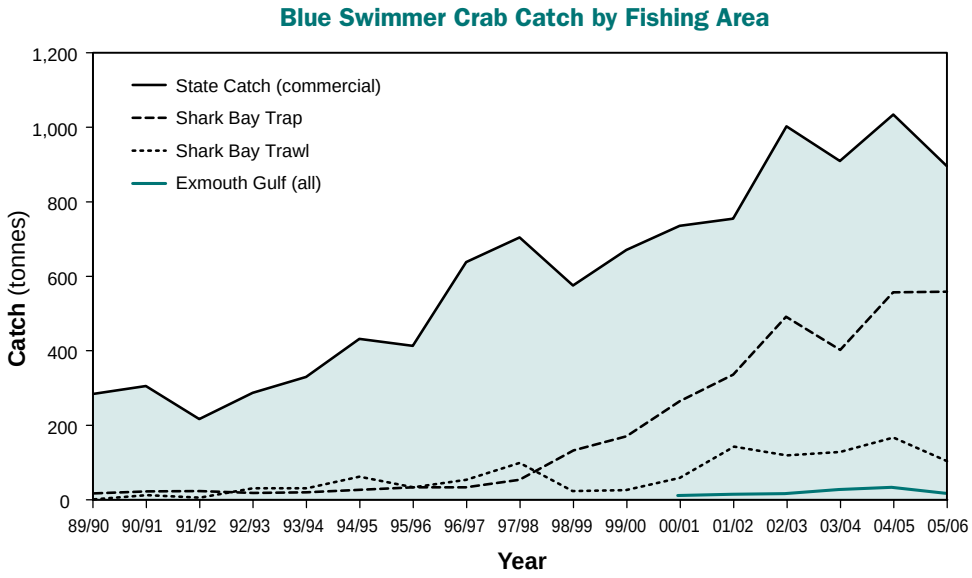
On 1 December 2005, an interim management plan came into effect to govern the administration of the Shark Bay crab fishery. The plan, which supersedes the varied management arrangements previously in place, is intended to allow for the further development of the fishery, while maintaining a sustainable level of fishing effort and providing greater tenure and security for operators.

The Exmouth Gulf Experimental Crab Trap Fishery will form part of the 'Developing New Fisheries' review process that will take place during 2006 and 2007. This review will provide a framework to determine the future viability of a fishery in this region.

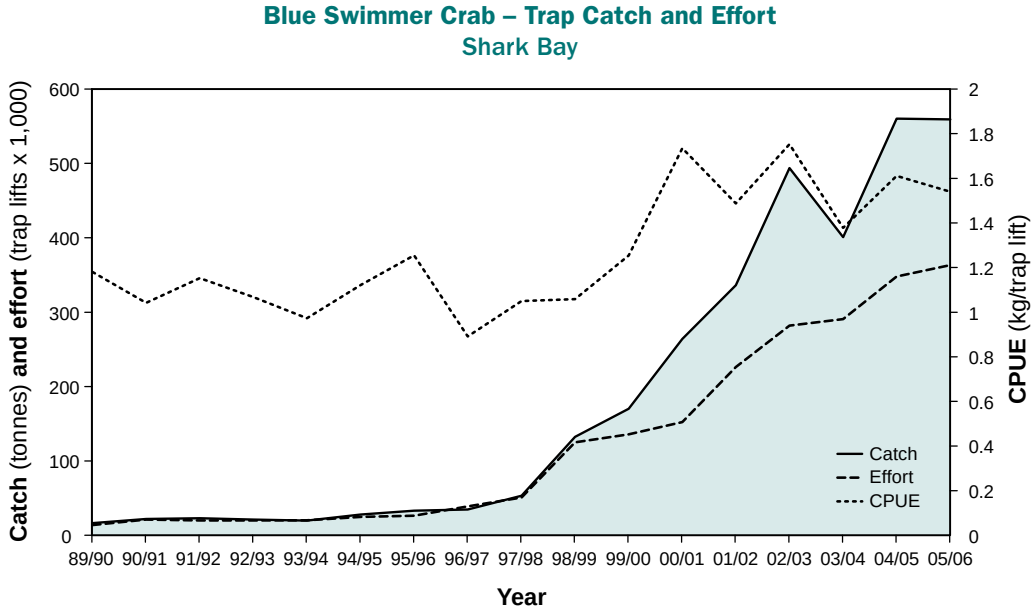
External Factors

Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of this variation are not fully understood, it is considered most likely due to environmental influences on larval survival.

Currents and water movement play a significant role in determining recruitment success, as a specific window of time is available during the megalopal larval stage of the blue swimmer crab to reach and/or select a suitable settlement site. Both temperature and salinity influence the spawning behaviour, distribution, activity and movement of blue swimmer crabs, while juvenile growth is also markedly influenced by the availability of food.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 1
Commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia compared with fisheries in the Gascoyne Coast bioregion between 1989/90 and 2005/06.



GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 2
Blue swimmer crab catch (t), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in Shark Bay from 1989/90 to 2005/06 using traps.

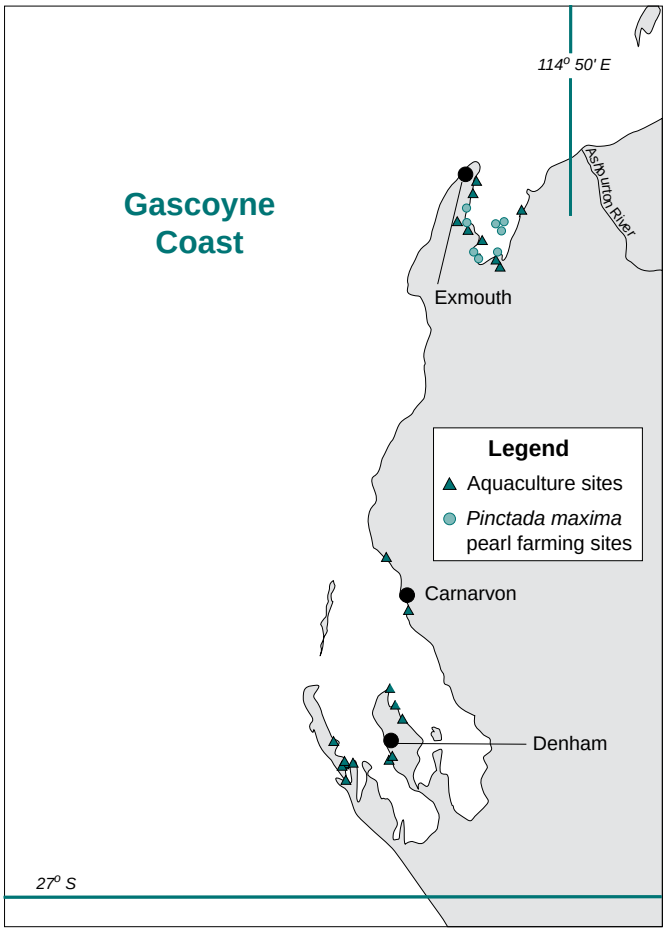
AQUACULTURE

Regional Research and Development Overview

The Department of Fisheries' main focus in the Gascoyne continues to be on the regulation of the regional pearling industry, based on species such as *Pinctada margaritifera*, that complements the major state industry built on silverlip pearls (*Pinctada maxima*).

Major research activities during 2005/06 included health monitoring by the Department's Fish Health Unit of pearl oysters and marine finfish (see Appendix 5). In addition, the marine finfish aquaculture research team is actively collaborating with an industry partner in Exmouth who is currently producing mahi mahi (*Coryphaena hippurus*). The team is assisting the company with the design of different systems, as well as feeds for larvae and adult fish.

Other key development tasks continue to involve supporting the emergence of a local aquarium fish production sector. A policy document for the culturing of live coral and rock, which was previously released for public comment as a draft, is expected to be available as a final policy in 2007.



GASCOYNE COAST AQUACULTURE FIGURE 1
Map showing the major licensed aquaculture and pearl farming sites of the Gascoyne coast bioregion. Note that aquaculture operations may also encompass the culture of non-*Pinctada maxima* pearl oysters.

Silverlip pearls (*Pinctada maxima*) are sometimes called South Sea Pearls.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services for the Department of Fisheries in the Gascoyne Coast bioregion are delivered by Fisheries and Marine Officers (FMOs) and associated management and administrative support staff based at district offices in Denham, Carnarvon and Exmouth. During 2005/06, the 3 district offices supported a total of 9 FMOs who delivered services to several operational areas and client groups including commercial and recreational fisheries, pearling and aquaculture operators and Fish Habitat Protection Areas.

FMOs carry out at-sea marine safety compliance as part of their normal patrol routine, inspecting recreational and commercial vessels for compliance with marine safety legislation, as well as promoting safer boating practices. A further significant aspect of their work is the provision of compliance services to the State's marine reserves. This involves working under a unique and evolving collaborative model in conjunction with the Department of Environment and Conservation (DEC).

Throughout the Gascoyne coast bioregion, FMOs undertook regular land, air and sea patrols using specially equipped 4-wheel-drive vehicles, quad bikes and small towable vessels. They also make use of sophisticated surveillance, mapping and GPS equipment to assist in evidence gathering. This includes high-powered telescopes and photographic mapping technology.

The FMOs at Denham make extensive use of the 10-metre patrol vessel *John Brockman* to conduct inspections throughout Shark Bay and carried out 110 days of sea-based patrols. FMOs in Exmouth use the 8-metre patrol vessel *Gnulli* and the recently acquired 7.3-metre rigid inflatable boat FD47 to conduct at-sea inspections in Exmouth Gulf and within the Ningaloo Marine Park.

Exmouth FMOs carried out 64 days of at-sea patrols. Large fisheries patrol vessels (greater than 20 metres in length) assist FMOs at various times of the year for offshore patrols, especially in the Shark Bay Prawn and Scallop Fisheries; this accounted for 10 days of at-sea patrols. A further 15 days of at-sea patrols were carried out in conjunction with the WA Police and Customs.

FMOs also conducted aerial surveillance, dive inspections, at-sea and on-land catch, license, gear and marine safety inspections, and attended community events.

The management of the Shark Bay Snapper Fishery continues to be a high priority and major management challenge. The monitoring of commercial catch quota via the 'Catch and Disposal Record' (CDR) process remains a vital part of the management process, as does the monitoring of recreational snapper tags in the Freycinet Estuary area. Ensuring fair, balanced and equal access to the fishery for both commercial and recreational fishers, whilst ensuring the sustainability of the species, remains a high priority for management and FMOs in the region.

The continuing recovery of the Shark Bay Inner Gulf pink snapper stocks has been, in part, attributable to the efforts of the Department of Fisheries' staff in the Gascoyne region, in particular to those of the Denham District Office. The Department of Fisheries won the 2006 overall Premier's Award for public sector management for the success of this work.

FMOs continue to support and maintain important and long-term relationships with the community through their participation in community events and coordination of educational interpretive activities during peak periods throughout the Gascoyne Coast bioregion. These peak periods commence in late March and finish in early October. During this peak season, fishing competitions like Carnarfin, Shark Bay Fishing Fiesta and Gamex – and community events such as the Whale Shark Festival and Gascoyne Expo – provide high-exposure community education opportunities for FMOs. The officers make a substantial contribution to the pre-season preparations of the Shark Bay and Exmouth trawl fleets by providing advice, pre-season briefings and inspections of vessels, fishing and safety equipment.

The Department of Fisheries' satellite-based vessel monitoring system (VMS) continues to be a central compliance tool, enabling positional surveillance and monitoring of commercial vessels, and provides an important safety tool for fishers in case of emergency. The VMS allows for fishery-specific management plan closures to be enforced remotely by triggering an alarm should a boundary be crossed or an unauthorized activity be detected.

FMOs are able to program their inspection regimes and apply their investigation methods more efficiently by using the facilities provided by VMS. The expansion of the VMS into other fisheries such as the snapper and mackerel fisheries will ensure that a higher and more effective rate of compliance is achieved.

Activities during 2005/06

During 2005/06, FMOs delivered a total of 4,340 hours of 'in-field' compliance activity (Gascoyne Coast Compliance Table 1 which excludes Gascoyne pearling compliance activities which are reported in the North Coast Bioregion), representing a significant increase on the previous financial year (Gascoyne Coast Compliance Figure 1).

The total budgeted hours for compliance were delivered by FMOs in the region during 2005/06, in spite of the fact that 2 staff that were off sick for extended periods of time. The ongoing effects of a stable work group continue to result in a better working relationship between fishers and FMOs, especially commercial fishers.

Commercial and recreational fishers alike continue to provide feedback that the routine attendance of familiar FMOs in their workplace and recreational fishing locations has led to a better understanding and knowledge of the regulations and a higher rate of compliance.

In delivering compliance services to the Gascoyne, FMOs and the Compliance Manager made use of a risk assessment and intelligence analysis-driven model to compliance planning and prioritization. A number of Operational Compliance Plans (OCP) were completed using this model during the year and put into operation, which provided, for the first time, a planned and measurable approach to compliance delivery.

The OCP delivered agreed outcomes and provided a more accountable and realistic process for budget creation and the actual services that would be delivered. OCPs were introduced into the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery and the Gascoyne Aquaculture and Pearling Fishery, and for the management of the Ningaloo Marine Reserve. A more targeted, effective and relevant compliance service, in terms of both cost and activities, was delivered using this planning process.

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections and investigations resulting from offences detected via the VMS. FMO effort was again directed at building stronger relationships with industry through higher levels of contact both at sea and in port.

The number of breaches of closed waters detected through the VMS and other monitoring methods was down again this year. However, the number of breaches relating to net compliance was up significantly, especially with the introduction of Fish Escape Devices (FEDs) into the trawl fisheries. Overall however, compliance was generally at an acceptable level and confirmed the positive approach of the commercial fishing industry in complying with regulations and playing their part to ensure the sustainability of fisheries.

A total of 10 infringement warnings and 16 infringement notices were issued and 11 prosecutions were instigated from a total of 601 field contacts with commercial fishers.

The monitoring of marine reserve activities with respect to recreational fisheries has divided the recreational fishing focus from a stand-alone fishery into 2 distinct fisheries – one with a marine reserve focus. FMOs increased their compliance activities in relation to Ningaloo Marine Reserve and commenced compliance activities in Shark Bay Marine Reserve in line with the increased importance and focus of government on marine reserves across the State.

Managed marine reserves account for over half the coastline within the Gascoyne. Performance measures in respect to marine park services were exceeded and better than expected. The number of infringement warnings (99) and infringement notices issued (37) and prosecutions instigated (6) from a total of 11,880 recreational fishing field contacts reflects the increased importance placed on recreational fishing and marine reserves in general across the Gascoyne.

2 FMOs from 'Mobile 1' were active in the Gascoyne for a shorter period this year, due to other priorities across the State. 'Mobile 1' provides a dedicated mobile recreational fishing patrol, using specialized remote-area-equipped vehicles and surveillance equipment.

Mobile 1 patrols focused on the Denham and Carnarvon districts this year, working in a coordinated approach with district FMOs to provide greater coverage and improved compliance outcomes.

The focus for this unit was again on education and enforcing management arrangements for Shark Bay Inner Gulf pink snapper.

During 2005/06, FMOs contributed significantly to the marine safety compliance program within the Gascoyne Coast bioregion and officers conducted 1,323 safety checks on recreational vessels. In particular, marine safety checks were carried out on a large number of recreational vessels taking part in fishing competitions. Regionally, marine safety checks continued to be a developing aspect of FMO activity.

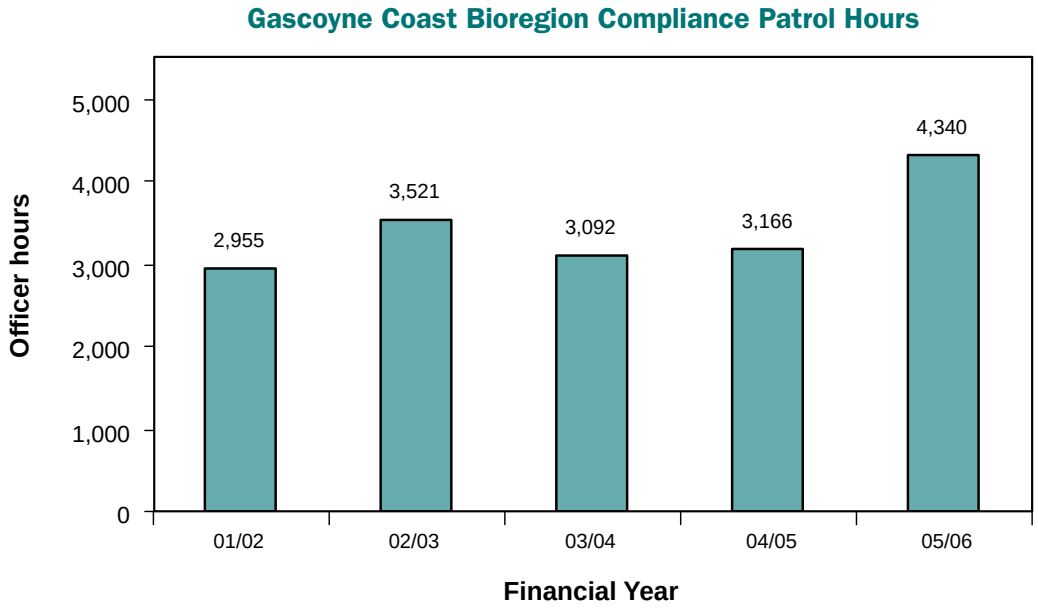
A 3-year project commenced in the Gascoyne to inspect all aquaculture leases in the 3 bioregion districts of Denham, Carnarvon and Exmouth. Inspections commenced in Shark Bay and resulted in a number of deficiencies being detected. By working in a consultative process with lease owners, these deficiencies were rectified in a very short timeframe and a subsequent inspection of the leases revealed full compliance with Department of Fisheries and marine safety requirements for these sites.

The Gascoyne Coast bioregion's Volunteer Fisheries Liaison Officer (VFLO) program continued to find it difficult to attract volunteers during 2005/06. As in previous years, the population base of less than 12,000 people in the Gascoyne cannot support the large number of volunteer organizations existing within the region. Solutions to this problem remain elusive, but work continues on developing viable ways of making the VFLO program work.

Initiatives in 2006/07

For the 2006/07 year, a number of initiatives across the Gascoyne Coast bioregion have been planned. These initiatives include:

- Expanding marine reserve services to the Muiron Islands Marine Management Area;
- Carrying out the first review of the Ningaloo and Shark Bay Marine Reserve Collaborative Operational Plans and Operational Compliance Plan;
- Carrying out development work on processes to measure outcome-based compliance within marine reserves;
- Continuing the aquaculture audit across the Gascoyne by inspecting sites in the Exmouth district;
- Planning for the replacement of the Patrol Vessel *John Brockman;*
- Creating Operational Compliance Plans for Shark Bay Marine Reserve and the Commonwealth Waters of the Ningaloo Marine Park for the federal Department of Environment and Water Resources;
- Creating risk assessments for the Shark Bay Crab Fishery;
- Expanding the VMS into the mackerel and snapper fisheries; and
- Educating the trawl industry about the risk assessment and operational compliance planning processes.



GASCOYNE COAST COMPLIANCE FIGURE 1

This figure gives the 'on patrol' Officer Hours, showing the level of compliance patrol activity delivered to the Gascoyne Coast bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the Gascoyne Coast bioregion that resulted in the contacts detailed in Table 1. Note the totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

GASCOYNE COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and education contacts and detected offences within the Gascoyne Coast bioregion during the 2005/06 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	4,340 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	601
District Office contacts	1,942
Infringement warnings	10
Infringement notices	16
Prosecutions	11
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	11,880
District Office contacts	5,880
Infringement warnings	99
Infringement notices	37
Prosecutions	6
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	2,054
District Office contacts	3,554
Fishwatch reports**	12

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts of these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between the 2 sectors. It also includes any calls relating to the Northern Inland bioregion that were referred to Exmouth, Carnarvon or Denham district staff.

North Coast Bioregion

Pearl Passage at One Arm Point.
Photo: Eloise Dortch

North Coast Bioregion

ABOUT THE BIOREGION

The oceanography of the North Coast bioregion is generally tropical, with its origins in the flow of Pacific Ocean waters through the Indonesian archipelago. Under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) scheme, published in 1998 by the Australian and New Zealand Environment and Conservation Council, the bioregion has been divided into 8 meso-scale regions: Pilbara inshore, Pilbara offshore, North West Shelf, Eighty Mile Beach, Canning, King Sound, Oceanic Shoals and Kimberley.

Ocean temperatures range between 22°C and 33°C, with localised higher temperatures in coastal waters due to the arid nature of the hinterland, particularly along the Pilbara coastline. Fish stocks in the North Coast bioregion are entirely tropical, with most having an Indo-Pacific distribution extending through Indonesia to the Indian subcontinent and Arabian Gulf regions.

Coastal waters are generally low-energy in terms of wave action, but are seasonally influenced by infrequent but intense tropical cyclones, storm surges and associated rainfall run-off. These cyclone events generate the bulk of the rainfall, although the Kimberley section of the coastline does receive limited monsoonal thunderstorm rainfall over summer.

Significant river run-off and associated coastal productivity is only associated with cyclone events, with run-off ceasing during winter. The entire north coastal region is subject to very high evaporation rates (3 metres per year), although the Pilbara coastline is more arid than the Kimberley due to its lower cyclone frequency.

The second significant influence on coastal waters is the extreme tidal regime, related to the wide continental shelf. Spring tides range from up to 11 m along the Kimberley section of the coast down to around 2 m at Onslow in the west Pilbara.

As a result of these factors, the generally tropical low-nutrient offshore waters are significantly influenced by rainfall run-off and tidal mixing to generate varying water quality in different sections of the North Coast bioregion. Along the Kimberley coastline, waters are turbid and relatively productive, while the Pilbara coast with its lower run-off and lesser tidal influence has the clear waters more typical of the tropics.

The coastal geography of the various sections of the coastline also differs. The Kimberley coast is highly indented, with bays and estuaries backed by a hinterland of high relief. Broad tidal mudflats and soft sediments with fringing mangroves are typical of this area.

The eastern Pilbara coast is more exposed than the Kimberley, with few islands and extensive inter-tidal sand flats. Softer sediments and mangroves occur around the river entrances.

The western Pilbara coastline is characterised by a series of significant but low-relief islands including the Dampier Archipelago, Barrow Island and the Montebello Islands. Near-shore coastal waters include rocky and coral reef systems, creating significant areas of protected waters. West Pilbara shorelines also include areas of soft sediment and mangrove communities.

The principal commercial fisheries in the North Coast bioregion focus on tropical finfish, particularly the high-value emperors, snappers and cods which are taken by the Pilbara Fish Trawl Fishery and the Pilbara and Northern Demersal trap fisheries. The typical catch is in the order of 3,000 t annually, making these fisheries, at an estimated annual value of around $12 million, the most valuable finfish sector in the state.

The North Coast bioregion has a number of small, limited-entry trawl fisheries for prawns, producing about 700 t annually, valued at around $10 million. There are also significant fisheries for Spanish mackerel, barramundi/threadfin salmon and shark, and a developing fishery for blue swimmer crabs. However, the bioregion is increasingly coming under threat from international poaching, particularly for sharks.

A number of wetline activities, including offshore demersal line fishing and near-shore beach seining and gillnetting, also occur in the region.

Recreational fishing is experiencing significant growth in the North Coast bioregion, with a distinct seasonal peak in winter when the local population is swollen by significant numbers of metropolitan and inter-state tourists travelling through the area and visiting, in particular, the Onslow, Dampier Archipelago and Broome sections of the coastline.

Owing to the high tidal range, much of the angling activity is boat-based, with beach fishing limited to periods of flood tides and high water.

Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish.

Aquaculture development in the North Coast bioregion is dominated by the production of pearls from the species *Pinctada maxima*. Wild pearl oysters seeded for pearl production are obtained from the fishing grounds primarily off the Eighty Mile Beach, with smaller catches being taken around the Lacepede Islands north of Broome, near Port Hedland, and off Onslow and Exmouth Gulf.

Wild stocks are supplemented by hatchery-produced oysters, with major hatcheries operating at Broome and King Sound. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands.

Developing marine aquaculture initiatives in this region include growing trochus and black tiger prawns. A focus of aquaculture development is provided by the Department of Fisheries' Broome Tropical Aquaculture Park, which houses a commercial pearl oyster hatchery, an indigenous-owned multi-species hatchery and the Kimberley College of TAFE aquaculture training facility.

The Department of Fisheries' Research Division's newly formed Biodiversity Branch has recently commenced a state-wide project

aimed at evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions. One of the objectives of the project is to determine the risk of different vessel types introducing marine species to WA waters, based on shipping patterns and the species that are likely to be translocated through those movements.

Other objectives are the establishment of a centralised introduced marine species monitoring framework that:

- uses the national monitoring approach;
- determines locations where monitoring should occur, recognising both ports and high value areas; and
- provides information for the developing national database.

The project will also analyse potential future changes to threats due to increased shipping movements and changes in vessel origins.

Broome residents Jeni Martin and Peter Mitchell record seagrass densities at Roebuck Bay with project coordinator Danielle Bain (centre). Photo: Eloise Dortch

ENVIRONMENTAL MANAGEMENT

Regional Overview (North Coast)

Marine habitats along the North Coast bioregion of Western Australia are coming under increasing pressure through illegal foreign fishing, recreational fishing and tourism, as well as increased activity associated with the resource sector.

A number of new port developments and port upgrades in the Pilbara region, as well as proposed oil and gas extraction proposals which involve the construction of off-shore infrastructure and seismic activity, have been proposed. Specific development proposals are considered on a case-by-case basis by the Department of Fisheries as a matter of course through the environmental impact assessment process managed by the Environmental Protection Authority. These include the proposed Gorgon Gas Development at Barrow Island, and a number of others in the Kimberley region.

The increase in shipping, in particular vessels arriving into WA waters from international destinations, is seen as a high risk in terms of the potential for the introduction of non-endemic marine species into WA's coastal environment. The Department is working closely with the Australian Government and other jurisdictions to develop and implement the National System for the Prevention and Management of Marine Pest Incursions that will minimise the environmental risks associated with increased shipping in the Pilbara and Kimberley regions. Within WA, this will be achieved through the proposed Biosecurity and Agriculture Management Act and associated regulations.

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Habitat Protection Figure 1). However, trawling is still permitted in a number of locations (see specific commercial trawl fishery reports elsewhere in this volume). This activity is carefully managed to ensure that impacts are acceptable. The trawling is subject to Ecologically Sustainable Development (ESD) requirements in accordance with Australian Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the *Environment Protection and Biodiversity Conservation Act 1999.*

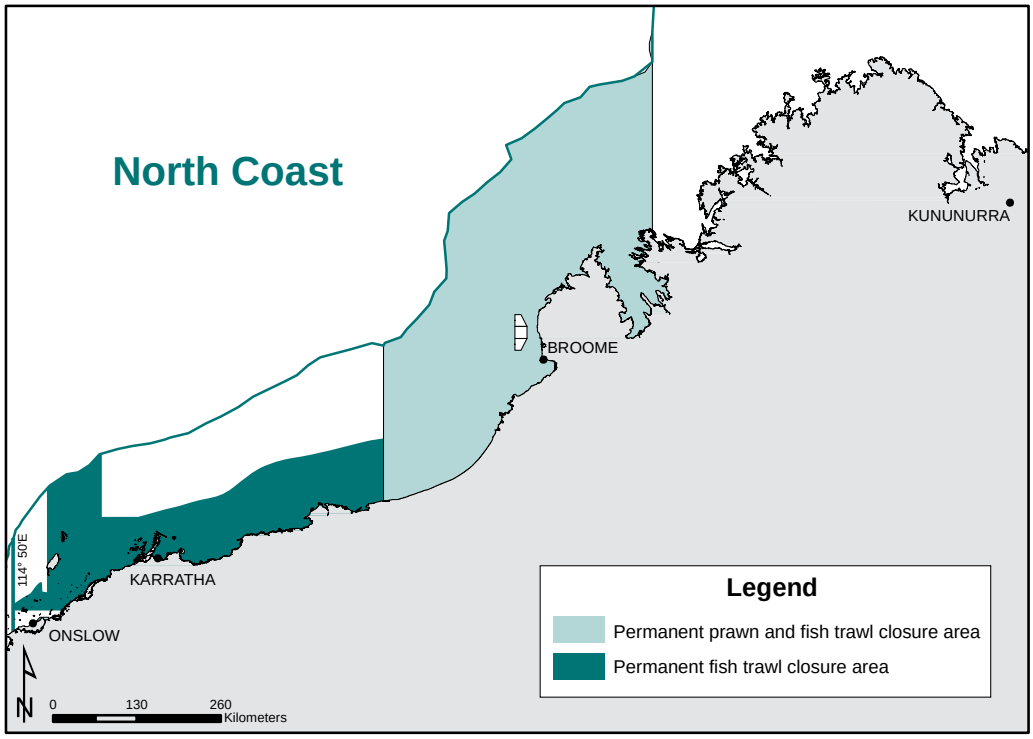
In addition to the fisheries closures, the bioregion has a number of marine protected areas including the Montebello, Barrow Island, Rowley Shoals and proposed new Dampier Archipelago marine conservation reserves proclaimed under the *Conservation and Land Management Act 1984*, and closures to fishing under section 43 of the *Fish Resources Management Act 1994* at Point Samson, Peron Peninsula and the wreck of the *Kunmunya Samson II* (Delambre Reef) (North Coast Habitat Protection Figure 2).

The Department of Fisheries is actively participating in a new marine conservation reserve planning process in the Pilbara and South Kimberley, coordinated by the Department of Environment and Conservation, and is also in the process of preparing a 'Kimberley Fish Plan', which will identify pro-active management arrangements for fishing activity in the Kimberley region for the next 5 to 10-year period. The Department continues to work closely with the Rangelands Natural Resource Management Coordinating Group to develop strategies to minimize environmental effects in the marine environment.

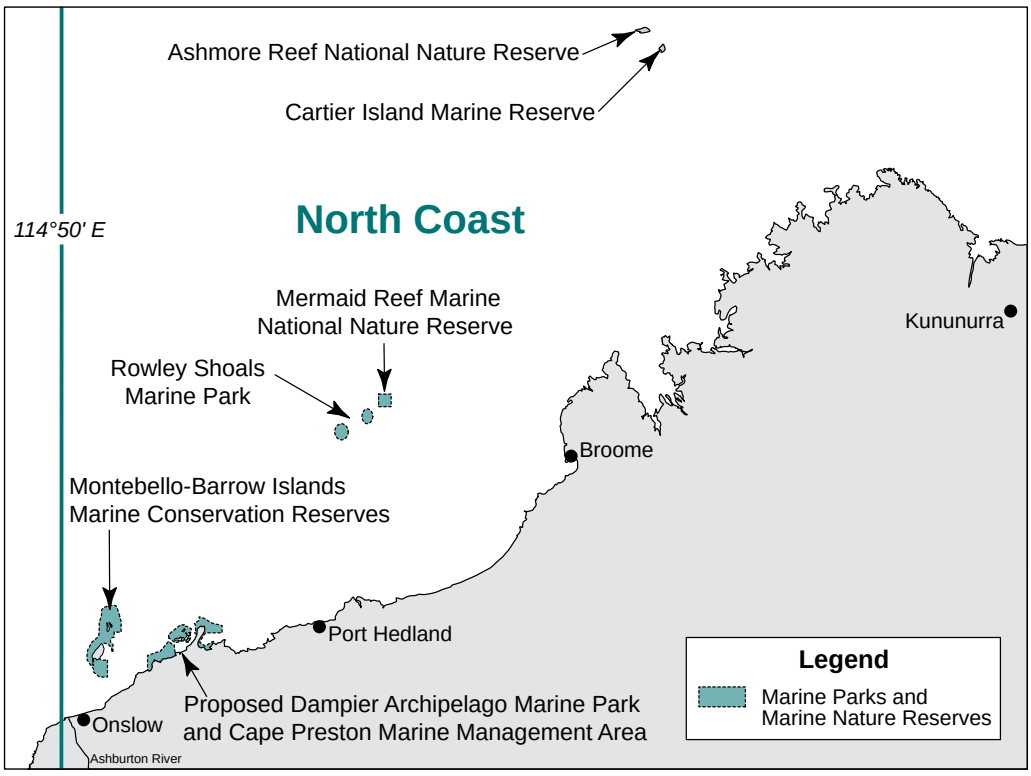
The Australian Government's Department of Environment and Water Resources is also undertaking a marine bioregional planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with a view to finalizing a North West marine bioregional plan which will contain individual marine protected areas. These are expected to complement existing protected areas at Ashmore Reef, Cartier Island and Mermaid Reef.

Pro-active feral fish incursion response mechanisms are in place, in conjunction with the Department of Agriculture, to react to feral fish incursions where they occur. Mechanisms are also in place to respond to 'fish kill' incidents and to monitor for non-endemic disease outbreaks.

Finally, biosecurity arrangements to develop and implement a 'National System for the Prevention of Marine Pest Incursions' are in place, to minimise the environmental risks created as a result of increased shipping to the Pilbara and Kimberley Regions.



NORTH COAST HABITAT PROTECTION FIGURE 1
Map showing areas permanently closed to trawling in the North Coast bioregion.



NORTH COAST HABITAT PROTECTION FIGURE 2
Map showing current and proposed areas of protected fish habitat in the North Coast bioregion.

FISHERIES

Onslow Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from S. O'Donoghue

Fishery Description

The Onslow Prawn Managed Fishery operates along the western part of the North West Shelf and targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*) using otter trawls.

Governing legislation/fishing authority

Onslow Prawn Fishery Management Plan 1991
Onslow Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are 'all Western Australian waters of the Indian Ocean below high water mark lying west of 116°45′ east longitude and east of a line commencing at the high water mark on the mainland due south of the southernmost extremity of Locker Island drawn due north to the high water mark at that extremity; thence northwesterly to the high water mark at the southernmost extremity of Serrurier Island; thence northerly along the high water mark of that island on its western shore to its northernmost point; thence due north' (Onslow Prawn Figure 1).

The fishery is divided into 3 fishing zones with associated size management fish grounds (SMFGs) and nursery areas as follows: Area 1, incorporating the Ashburton SMFG; Area 2, incorporating the Mangrove Island and Weld Island SMFGs and Coolgra Point Nursery; and Area 3, incorporating the Fortescue SMFG.

Management arrangements

Management controls for the Onslow Prawn Managed Fishery are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices ('grids').

The opening and closing dates for the fishery prior to 2006 were generally early March. For 2006, the opening date was aligned to the moon phase that was best suited for this prawn fishery.

Annual meetings are held with licence holders to consider the status of the stocks and recommend changes to fishing operations' closing dates within the season, which protects smaller prawns and allows access to the various target species, primarily tiger and banana prawns, at appropriate times.

Discussions regarding the merit of opening later were held between the Department of Fisheries' Research Division and industry prior to the commencement of the 2006 season, and it was agreed to commence fishing later than has occurred in past years.

This decision was taken to improve prawn size and quality to counter the low prawn prices and rising fuel costs, and to take advantage of a more favourable moon phase.

The official season arrangements for the various areas were as follows:

Area 1	21 April – 30 October
Area 2	21 April – 30 October
Area 3	21 April – 30 October
Fortescue SMFG	1 May – 1 September
Ashburton SMFG	1 June – 1 September

Moon closures were again implemented this season on a voluntary basis. The moon closure period was 3 days around each full moon during the fishing season across all areas.

The management system involves a total allowable effort arrangement, whereby all boats have an equal allocation of headrope length for all areas. The fleet is composed of trawlers up to 23 m in length, operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

The Department of Fisheries' Vessel Monitoring System continues to monitor the activities of all boats.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of target species (e.g. tiger and king prawns) and secondary target species (black tiger prawns). Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research needed to manage this small fishery involves stock monitoring and assessment utilising the CAES monthly returns data provided by industry, along with information from voluntary daily log books and some interviews with boat skippers.

A Fisheries Research and Development Corporation-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay, Exmouth Gulf and Onslow Area 1 will be completed in 2007.

In 2005, a field-based consultative process was undertaken whereby industry and the Department of Fisheries' Research Division decided on the extent of an area to be fished within areas that are opened by 'determination'. This process this has continued for the 2006 fishing season.

When Area 1 opened to fishing, a closed buffer zone was implemented seaward of the Ashburton SMFG to protect small tiger prawns. Prawn size sampling surveys were undertaken in Area 1. The information from the surveys showed small-size prawns and delayed the opening of the buffer zone until June, together with the Fortescue area.

The Ashburton SMFG itself was opened according to the season arrangements. However, industry made a voluntary decision not to fish this banana prawn ground because of very low banana prawn abundance from survey and fishing fleet catch information in the adjacent area.

The Fortescue and Weld Island SMFGs opened on 1 June, but the Mangrove Islands SMFG remained closed for the entire season. Industry has agreed that this closure should be maintained for most or all of each season, with any opening to depend on the results of a survey undertaken during August to establish the size and catch rate of prawns within the area.

Retained Species

Commercial production (season 2006): 54 tonnes

Landings

The total landings of major penaeids for the 2006 season were 54 t, including 5 t of king prawns, 39 t of tiger prawns, 2 t of endeavour prawns and 8 t of banana prawns. This season's catch was lower than the target range for this fishery (60 – 180 t).

Tiger prawn landings dominated the very high catches in 2003 and 2004, but the tiger prawn catches declined to a lower level in 2005. The decline in the catch trend continued for the 2006 season.

This lower level in 2006 again mirrored a similar decline observed in the adjacent Exmouth Gulf fishery. The king prawn catch was slightly below average and below the target catch range for the species. Landings of secondary prawn species were less than 1 t of coral prawns and black tiger prawns (*Penaeus monodon*).

Recorded landings of by-product species included 2 t of bugs (*Thenus orientalis*), 1 t of blue swimmer crabs (*Portunus pelagicus*) and less than 1 t each of squid, cuttlefish and mixed finfish species.

Recreational component: Nil

Fishing effort/access level

Different licence classes apply to this fishery, allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating 2006 endorsements:

Class A Areas 1, 2 and 3 (4 boats)
Class B Areas 2 and 3 (3 boats)
Class C Area 2 (12 Exmouth Gulf boats)
Class D Area 3 (12 Nickol Bay boats)

During 2006, of the boats licensed to fish in this fishery, only 3 class A boats fished and recorded a total of 214 boat days for a total of 2,767 hours of fishing. This was a significant decline in fishing effort and this is reflected in the total landings.

All boats that fished completed research log books, from which the data was derived. The effort is for the Onslow class A boats only and does not include class D boats. No class B or C boats fished during the 2006 season.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The prawn landings during 2006 were below the average for tiger, king and endeavour prawns and only the tiger and banana prawns were within their individual target ranges.

The lower tiger prawn landings reflect the return to average environmental conditions. Fishing effort has been targeted towards larger tiger prawns by opening the season later and including surveys to close areas where small-sized prawns occur. This prevents growth overfishing and reduces impacts on recruitment, with the aim of providing more stable catches under increasing effective fishing effort.

This is being achieved in combination with moon closure periods of 3 days. In addition, the closure of the Coolgra area and its inclusion as a nursery provides added protection of habitat and of small prawns in this area.

The king and endeavour prawn landings were below the catch range but acceptable.

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels. However, poor environmental conditions can result in poor recruitment and hence a low spawning stock.

For king prawns, the analysis of catch and effort data in the 1980s and 1990s provides no evidence of a stock–recruitment relationship. For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) among years.

Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year.

Banana prawn catches were negligible, therefore industry maintained a voluntary closure of the Ashburton SMFG for the season. The rainfall recorded for the 2005/06 summer was 272 mm, but improved banana prawn catches were not seen in 2006 as expected from the amount of rainfall. This may be due to the low spawning stock available in 2005. Work continues on assessing the relationships between spawning stock, summer rainfall and river flow, and banana prawn catches from Area 1, which includes the Ashburton River estuary.

Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. The low banana prawn stock was not targeted in 2006, which would have allowed most of the stock to contribute to egg production.

The endeavour prawn is a by-product species and is not specifically targeted, so the exploitation levels are low and there is adequate protection of breeding stock.

Historical catch ranges from periods where it is known that recruitment was not affected by fishing effort for any of these species have been used as the basis for acceptable catch ranges. These historical catch ranges are used as an indicator of breeding stock adequacy.

The main performance measures for the Onslow fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006 the breeding stock indicators (catches within specified ranges) for tiger and banana prawns were met, although at the lower end of their range. The king and endeavour prawn catches were below the acceptable range. The poor catch of banana prawns is due to consecutive low rainfall years and to the decision not to fish this species in order to protect the breeding stock.

Non-Retained Species

Bycatch species impact: **Low**

Bycatch from the fishery is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species' populations. The introduction of fish escapement devices in all the nets towed by each boat in 2006 reduced this risk even further.

Protected species interaction: **Low**

The Onslow prawn fishery has, on rare occasions, previously caught turtles and sea snakes, which are generally returned to the sea alive, but the overall low effort level and targeted coverage of the fishery suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') are now fully implemented in the fishery, minimising the capture of large animals including turtles. No turtles were reported as landed in the log books kept by fishers.

Ecosystem Effects

Food chain effects: **Low**

Given the limited spatial coverage of this fishery and its low levels of catch, it is unlikely to have any significant ecological consequences.

Habitat effects: **Low**

This fishery targets primarily king and tiger prawns in most years and, occasionally, schooling banana prawns in the infrequent high rainfall periods, as in 2000. Within the extensive licensed fishing zone, relatively few discrete areas offshore from SMFGs are fished. In 2006, again, the area fished was less than 5% of the overall fishery.

The fishery is restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

Social Effects

Estimated employment in the fishery for the year 2006 was 9 people, including skippers and crew, with up to 8 people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$0.65 million**

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing in this fishery in 2006 were as follows:

King prawns	$11.80/kg
Tiger prawns	$13.70/kg
Endeavour prawns	$7.60/kg
Banana prawns	$8.00/kg
Coral prawns	$2.50/kg

Fishery Governance

Target catch range: **60 – 180 tonnes**

Under current effort levels and previous environmental conditions, the target ranges of prawn catches, based on the catches of the 1990s, are as follows:

King prawns	10 – 55 t
Tiger prawns	10 – 120 t
Endeavour prawns	5 – 20 t
Banana prawns	2 – 90 t

The overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species, as occurred in 1997 and 2000.

The overall catch for the fishery in 2006 was below the target range.

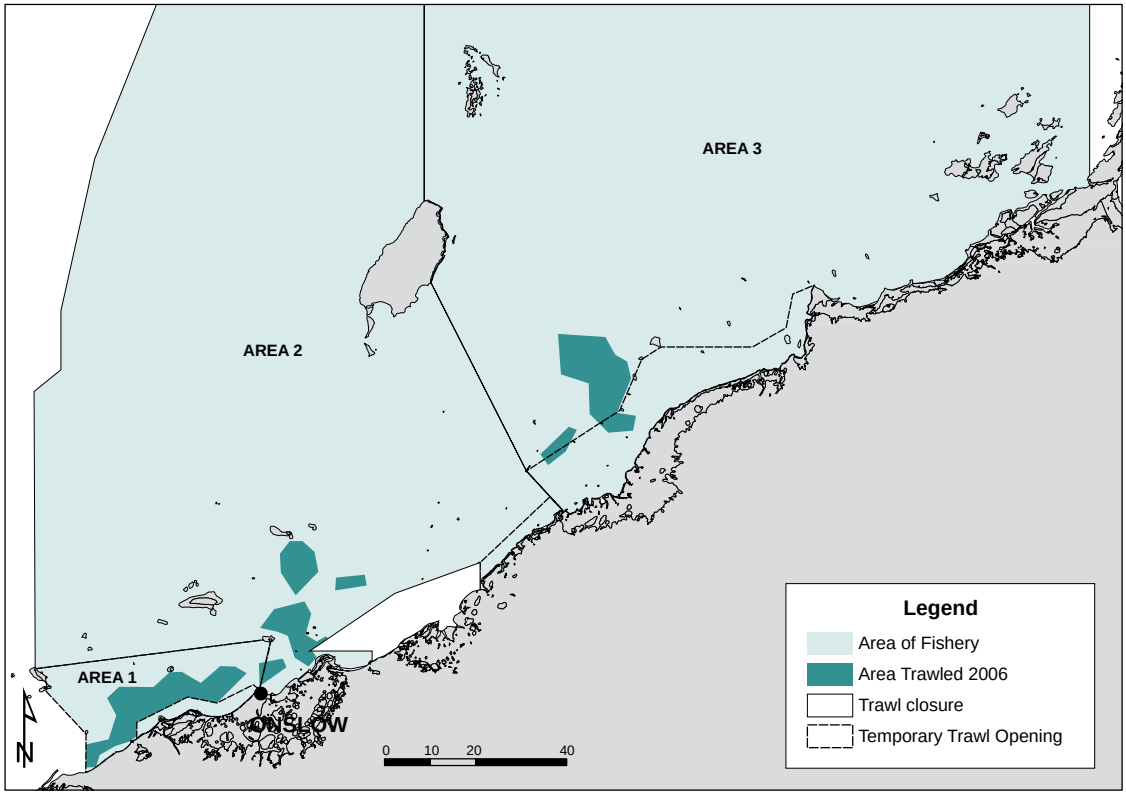
New management initiatives (2006/07): **None**

External Factors

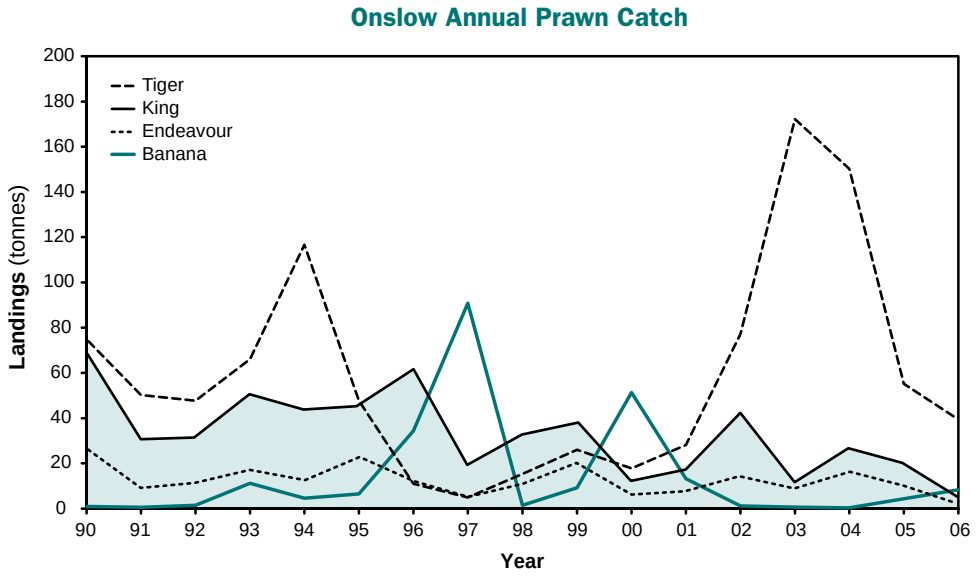
The catches taken are from a number of separate size management fish grounds and can be highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn, taken predominantly off the mouth of the Ashburton River.

Catches of tiger prawns from this fishery are also quite variable, with very high catches seen in 2003 and 2004 following beneficial environmental conditions. Severe cyclonic activity can have negative impacts on tiger prawns in some years. The effect is thought to vary depending on whether juvenile prawns are still in vulnerable, shallow nursery areas at the time.

The king prawn catch has remained stable, indicating that environmental effects such as cyclonic activity (producing heavy rainfall) have limited effect on the abundance of the king prawn stock.



ONSLOW PRAWN FIGURE 1
Boundaries of the Onslow Prawn Managed Fishery indicating new nursery areas and size management fish grounds and areas trawled in 2006.



ONSLOW PRAWN FIGURE 2
Annual landings for the Onslow Prawn Managed Fishery, 1990 – 2006

Nickol Bay Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and R. Allen
Management input from S. O'Donoghue

Fishery Description

The Nickol Bay Prawn Managed Fishery (NBPF) operates along the western part of the North West Shelf and targets banana prawns (*Penaeus merguiensis*), western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*) and endeavour prawns (*Metapenaeus* spp.) using otter trawls.

Governing legislation/fishing authority

Nickol Bay Prawn Fishery Management Plan 1991
Nickol Bay Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries and access

The boundaries of this fishery are 'all the waters of the Indian Ocean and Nickol Bay between 116°45 east longitude and 120° east longitude on the landward side of the 200 m isobath' (Nickol Bay Prawn Figure 1).

Management arrangements

Management controls for the Nickol Bay Prawn Managed Fishery are based on limited entry, seasonal and area closures, gear controls (including bycatch reduction devices or 'grids'), and restrictions on boat size. Different areas within the fishery have different season dates, allowing access to target species at appropriate times.

The Department of Fisheries' Vessel Monitoring System (VMS) continues to monitor the activities of all boats in the fishery.

The 2006 season commenced on 15 March and closed on 30 October. The season arrangements specified that the major fishing areas would be open during the following periods:

Nickol Bay	20 May – 31 August
Extended Nickol Bay 'size management fish ground' (SMFG)	20 May – 30 October
Depuch SMFG	20 May – 31 August
De Grey SMFG	20 May – 30 October

The management system involves a total allowable effort arrangement, whereby all boats have an equal allocation of headrope length. The fleet is composed of trawlers up to 23 m in length, operating twin or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue that has been identified through this process related to the breeding stock levels of 'target' and 'secondary target' prawn species. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research for the management of this small fishery involves stock monitoring and assessment utilising monthly returns data provided by industry, voluntary daily log book information from boat skippers, and rainfall records. Stock assessment of the banana prawn stocks involves updating the catch–rainfall relationship.

Research outcomes are reviewed at annual industry meetings, which consider the status of the stocks and recommend changes to fishing arrangements.

From the 2006 season, daily prawn log books are to be introduced to provide catch, effort, fishing location and prawn size category data, so that research assessments can be improved in the future.

During the 2006 season, bycatch samples were obtained from 1 of the boats in the fishery, and all species in the samples were identified and recorded. These will be analysed in association with a Fisheries Research and Development Corporation-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay, Exmouth Gulf and Onslow Area 1, which is due for completion in 2007.

The SMFGs of DePuch and Nickol Bay closed on 31 August as per the season arrangements. However due to the high banana prawn catches when closed (August 31), the Department of Fisheries' Research Division investigated the stock abundance for banana prawns after the key spawning period. This fishery was re-opened mid October for all boats to fish. Research personnel were on-board one of the boats to obtain catch and effort information, together with bycatch samples.

Retained Species

Commercial landings (season 2006): 394 tonnes

The total landings of major penaeids for the 2006 season were 394 t, comprising 366 t of banana prawns, 2 t of king prawns, 25 t of tiger prawns and less than 1 t of endeavour prawns (Nickol Bay Prawn Figure 2).

The catch of banana prawns in 2006 was above the target range, but within the projected catch range based on the rainfall–catch relationship. Tiger prawn catches were within the target range, whilst king prawns were well below the target catch range. Endeavour prawns were slightly below target range, but this is in part to low retention of this species due to lower value.

Recorded by-product species for 2006 were 3 t of blue swimmer crabs (*Portunus pelagicus*), and less than 1 t of bugs (*Thenus orientalis*), coral prawns, squid and mixed finfish species.

Recreational catch: **Nil**

Fishing effort/access level

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2006, with 11 boats fishing during the season.

During 2006, boats licensed to fish in the NBPF recorded 579 days for fishing effort and 8 days recorded as searching time. This compares to the 240 fishing days in 2005. The effort expended in the fishery this year is at the level expected for the good catch of banana prawns taken.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Projected catch next season (2007):
Banana prawns 120 – 180 tonnes

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels. In addition, the season has shifted to a later season opening date, lessening the exploitation rate on small-size prawns ('growth overfishing'). Closures in certain areas at the latter part of the season protect breeding stocks.

A broad relationship exists between the summer rainfall (December – March) and the catch of banana prawns in the following season (April – July). This relationship is assessed annually (Nickol Bay Prawn Figure 3).

Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment.

For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) amongst years. Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year.

The analysis of catch and effort data for king prawns in the 1980s and 1990s provides no evidence of a stock–recruitment relationship. The endeavour prawn is a by-product species and is not specifically targeted, so the exploitation levels are low and there is adequate protection of breeding stock.

Historical catch ranges from periods where it is known that recruitment was not affected by fishing effort for any of these species have been used as the basis for acceptable catch ranges. These historical catch ranges are used as an indicator of breeding stock adequacy.

The catch projection for banana prawns, based on the moderate summer rainfall level of 212 mm during the 2006/07 summer period, is between 120 t and 180 t (Nickol Bay Prawn Figure 3).

The performance measures for the Nickol Bay fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006 the breeding stock indicators (catches within specified ranges) for banana prawns were above the catch range, due to favourable rainfall. Tiger prawns were in the target range, but the king and endeavour prawn catches were below the target catch range.

Non-Retained Species

Bycatch species impact: **Low**

The NBPF operates predominantly by specifically targeting schools of banana prawns. This situation results in relatively low effort and minimal bycatch compared with other trawl fisheries.

In 2006, only 3% of the total Nickol Bay prawn fishery area was fished. The introduction of fish escapement devices within all the nets towed by each vessel in 2006 should reduce this risk even further.

Protected species interaction: **Negligible**

The NBPF has, on rare occasions, previously caught turtles and sea snakes, but the very low effort levels and targeted coverage of the fishery suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') are now fully implemented in the fishery, further reducing the capture of large animals including turtles.

Ecosystem Effects

Food chain effects: **Low**

In view of the highly variable nature of banana prawn recruitment, positively related to cyclonic rainfall, any food chain impacts from fishing are likely to be minimal despite the relatively high annual exploitation rate.

Habitat effects: **Low**

The small fleet fishes on a limited number of discrete fishing grounds, which make up approximately 5% of the coastal habitat within the fishery. Habitat types in the trawl areas associated with banana and king prawns are mud and sand respectively, which are not impacted significantly by trawl gear.

Social Effects

The estimated employment in the fishery for the year 2006 was 40 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2006:
$3.7 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. Generally, average prices received by vessels fishing in this fishery in 2006 were as follows:

King prawns	$11.80/kg
Tiger prawns	$13.70/kg
Endeavour prawns	$7.60/kg
Banana prawns	$9.00/kg
Coral prawns	$2.50/kg

Fishery Governance

Target catch range: **90 – 300 tonnes**

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	40 – 220 t
King prawns	20 – 70 t
Tiger prawns	2 – 40 t
Endeavour prawns	1 – 10 t

The overall target range for all species combined is different from the aggregate of the individual species ranges shown because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year. It should also be noted that the banana prawn catch has exceeded 400 t following extreme cyclonic rainfall on 3 occasions over the past 35 years.

New management initiatives (2006/07): **Nil**

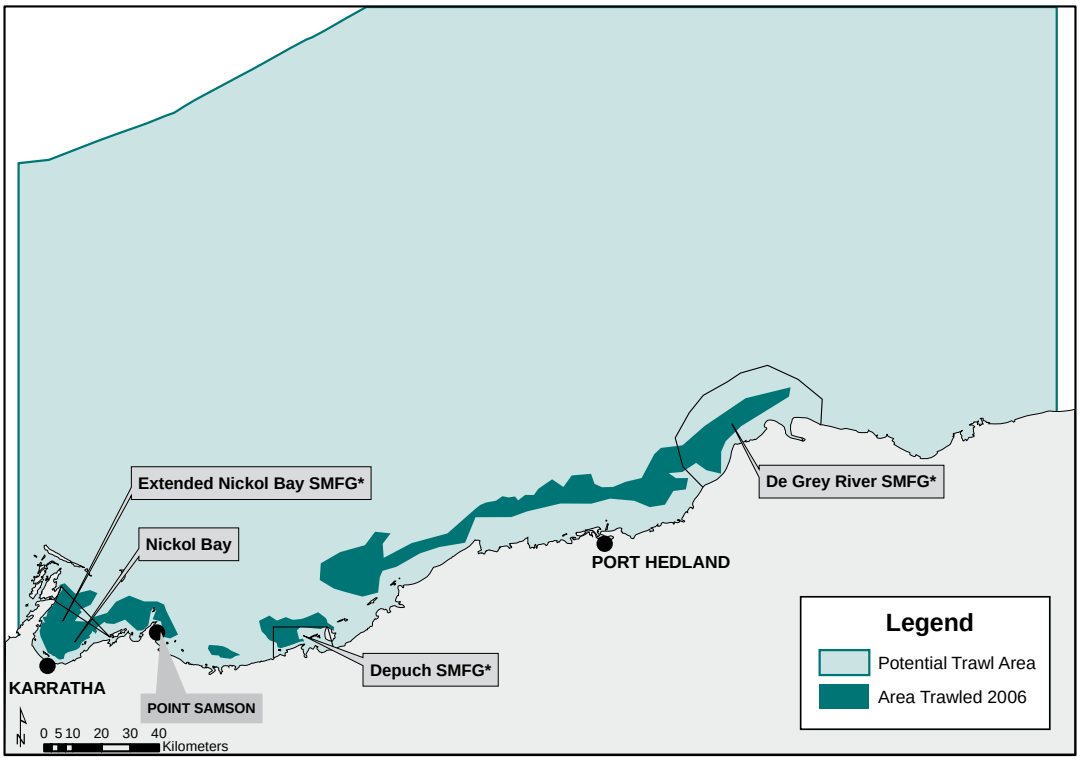
External Factors

There is 1 boat in the prawn fleet of Nickol Bay which is also licensed to trawl for finfish stocks offshore in the Pilbara Fish Trawl (Interim) Managed Fishery (PFTF).

All boats are also licensed to fish for prawns in the Kimberley Prawn Managed Fishery. As such, the fishing effort in the Nickol Bay Prawn Managed Fishery is also affected by management measures imposed elsewhere.

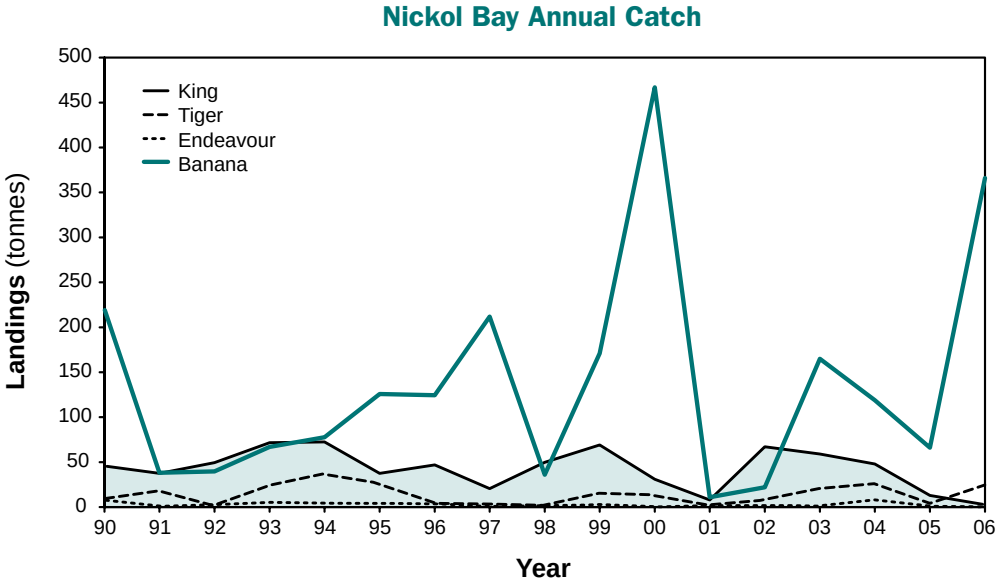
Also, when predicted catches (primarily of banana prawns) are high in other fisheries, licensees may choose to move and fish in these fisheries instead of remaining in the Nickol Bay fishery. Changes in the opening schedules in these fisheries may impact on effort levels in this fishery.

The smaller boats formerly used in this fishery are being replaced by larger boats that have the capacity to process prawns to-freezer relatively fast, thus maintaining high catch rates for longer periods than seen before. This increased capacity may have an impact on the prawn stocks and needs to be monitored.

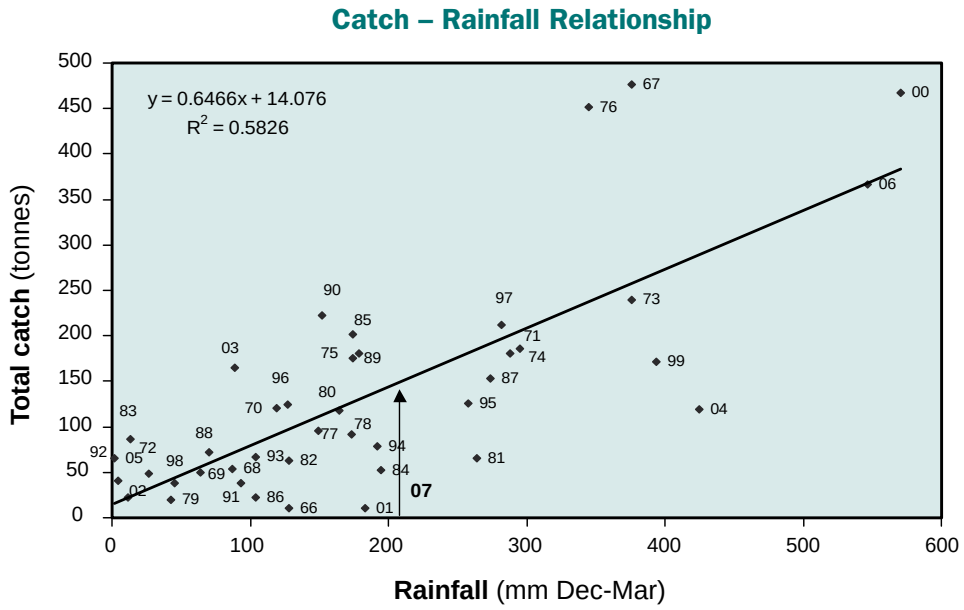


NICKOL BAY PRAWN FIGURE 1

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds (SMFGs).



NICKOL BAY PRAWN FIGURE 2
Annual landings for the Nickol Bay Prawn Managed Fishery, 1990 – 2006.



NICKOL BAY PRAWN FIGURE 3
Relationship between banana prawn landings and rainfall between December and March for the years 1966 – 2006.

Broome Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from S. O'Donoghue

Fishery Description

The Broome Prawn Managed Fishery operates in a designated trawl zone off Broome and targets western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species) using otter trawl fishing gear.

Governing legislation/fishing authority

Broome Prawn Managed Fishery Management Plan 1999
Broome Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meeting between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are 'all waters of the Indian Ocean off the north-west coast of Western Australia east of 120° east longitude and west of 123°45′ east longitude on the landward side of the 200 m isobath'. The actual fishery is restricted to a small area north west of Broome.

Management arrangements

Management controls for the Broome Prawn Managed Fishery (BPF) are based on limited entry, seasonal closures and gear controls including bycatch reduction devices ('grids'). There are 5 managed fishery licenses in the fishery.

The fishery's open period generally coincides with the seasonal closures for the Commonwealth's Northern Prawn Fishery (NPF) and the Kimberley Prawn Managed Fishery. In 2006, the season opened on 14 June and closed on 3 September.

The Department of Fisheries' satellite Vessel Monitoring System (VMS) monitors the activities of all boats in the fishery.

This fishery currently has a 5-year Ecological Sustainable Development (ESD) accreditation with the Commonwealth's Department of Environment and Water and Resources.

A comprehensive ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of target prawn species. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research data for managing this small seasonal fishery are provided by detailed research log books completed by all boats. These data are used for stock assessment and monitoring which is discussed with industry at annual review meetings.

A Delury depletion analysis is usually completed, which assists in the assessment of the king prawn stocks within this region. This included 3 new moon phases, thus optimising the best catching periods for king prawns for the time available in this fishery.

Retained Species

Commercial Landings (season 2006): **46 tonnes**

Recreational catch: **Nil**

The total landings for the 2006 season were 46 t, comprising 40 t of king prawns and 6 t of coral prawns (Broome Prawn Figure 2). King prawn landings for 2006 were low but within the target range.

The catch of coral prawns was the lowest recorded and below the target range. No by-product species were recorded in 2006.

Fishing effort/access level

5 boats are licensed to operate in this fishery, however only 4 boats operated during the 2006 season.

The fishing arrangements provided 81 nights of fishing and a total of 60 nights were fished. Fishing ceased by 20 August because of low catch rates of king prawns.

Nominal effort recorded in the daily research log books for the fleet was 1,202 hours, the lowest recorded in this fishery compared to the average effort (3,168) for the years 1997 to 2004 inclusive. The low effort is a reflection of the economic downturn in prawn fisheries, low prawn prices and high fuel costs, with licensees focusing on effort during better catch rate periods.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

As the actual fishing area is small and confined, and a relatively short period of time is fished annually, a depletion analysis can be undertaken to assess the stock size in the area. For the 2006 season a Delury depletion analysis was carried out, which showed that 65% of the stock was exploited.

It is unlikely that commercial fishing will have an impact on the breeding stock due to the widespread nature of this species and the fishing effort applied in this fishery. Due to the static position of the open fishing area, it is unlikely the entire stock of king prawns in this region is taken into account in the Delury analysis.

A more detailed stock assessment is not undertaken for the coral prawn stock, as the small size of these species relative to the trawl mesh size ensures a low exploitation rate is maintained. This species has not been fully retained in the last 2 years due to low prices therefore catches do not reflect actual abundance.

Generally, fishing is continuous during the BPF season, and shows high and low prawn catchability periods influenced by the lunar phase. In 2006 the mean catch rate observed was 32.9 kg/hr. The king prawn catch rate was above the average of 25.2 kg/hr (1997 to 2004) observed in this fishery.

Although the catch rate is relatively high, this was maintained because economic forces in 2005/06 kept fishing effort low during periods of low catch rate.

The Delury analysis indicated that the king prawn stock remaining at the end of the season was at the level considered sufficient for sustainability.

In the case of coral prawns, the annual catch in 2006 was very low, but this is because of a low retention rate and should not be used as a index of abundance. The species has an annual life cycle and low catchability, with the mesh size used and a widespread distribution, and therefore is considered to be low risk.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006 the breeding stock indicators for king prawns were met, as the exploitation rate for the king prawn stock was 65%. Coral prawns were below their target catch range, but this was acceptable due to low effort this year and the restricted size of the area fished, which limits overall exploitation of both species.

Non-Retained Species

Bycatch species impact: **Low**

Owing to the short duration of this fishery and the small number of boats involved, the impact on bycatch species is considered to be minimal.

In 2006, 34% of the gazetted fishing area was fished, which represents less than 1% of the total Broome Prawn Managed Fishery area. The introduction of fish escapement devices (FEDs) within half the nets towed by each boat, with the intent of fitting FEDs to all nets towed in the future, should reduce this risk even further.

Protected species interaction: **Negligible**

The fishery operates in relatively deep water. This fact, combined with the short season, restricted trawl area and low number of boats involved, means that interaction with protected species is minimal.

Bycatch reduction devices ('grids') are now fully implemented in the fishery, minimising the capture of large animals including turtles. No turtles were reported as captured in 2006.

Ecosystem Effects

Food chain effects: **Low**

The short duration and limited spatial coverage of this fishery, combined with the small number of boats involved, results in a relatively small amount of biomass being taken by the fishery. Consequently the impacts on the food chain will be small to insignificant.

Habitat effects: **Negligible**

The fishery targets non-schooling king prawns, with a secondary catch of coral prawns (common name due to colour, not habitat association) in relatively deep water.

In this fishery, the boats are permitted to operate only in a discrete area offshore, north-west of Roebuck Bay (which is the nursery area for this king prawn stock).

The defined trawling area was surveyed by the Department of Fisheries' Research Division and the sea floor examined by industry and research divers prior to establishment of the management plan to ensure minimal impact on the adjacent pearl fishery habitat. The sea floor in the trawl area was found to be mud or sand, which is unlikely to be adversely impacted by trawling.

Social Effects

The estimated employment generated by the fishery for the year 2006 was 16 skippers and crew over the 3-month season. The vessels operate for the remainder of the year in the prawn fisheries further north.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$0.5 million**

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing off Broome for 2006 were as follows:

King prawns	$12.00/kg
Coral prawns	$2.00/kg

Fishery Governance

Target catch range: **55 – 260 tonnes**

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches are as follows:

King prawns	35 – 170 t
Coral prawns	20 – 90 t

For king prawns the acceptable range is based on the catches of the 1990s, while for coral prawns it is based on the 7-year range (1996 – 2002) since catches were first recorded. Therefore, the 40 t of king prawns was within the acceptable catch range, albeit at the lower end of the range.

The 6 t of coral prawns taken were below the minimum set for the target range for each species. However, it is noted that most coral prawns caught were not retained catch because of the low price paid for this species, thus was not recorded as catch.

In both cases, the low landings are due in part to low effort levels resulting from market forces (fuel costs, small-size prawns (20% of catch composition) yielding low value).

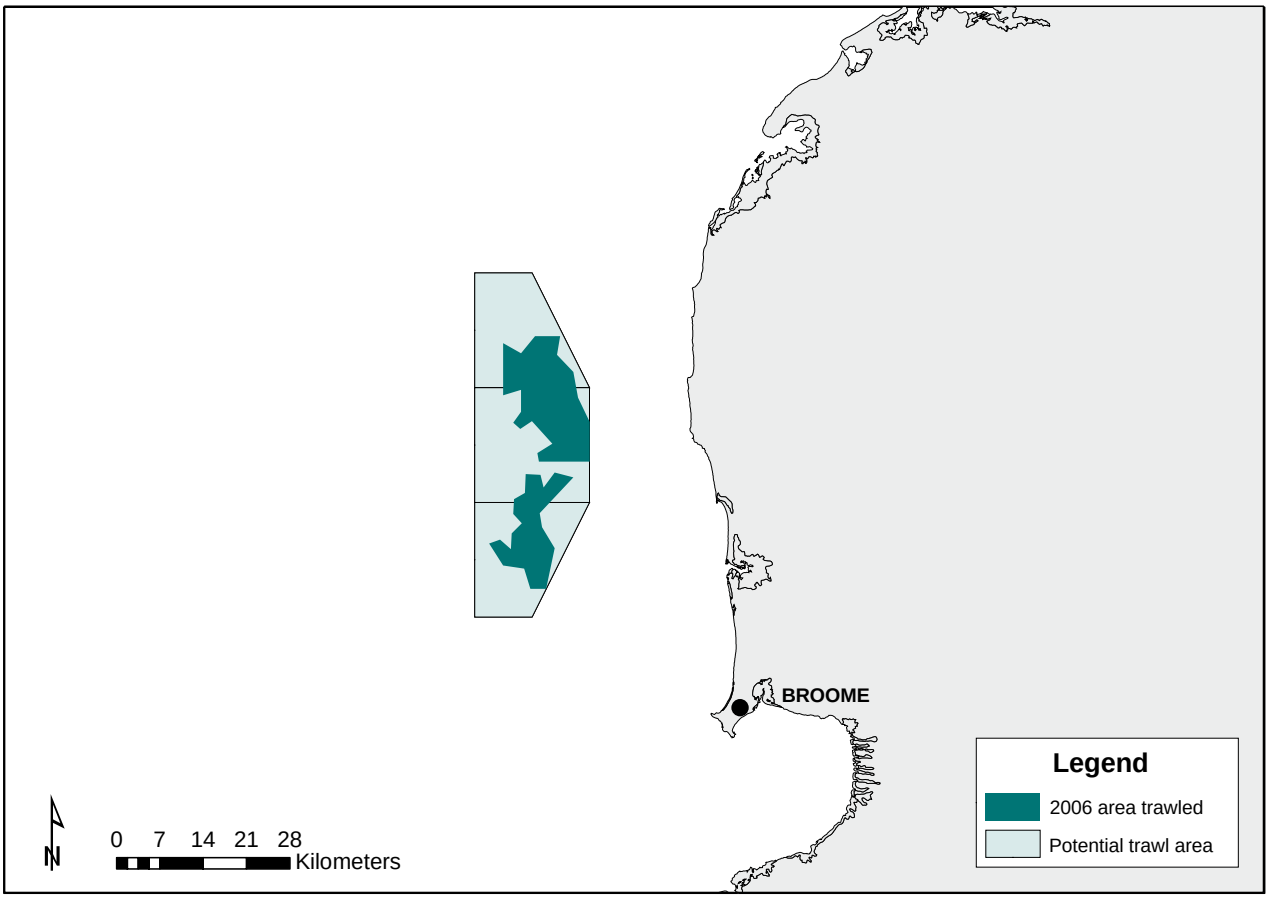
Other factors influencing catches are that the timing of the season is set by the mid-season closure for the Northern Prawn Fishery. Since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in high abundances in the permitted fishing area. This situation will be monitored over the next few years.

New management initiatives (2007): **None**

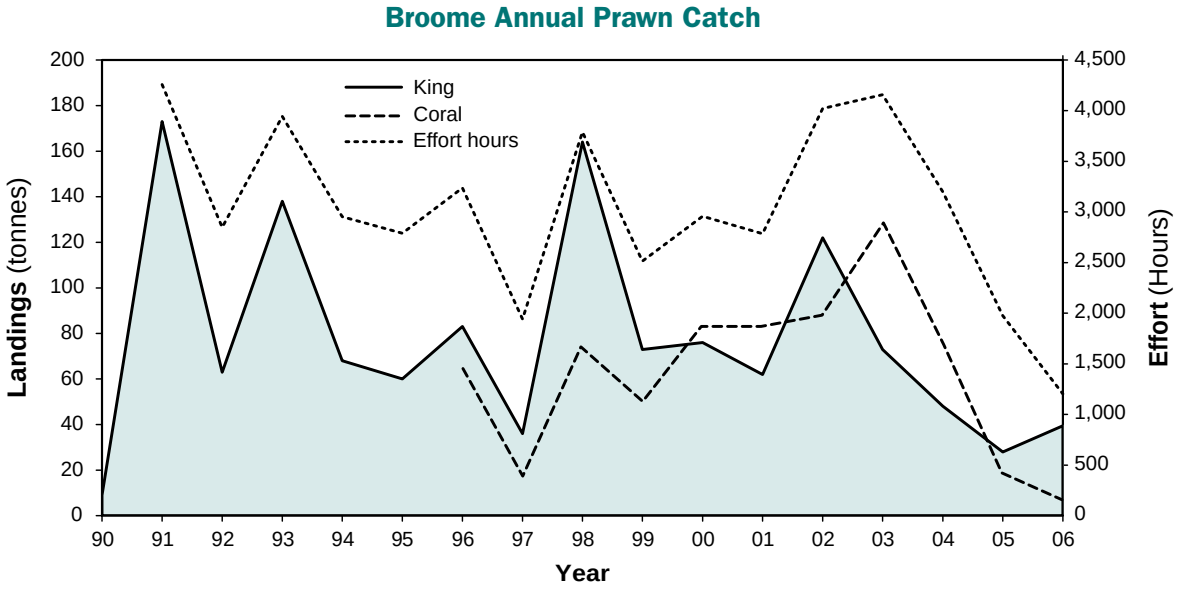
External Factors

The success of this fishery depends on how the limited fishing season coincides with the king prawn recruitment and catchability, which is strongly influenced by the lunar period.

This fishery is valuable, despite its short season, because it allows up to 11 weeks of fishing by 5 boats in a way that complements their fishing activity in the NPF, and in other fisheries in Western Australia.



BROOME PRAWN FIGURE 1
Boundaries of the Broome Prawn Managed Fishery and areas trawled in 2006.



BROOME PRAWN FIGURE 2
Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2006.

Kimberley Prawn Managed Fishery Status Report

M. Kangas, E. Sporer and R. Allen
Management input from S. O'Donoghue

Fishery Description

The Kimberley Prawn Managed Fishery (KPF) operates off the north of Western Australia between Koolan Island and Cape Londonderry. It predominantly targets banana prawns (*Penaeus merguiensis*) but also catches tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus endeavouri*) and western king prawns (*Penaeus latisulcatus*). Fishing is undertaken using otter trawls.

Governing legislation/fishing authority

Kimberley Prawn Fishery Management Plan 1993
Kimberley Prawn Managed Fishery Licence
Commonwealth *Government Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation Process

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are 'all Western Australian waters of the Indian Ocean lying east of 123°45′ east longitude and west of 126°58′ east longitude'. The KPF also abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).

Management arrangements

The management controls for the KPF are based on limited entry, effort controls, seasonal closures, gear controls including bycatch reduction devices (grids), and restrictions on boat replacements.

Seasonal dates for the KPF are generally aligned with those of the adjacent NPF. A significant number of vessels hold authorisations to operate in both the KPF and the NPF, and opening and closing dates are aligned to prevent large shifts of fishing effort into the KPF.

Consequently, the 2006 KPF season opened on 15 April and closed for the mid-season closure on 10 June. The fishery re-opened on 1 August, with a promulgated final season closure on 15 November. All fishing activities are monitored by the Department of Fisheries' vessel monitoring system (VMS).

Since 2003, a total effort cap system has been in place that restricts the number of fishing days available within the fishing season, based on historical effort levels in the fishery. This was split as 600 days for the first half of the season and 900 days for the second half.

The fishery currently has a 5 year Ecological Sustainable Development accreditation from the Commonwealth Department of Environment and Water Resources. A comprehensive Ecologically Sustainable Development assessment of this fishery determined that performance should be measured annually for the breeding stock of target prawn species. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Research data for monitoring this fishery are provided by Western Australian fishers' monthly returns, and by research log books collected by the Australian Fisheries Management Authority for NPF boats licensed to operate in the Kimberley fishery, as well as daily research log books from a few WA licensed boats.

Research assessments are provided to annual meetings of boat operators and provide the basis for recommending changes to management arrangements each year.

Retained Species

Commercial production (season 2006): 335 tonnes

Landings

The total recorded landings for the 2006 season were 335 t, comprising 308 t of banana prawns, 22 t of tiger prawns, 4 t of endeavour prawns and 1 t of king prawns (Kimberley Prawn Figure 1).

The banana prawn catch was within the projected catch range (230 – 350 t) calculated using the relationship between summer rainfall and catches. Catches of banana and tiger prawns were within their target catch ranges. The recorded landings of endeavour prawn were slightly lower than the acceptable catch range. This may be due to low targeting and retention of this species due to a lower value.

Recorded by-products were 1 t of bugs (*Thenus orientalis*) and less than 1 t each of squid and cuttlefish.

Recreational component: Nil

Fishing effort/access level

Although a total of 137 managed fishery licences have access to the KPF, 22 different boats operated in the fishery during some period of the year. Eighteen boats fished in the first half of the season and 11 during the second half.

During the 2006 season, the boats operated in the fishery for a total of 812 days. The effort cap in the first half of the season was 600 days, and 376 days fished were recorded by VMS polling during this period. The effort cap in the second half of the season was set at 900 days and 436 days were fished.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected catch next season (2007): Banana prawns 200 – 300 tonnes

While no formal stock assessment based on catches and fishing effort has been completed for the Kimberley prawn stocks, the relationships identified between rainfall and catches of banana prawns (the dominant species taken in this area) may provide a degree of forecasting.

Investigations have shown a promising relationship between early season rainfall (January and February) and the subsequent catch of banana prawns. Rainfall during the period January to February 2007 was 39 mm at Derby and 335 mm at Kalumburu so the rainfall – catch relationship predicts that banana prawn catches for 2007 should be in the range of 200 to 300 t.

For most penaeid stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels.

Banana prawn catches are highly variable and mainly related to the amount of rainfall recorded in the region, with consecutive high rainfall years providing the optimal conditions for banana prawn recruitment. For tiger prawns, the catches are mostly related to the level of effort on the stocks and the normal environmental fluctuations (primarily rainfall) among years.

Current catch and effort levels are considered adequate to maintain breeding stocks because they are distributed in discrete areas and not all areas of tiger prawn stocks are necessarily fished each year. The endeavour prawn is not specifically targeted, so there is adequate protection of breeding stock.

Historical catch ranges from periods where it is known that recruitment was not affected by fishing effort for any of these species have been used as the basis for acceptable catch ranges. These historical catch ranges are used as an indicator of breeding stock adequacy.

The main performance measures for the Kimberley fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2006, the breeding stock indicators (catches within specified ranges) for banana and tiger prawns were met. Endeavour prawns were just below the target range, but this was in part due to lower retention due to low market value for this species.

Non-Retained Species

Bycatch species impact: Low

The majority of the catch in this fishery comprises banana prawns, which usually form schools that are specifically targeted, meaning that bycatch is minimal. However, banana prawns may occasionally be dispersed due to the local tidal conditions in the Kimberley, with the result that some untargeted trawling may also occur.

Overall, the fishery is likely to have a low impact on bycatch species. The introduction of fish escapement devices within all the nets towed by each vessel in 2006 should reduce this risk even further.

Protected species interaction: Negligible

Bycatch reduction devices (grids) are now fully implemented in the fishery, minimising the capture of large animals including turtles.

Ecosystem Effects

Food chain effects: **Neglibible**

As the fishery targets banana prawns, which are highly variable in recruitment due to cyclonic rainfall, any food chain impacts from fishing are likely to be negligible.

Habitat effects: **Low**

The KPF operates over a very limited area, estimated to be about 5% of the licensed area. Owing to the unusual nature of the environment, characterised by extreme (10 m) tidal ranges, heavy mud substrates and high turbidity, fishing is judged to have minimal impact on the habitat.

Social Effects

Estimated employment for the year 2006 in the fishery was 85 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$3.1 million**

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. Generally, average prices received by boats fishing along the Kimberley coast in 2006 were as follows:

Banana prawns	$9.00/kg
Tiger prawns	$13.70/kg
King prawns	$11.80/kg
Endeavour prawns	$7.60/kg

Fishery Governance

Target catch range: **240 – 500 tonnes**

Under current effort levels and previous environmental conditions, the acceptable ranges of prawn catches, based on the catches of the 1990s, are as follows:

Banana prawns	200 – 450 t
Tiger prawns	15 – 60 t
Endeavour prawns	7 – 80 t

Note the overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown, as the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species in the same year.

New management initiatives (2006/07)

From the 2006 season, daily prawn log books were introduced to provide catch, effort, fishing location and prawn size category data so that research assessments can be improved in the future. 5 boats completed log books in 2006.

The 2007 season will commence in early August and therefore size management fish grounds will not be implemented. However, permanently closed inshore areas will be adopted in 2007.

These new management arrangements will provide economic benefits by optimising the size at harvest, as well as minimising the capture of small prawns at the start of the season and protecting the spawning stocks during the latter part of the season.

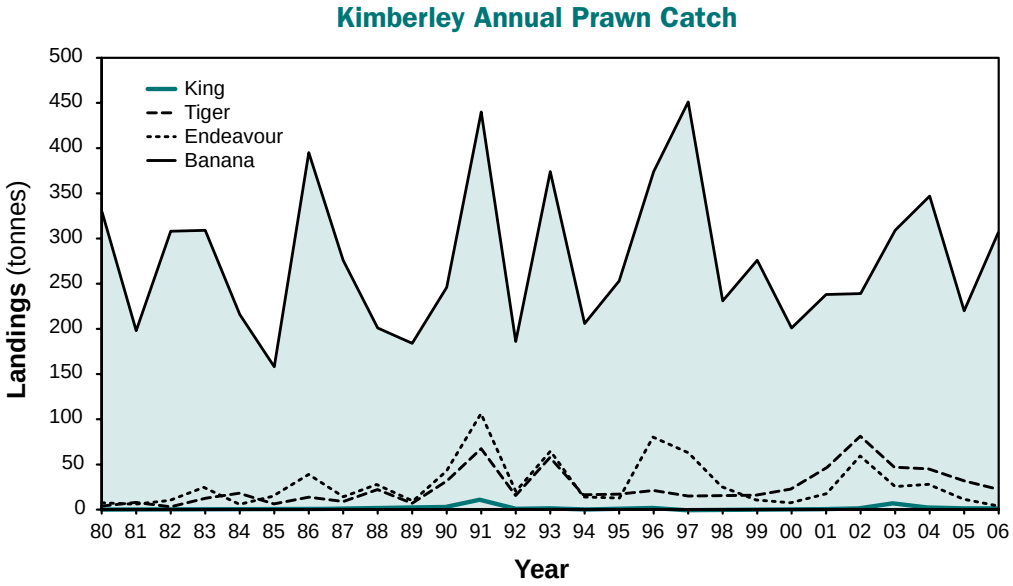
A review of the management arrangements for the fishery will be carried out during 2007 and 2008 to address key issues including, de-linking the fishery from the NPF and addressing latent effort.

External Factors

The relationship between summer rainfall and the catch of banana prawns continues to be examined. Banana prawns usually comprise the majority of the prawn catch from this fishery therefore this correlation will assist fishers and managers to plan the best use of this resource.

This fishery has few boats that operate for the complete fishing season. Other boats operate within this fishery at certain times of the year to complement catches in their ‘local’ fisheries.

Currently, the KPF fishing season is set to mirror dates used in the NPF to prevent the Kimberley fishery from attracting too much fishing effort from the NPF. The effort cap also addresses, in some part, the issue of latent effort in the fishery.



KIMBERLEY PRAWN FIGURE 1
Annual landings for the Kimberley Prawn Managed Fishery, 1980 – 2006.

Kimberley Gillnet and Barramundi Managed Fishery Status Report

S.J. Newman, C. Skepper and R. McAuley
Management input from A. Bain

Fishery Description

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the Western Australian/Northern Territory border to the top of Eighty Mile Beach, south of Broome. It encompasses the taking of any fish by means of gillnet in inshore waters and the taking of barramundi by any means.

The species taken are predominantly barramundi (*Lates calcarifer*), giant threadfin salmon (*Polydactylus macrochir*) and blue threadfin salmon (*Eleutheronema tetradactylum*). The main areas of the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the top end of Eighty Mile Beach.

Governing legislation/fishing authority

Commercial

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence

Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)

West Kimberley Regional Recreational Fishing Advisory Committee (Broome)

East Kimberley Regional Recreational Fishing Advisory Committee (Kununurra)

Boundaries

The waters of the KGBF are defined as 'all Western Australian waters lying north of 19° south latitude and west of 129° east longitude and within 3 nautical miles seaward of the low water mark of the mainland of Western Australia and the waters of King Sound of 16°21.47′ south latitude and Jacks Creek, Yardogarra Creek and in the Fitzroy River north of 17°27′ latitude'.

The distribution of barramundi and threadfin salmon catches in WA extends south of the KGBF along the Pilbara coast. Catches south of the southern boundary of the managed fishery have been included in the summary table (Kimberley Gillnet Table 1) for completeness.

Management arrangements

The KGBF is managed primarily through input controls in the form of limited entry, seasonal and spatial area closures, and gear restrictions.

Access to the KGBF is currently limited to 7 licences, with all 7 vessels fishing during 2006. Currently, there are also 2 exemption

holders authorised to commercially fish with gillnets along the Eighty Mile Beach in the Pilbara coast fishing area south of the managed fishery.

There is a closed season in which fishing is prohibited in the KGBF. In the southern section of the KGBF (west of Cunningham Point, 123º08.23´ east longitude) the closure extends from 1 December to 31 January the following year, while in the northern section of the KGBF (east of Cunningham Point) the closure extends from 1 November to 31 January the following year.

Following the development in 2000 of the 'Barramundi Accord', additional management arrangements were put into place for both the commercial and recreational exploitation of barramundi. These arrangements include extensive areas closed to commercial fishing around major town sites and recreationally-important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River north of 17º27´ S and the lower Ord River upstream of Adolphus Island.

There are also limits on the length of net and mesh sizes that can be used in the fishery.

Research summary

The biology of both the threadfin salmon species has recently been completed (Pember *et al.* 2005). These data are to be used to provide a detailed stock assessment of threadfin salmon in the KGBF and Pilbara, when resources become available.

The bycatch of elasmobranchs in the KGBF and the Pilbara coast fishing area was examined during 2002 and 2003 (McAuley *et al.* 2005).

The data used in this report to assess the status of the series of barramundi stocks targeted by this fishery are provided from the Department of Fisheries' CAES database. This status report is compiled annually and provided to industry and regional management.

Retained Species

Commercial landings (season 2006):

All species 109.9 tonnes
Barramundi 36.3 tonnes
Threadfin salmon 67.7 tonnes

The principal species in the landed catch are 2 species of threadfin salmon, the giant threadfin salmon (also called 'whites') and the blue threadfin salmon (also called 'blues'), and barramundi. Lesser quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis)* are also landed.

The composition of the elasmobranch catch varies considerably between fishing areas. However, it mainly consists of whaler shark species (Carcharhinidae), including pigeye sharks (*Carcharhinus amboinensis*), blacktip whalers (mainly *C. tilstoni*) and various species of rays, including sawfish (Pristidae), although the latter were totally protected in December 2005 and may not be retained.

There are 5 principal fishing areas within the north coast (Pilbara/Kimberley) bioregion: Cambridge Gulf (including Ord River), Kimberley coast (6 small river systems), King Sound (including Fitzroy River), Broome coast (Roebuck Bay), and Pilbara coast (extending to the Ashburton River). Only 4 of these fishing areas lie within the boundaries of the prescribed KGBF, with the Pilbara coast fishing area lying outside the managed fishery area below latitude 19° S (Kimberley Gillnet Figure 1).

Each of these principal fishing areas is considered separately because of their differing histories of development, effort application, and recreational fishing interest and unit stock considerations. Landings from the Pilbara coast are not included in the total catch figure for the KGBF, but are reported in Kimberley Gillnet Table 1 for completeness, along with the catch from each of the 4 sectors within the managed fishery.

The total reported catch of all species in the KGBF in 2006 was 110 t (Kimberley Gillnet Figure 2). Recent annual catches of the major target species by the KGBF are shown in Kimberley Gillnet Table 2.

The total landings of barramundi from all 4 prescribed fishing areas within the KGBF were 36.3 t for 2006 (Kimberley Gillnet Figure 3). This level of catch is similar to that reported in 2005.

The 2006 landings of threadfin salmon in the KGBF were 67.7 t, which is higher than the reported catch of barramundi (Kimberley Gillnet Figure 4). Catches of threadfin salmon from the KGBF in 2006 are similar to that reported in 2005, however they are lower than the near record high catch of 94 t reported in 2003. In addition, the reported catch of 19 t of threadfin salmon in the Pilbara coast fishing sector in 2006 is similar to the 2005 level of catch, but substantially lower than the 2004 level of catch.

These 2 main species groups (barramundi and threadfin salmon) comprise greater than 90% of the total catch of the KGBF. The reported catch in tonnes and the percentage composition of each of the major species taken in the fishery in 2006 are summarised in Kimberley Gillnet Table 3.

Recreational catch:

Key species 2–10% (approximately) of total catch

The most recent data available are from a 12-month creel survey of recreational boat-based and shore-based fishing in the Pilbara and West Kimberley region, conducted from December 1999 to November 2000 (Williamson *et al.*, 2006). In the entire survey area (Onslow to Broome), the total recreational fishing effort for the year was estimated to be 190,000 fisher days and the total recreational scalefish catch approximately 300 t.

Recreational fishers in the survey area reported an estimated total catch of approximately 18 t of threadfin salmon, whereas the estimated total catch of barramundi was less than 1 t. As this survey covered the Broome coast and Pilbara coast areas, the recreational catch can be estimated at around 10% of the combined (commercial and recreational) threadfin salmon catch

and around 2% of the combined barramundi catch in these areas in 2000.

The reported charter vessel catches for the north coast bioregion in 2006 was estimated to be approximately 5.5 t of barramundi and 0.5 t of threadfin salmon.

Fishing effort/access level

Procedures to validate and standardise reported fishing effort in the KGBF (and Pilbara gillnet sector) were developed by McAuley *et al*. (2005) and have been used to reassess the fishery's historical levels of effort. The resulting time series of effort data provide a more accurate record of fishing activity in the KGBF than was previously available and these validation procedures will therefore be used to document KGBF fishing effort for future status reports.

The fishery's 'effective effort' is now calculated from the validated data as the total length of net set per gillnet hour (km gn hr). During 2006, the total effective effort across the 4 prescribed fishing areas was 861.1 km gn hr. This level of effort is lower than that reported in the fishery in 2005 (1,071.6 km gn hr) and 2004 (1,811 km gn hr;) (Kimberley Gillnet Figure 2).

Stock Assessment

Assessment complete

Barramundi: **Yes**

Threadfin salmon: **No**

Breeding stock levels

Barramundi: **Adequate**

The catch rate of barramundi declined from the early 1980s to 1992. In the period from 1992 to 1999 the catch rate was relatively stable, before increasing in 2000. From 2001 to 2003 the catch rate declined again to levels commensurate with those in the mid-1990s before rising again since 2004, including 2006. The catch rate now appears to be varying around a higher level than that evident in the 1990s (Kimberley Gillnet Figure 3).

Historically, the catch rate of threadfin salmon was again low during the period 1984 to 1996. It increased rapidly from 1997 to 1998 and was then relatively stable at a high level from 1998 to 2000. The catch rate in 2006 has again increased to levels seen in the late 1990s.

The last detailed stock assessment (undertaken in 2002) indicated that the barramundi stocks in the Cambridge Gulf, Kimberley coast and King Sound sectors were being harvested at sustainable levels, while in the Broome coast sector the spawning biomass was declining. There is a need to undertake a further stock assessment of barramundi to examine the impact of recent catches on the status of the stocks. No formal assessment of threadfin salmon stocks has been undertaken.

Non-Retained Species

Bycatch species impact: **Low**

The fishery operates at a relatively low intensity over a wide area of the Kimberley region, specifically targeting barramundi and threadfin salmon. The fishing gear uses large mesh sizes, and hence does not generate a significant bycatch of species important to other sectors, but does take some unwanted sharks and rays. Because of the low effort levels, these impacts are unlikely to be significant to the stocks involved. Overall, this fishery is likely to be having only a minimal effect on the Kimberley ecosystem as a whole.

Protected species interaction: **Low**

The fishing gear used for this fishery does take some protected estuarine crocodiles (*Crocodylus porosus*) and sawfish (Family *Pristidae*). These species are released alive or avoided as far as is practicable. Because of the low effort levels, these impacts are unlikely to be significant.

There are no documented catches of either the speartooth shark (*Glyphis* sp. A) or the northern river shark (*Glyphis* sp. C), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as 'critically endangered' and 'endangered', respectively. However, as these species look similar to other whaler shark species, they may be captured but misidentified.

Given the fishery's low effort levels, particularly inside the freshwater drainages in which these species are most likely to occur, the KGBF is unlikely to be having a significant impact on the populations of these species.

Ecosystem Effects

Food chain effects: **Not Assessed**

Habitat effects: **Low**

The fishing gear has minimal impact on the habitat. The area and habitat fished is subject to extreme tidal currents and associated effects.

Social Effects

During 2006, 7 vessels fished in the KGBF with an average crew level of at least 2, indicating that at least 14 people were directly employed in the fishery. There was additional employment through local processors and distribution networks. The fishery provides fresh fish for the local communities and the tourism industry throughout the Kimberley region.

Economic Effects

Estimated annual value (to fishers) for year 2006

$690,000

The KGBF landed a total of 110 t of fish in 2006, for a catch value of approximately $690,000 (including an estimate of the value of shark fins landed by this fishery). This estimate is based on the landed weight of each species recorded in the CAES system

and the 2005 average price per kilogram of whole weight of each species as supplied by fish processors.

The Pilbara coast sector landed a total of 18.7 t of fish in 2006 for a catch value of around $80,000 (including an estimate of the value of shark fins landed by this fishery). The value of this sector is lower than the KGBF value as the catch of the highly prized barramundi is negligible in this sector.

However, the catch of the KGBF and the Pilbara coast sector together yields an annual value to fishers from this near-shore coastal fishing zone of around $0.8 million.

Fishery Governance

Target catch range: Barramundi 25 – 40 tonnes

The target catch range for barramundi (25 – 40 t) is derived from a double exponential smoothed forecasting model of the annual barramundi catches of the KGBF up to 1999. For the 5 years from 1999 to 2003, the level of barramundi catch was at the top end of the target catch range.

The catch in 2004 exceeded the target range, although this was achieved at a CPUE reflecting higher abundance levels than during the 1980s and 1990s. The barramundi catch in 2006 is within the target range.

Current fishing (or effort) level: Acceptable

The fishery is operating within the target catch range for the key indicator species (barrmundi) and the catch rate for this species is increasing. The breeding stock levels of barramundi are considered adequate and therefore the current fishing and effort levels are acceptable.

New management initiatives (2006/07)

The 'Barramundi Accord 2000' expired at the end of 2005. Negotiations are still in progress towards the establishment of a new accord to apply to the recreational and commercial take of barramundi and threadfin salmon throughout the Pilbara and Kimberley. The Department of Fisheries is facilitating meetings between commercial, recreational and charter stakeholders towards developing the new agreement.

A review of the KGBF management plan began in 2005 in order to modernise the fishery management arrangements and address concerns in relation to transferability of licences and the potential for shifting of effort and localised depletion of stocks.

External Factors

The barramundi stocks that utilise the large Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience more variable recruitment.

These stocks are subject to relatively uncontrolled levels of fishing pressure from wetline licence holders, as well as from recreational fishers, and are likely to need more specific management arrangements in the future.

KIMBERLEY GILLNET TABLE 1

The reported catch (tonnes) of the major commercial species from each of the principal fishing areas in the North Coast bioregion in 2006.

Catch Category	Principal Fishing Area				
	Cambridge Gulf	Kimberley Coast	King Sound	Broome Coast	Pilbara Coast
Barramundi	3.1	17.2	4.9	11.1	0.0
Threadfin salmon	1.3	2.8	2.3	61.2	18.7
Total	**4.6**	**22.1**	**7.2**	**75.9**	**20.5**

KIMBERLEY GILLNET TABLE 2

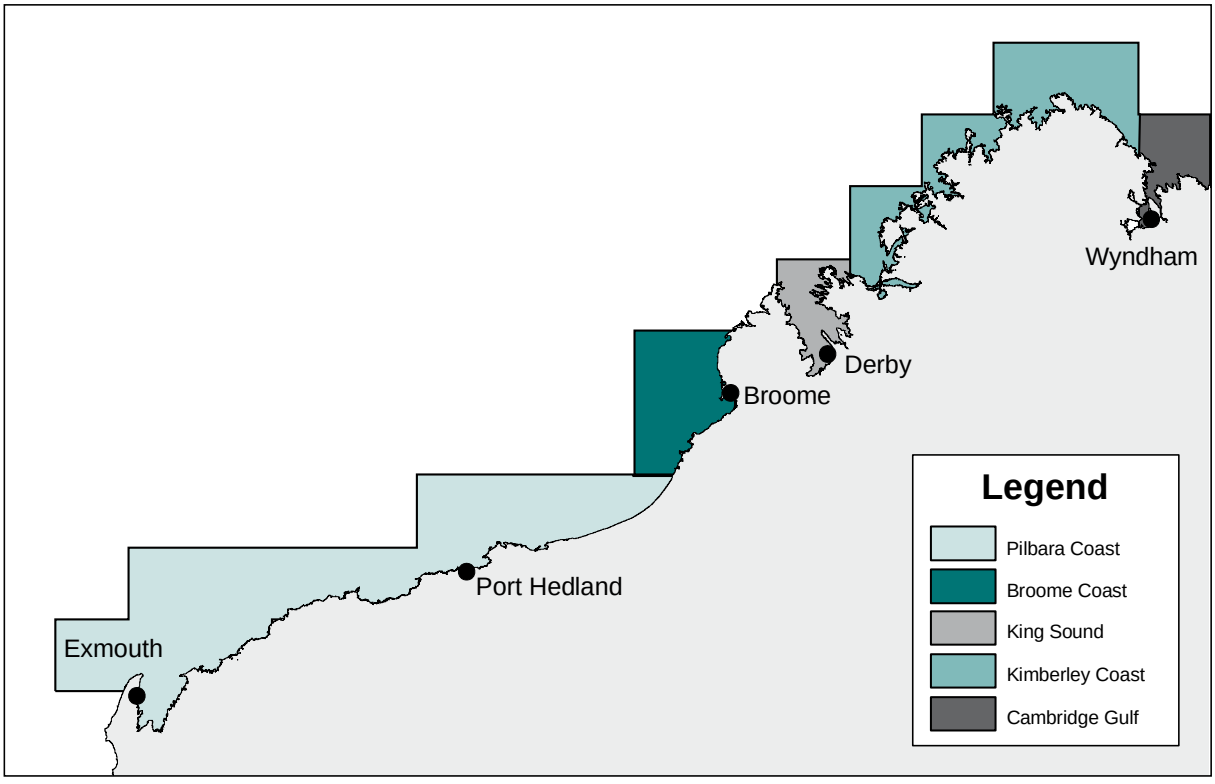
Recent annual catches of the major target species by the KGBF.

Species	Kimberley Gillnet Annual Catch (tonnes)									
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Barramundi	34.3	33.5	41.2	42.9	38.8	39.5	45.0	53.5	35.6	36.3
Threadfin salmon	80.2	81.3	109.8	66.7	50.9	76.4	94.1	75.8	70.6	67.7
Total	**124.6**	**123.2**	**160.4**	**120.7**	**100.5**	**124.4**	**148.0**	**136.1**	**117.8**	**109.9**

KIMBERLEY GILLNET TABLE 3

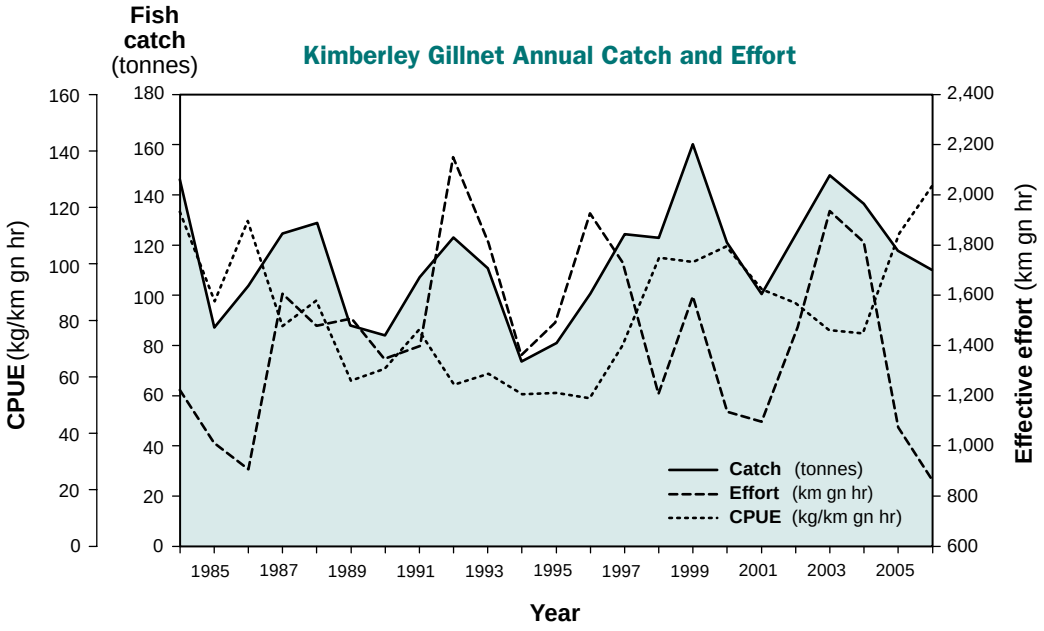
Summary of the reported catch (tonnes) and the percentage composition of each of the major species taken in the KGBF in 2006.

Species	Catch (tonnes)	Composition %
Threadfin salmon	67.7	61.6
Barramundi	36.3	33.0
Tripletail	3.0	2.7
Queenfish	0.8	0.7
Black jewfish	0.6	0.5
Sharks and rays	0.4	0.4
Other fish	1.2	1.1
Total	**110.0**	**100.0**



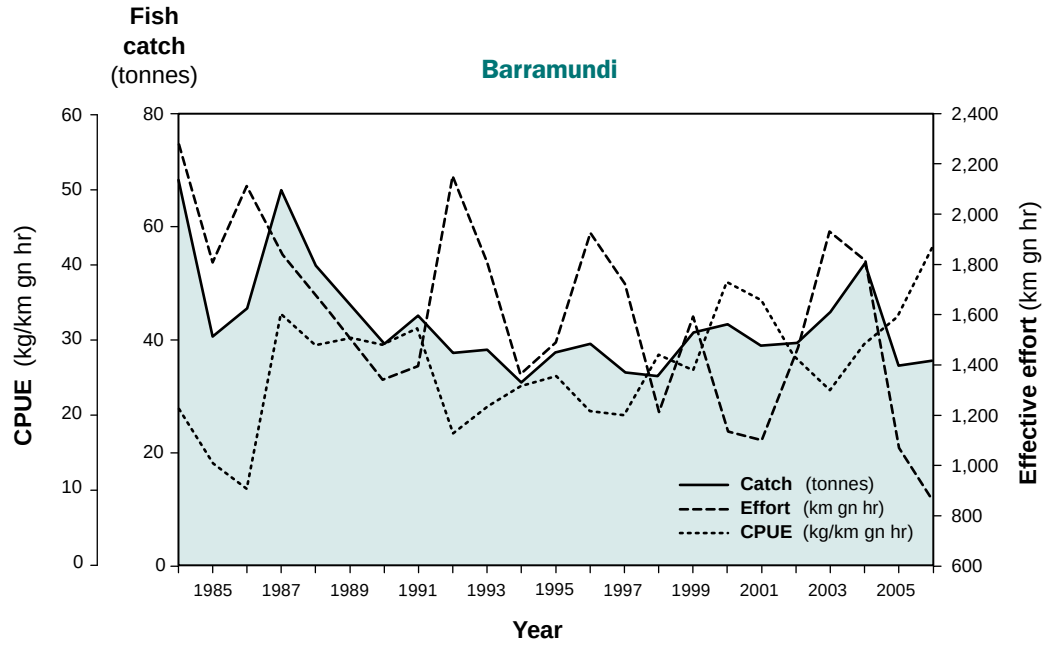
KIMBERLEY GILLNET FIGURE 1

Location of the 5 principal fishing areas within the North Coast (Pilbara/Kimberley) bioregion. 4 of the principal fishing areas from the Broome coast to the Cambridge Gulf lie within the boundaries of the Kimberley Gillnet and Barramundi Fishery (KGBF), with the Pilbara coast fishing area lying outside the managed fishery area below latitude 19°S.



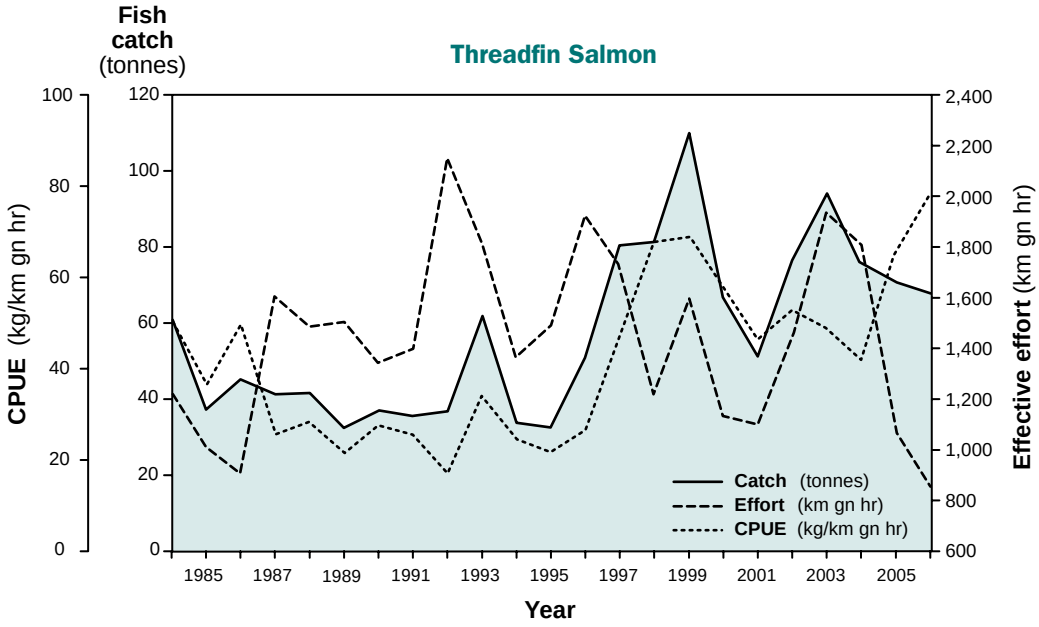
KIMBERLEY GILLNET FIGURE 2

The annual total catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, kg/km gn hr) from the KGBF over the period 1984 to 2006.



KIMBERLEY GILLNET FIGURE 3

The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, kg/km gn hr) for barramundi from the KGBF over the period 1984 to 2006.



KIMBERLEY GILLNET FIGURE 4
The annual catch, effective effort (km gillnet hours) and catch per unit effort (CPUE, kg/km gn hr) for threadfin salmon from the KGBF over the period 1984 to 2006.

Northern Demersal Scalefish Managed Fishery Status Report

S.J. Newman and C. Skepper
Management input from A. Bain

Fishery Description

The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the north-west coast of Western Australia in the waters east of 120° E longitude. The permitted means of operation within the fishery include handline, dropline and fish traps. Tropical snappers, emperors and groupers (or cods) dominate the landed catch in this fishery.

Governing legislation/fishing authority

Commercial

Closed Waters Fish Trapping (Kimberley Coastline) Notice 1991
Offshore Constitutional Settlement 1995, amendment 1998
Northern Demersal Scalefish Managed Fishery Management Plan 2000
Northern Demersal Scalefish Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)
West Kimberley Regional Recreational Fishing Advisory Committee (Broome)

Boundaries

The waters of the NDSF are defined as all Western Australian waters off the north coast of Western Australia east of longitude 120° E. These waters extend out to the edge of the Australian Fishing Zone (200 nautical mile) limit under the Offshore Constitutional Settlement arrangements (Northern Demersal Scalefish Figure 1).

The fishery is further divided into 2 fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2) (Northern Demersal Scalefish Figure 1). The offshore sector (Area 2) has been divided into 3 zones, A, B and C.

Zone B comprises the area of historical fishing activity and exploitation. Zone A is an inshore developmental area and Zone C is an offshore deep-slope developmental area, representing waters deeper than 200 m. The demersal scalefish resources of the deep-slope waters of Zone C (greater than 200 m depth) are yet to be adequately investigated.

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

Management arrangements

The NDSF is managed primarily through input controls in the form of annual fishing effort quotas, with supplementary gear controls and area closures.

The annual fishing effort quota limits the amount of effort available in the fishery to achieve the notional target total allowable catch. The annual effort quota is determined by dividing the notional target TAC by the average catch rates per vessel per day within the fishery and dividing this allocation equitably among vessels in the fishery.

As the fishery is now divided into Zones, there is a separate allocation for Zone B and Zone A, with exemption permits granted for any operations in Zone C. The notional target TAC for Zone B is a recommended level of catch for the entire demersal species complex and is derived from the estimated sustainable catch of the key target species (determined through detailed stock assessments) and their historical proportions in the catch.

In 2006, the notional TAC for Zone B was 800 t of demersal scalefish and the total effort allocation was 1,144 standard fishing days.

A notional conservative and exploratory target TAC for Zone A has been provisionally set at approximately 200 t, in order to try and stimulate expansion of the fishery into these areas in a similar manner. The Zone A TAC also represents a recommended level of catch for the entire demersal species complex.

The areas that encompass Zone A and also Zone C are likely to be low in productivity and thus the notional exploratory TAC of 200 t set for Zone A will need to revised if substantial catches of either goldband snapper or red emperor are forthcoming. In 2006, the notional TAC for Zone A was 200 t of demersal scalefish and the total effort allocation was 616 standard fishing days.

Access to the offshore sector (Area 2) of the NDSF is currently limited to 11 licences under an individually transferable effort quota system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2006, 7 vessels (trap fishing only) collectively held and operated the effort individually assigned to the 11 licences.

Each trap must have an internal volume equal to or less than 2.25 m^3. There is no restriction on the number of traps that can be fished per vessel.

However, as each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day, if the number of traps (or lines) being fished increases, the number of allowable fishing days declines. The number of days fished, as recorded by the vessel monitoring system, is converted to standard fishing days.

A comprehensive Ecologically Sustainable Development assessment of this fishery has determined that performance should be reported annually against measures relating to breeding stocks of the 2 indicator species – red emperor and goldband snapper – and the cod/grouper complex, as reflected by their catch levels.

The performance measures for this fishery relate to the maintenance of adequate breeding stocks for the key indicator species as indicated by the catch levels. In 2006, the catches of red emperor, goldband snapper and the cod/grouper complex either exceeded the trigger point of a 20% increase in catch, or were close to the trigger point despite a reduction in effort from 2005. As abundance has probably been maintained at higher catch levels, all 3 species/groups were still considered to have adequate breeding stock levels. However, the increasing trend in catch for these species has triggered the requirement for an updated stock assessment review that is currently in progress.

Research summary

Baseline research data on growth rates, age structure, reproductive biology and yield analyses, together with information gathered from the fishery, have been used within age-based stock assessment models to assess the status of the 2 key species, red emperor and goldband snapper. Ongoing monitoring of this fishery is being undertaken using both CAES data and Vessel Monitoring System (VMS) records.

The third largest component of the NDSF catch is the cod/grouper group. Information currently available on their species composition and relative abundance is limited to CAES records.

This gap in the knowledge of the NDSF represents an area of future research work, as does an improved understanding of the catchability of the key species in the fishery that would facilitate improved stock assessments and management arrangements. A research project funded by the Fisheries Research and Development Corporation (FRDC) commenced in late 2006, which aims to examine the relative catching efficiency of traps in the NDSF and to examine resource availability.

The future catch from the NDSF may also include some species from the waters of Zone C in depths greater than 200 m. The resources of this sub-region are unlikely to be substantial, and, given the lower production potential of these longer-lived deeper-slope reef fish, the sustainable catch from this zone is likely to be low.

Retained Species

Commercial landings (season 2006): 801 tonnes

The reported catch in the NDSF rose steadily after the initial development period from 1990 to 1992, reaching a peak in catch levels in 1996 (Northern Demersal Scalefish Table 1 and Figure 2). Following 1996, catch levels decreased and were relatively stable in the period from 1998 to 2003. In 2004, the catch of demersal scalefish in the NDSF began to increase.

The catch of demersal scalefish in the NDSF in 2006 was lower than that reported in 2005, due to a decrease in the trap catch, with no line catch reported.

The NDSF principally targets red emperor (*Lutjanus sebae*) and goldband snapper (*Pristipomoides multidens* and related *Pristipomoides* species), with a number of species of snappers

(Lutjanidae), emperors (Lethrinidae) and cods (Serranidae) comprising the remainder of the catch.

The catch of the major target and secondary target species over the last 5 years is provided in Northern Demersal Scalefish Table 1. The species composition of the landed catch is similar to that reported in 2005. There was a decrease in the landed catch of red emperor, down from 192 t in 2005 to 166 t in 2006 (Northern Demersal Scalefish Figure 3), and also a decrease in the catch of goldband snapper from 429 t in 2005 to 336 t in 2006 (Northern Demersal Scalefish Figure 4).

Furthermore, there was an increase in the landed catch of the cod/grouper complex, up from 110 t in 2005 to 129 t in 2006 (Northern Demersal Scalefish Table 1).

The increase in catch of the cod/grouper complex was driven by an increase in landings of 1 species – the Rankin cod (*Epinephelus multinotatus*). The 2004, 2005 and 2006 level of catch of Rankin cod is similar to that reported in the fishery in the early 1990s.

The 2006 catch of goldband snapper and the cods/groupers complex were above the acceptable levels for the third consecutive year (see 'Fishery Governance' section). The 2006 catch of red emperor was only marginally below the acceptable level.

Recreational catch: **Not assessed**

Historically, there has been little recreational or charter boat fishing effort directed towards the deeper-water fish species in Area 2 of the NDSF that are the key species targeted by commercial fishers. However, this situation is now changing, with charter vessels moving into the offshore waters of the NDSF.

The reported charter vessel catch of demersal scalefish in the offshore waters of the NDSF (depth greater than 30 m) in 2006 is estimated to be approximately 3 t. Most of the recreational fishing effort targeting demersal finfish in the Kimberley region is thought to be concentrated in the Broome sector of Area 1, which is closed to commercial fishing. The magnitude of recreational fishing catch is small relative to the total commercial catch.

Fishing effort/access level

The 7 fish trap vessels that fished in the NDSF in 2006 reported using between 20 and 48 fish traps per day. No line fishing was undertaken in the NDSF in 2006.

The effort allocated in Zone B in 2006 was 104 fishing boat days per licence, or a total of 1,144 standard fishing days (i.e. using 20 traps). The number of standard fishing days (SFDs) recorded using VMS data was 1,066, indicating that only 78 SFDs remained unutilised in the fishery at the end of the season.

The removal of latent and unutilized effort in Zone B in 2006 has meant that the allocated effort has virtually been fully utilized.

The effort allocated in Zone A in 2006 was 66 fishing boat days per licence, or a total of 616 standard fishing days (i.e. using 20 traps). The number of standard fishing days (SFDs) recorded using VMS data was 127, indicating that 489 SFDs remained unutilised in Zone A at the end of the season.

Zone A is an exploratory and developmental area and there is considerable scope for industry to operate in this area with a large amount of unutilized effort available.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

The catch per unit of effort from the fishery provides an indicator of annual variations in stock abundance, although changes in vessel efficiency need to be taken into account when using the data as a time series.

The introduction of management controls in 1998 resulted in an increase in CPUE for trap vessels in the NDSF. This increase was related to increases in efficiency, as fishers sought to maximise their catch return from each day fished in the fishery, as the available fishing effort was limited.

The Zone B CPUE for line vessels (handline and dropline only) in the period from 1998 to 2001 declined from 527 kg/day to 316 kg/day and subsequently no line fishing has been undertaken in the fishery in the period from 2002 to 2006. Prior to 1998, the handline and dropline CPUE was low and variable.

The average Zone B trap CPUE during 2006 was 705.9 kg per standard trap fishing day (20 traps x 35.29 kg/trap/day). This annual average trap CPUE in Zone B of the fishery in 2006 is almost identical to that reported in 2005 (702.9 kg/std day).

During 2006, Zone B catch rates for the indicator species were for red emperor 140 kg/std day, for goldband snapper 305 kg/std day and for cods 108 kg/std day. In the case of both goldband snapper and red emperor, the catch rates in 2006 were the same as those recorded in 2005, whereas the catch rate for cods was substantially higher.

A notional target TAC of 800 t for all species in Zone B is used in setting the effort quota allocation for vessels in the NDSF. Effort units (fishing days) are allocated annually on the basis of catch rate trends and set to enable the notional target TAC to be achieved within each year. The outcome from this effort determination process for the 2007 fishing season is outlined in the 'Target catch range' section below.

The 2006 trap catch rates for the 2 main target species are similar to those reported in 2005, with the cods/groupers catch rate increasing from the 2005 level. The levels of catch of red emperor, goldband snapper and the cods either exceeded the trigger point of a 20% increase in catch, or were close to the trigger point despite a reduction in effort from 2005. These increases in catch levels need to be assessed. A stock assessment review of the key target species in the NDSF will be undertaken in 2007 – 2008.

The spawning biomass of the key target species in the NDSF has been estimated by an age-structured stock assessment model and assessed in relation to the accepted international reference point for these types of species of 40% of virgin biomass.

The most recent full assessment of breeding stock levels for the 2 key species in 2002 was based on outputs from the stock assessment model incorporating catch history and catch rate data from the area of the fishery. This assessment indicated that goldband snapper was at approximately 41% of the estimated virgin level, while red emperor was at approximately 54% of the estimated virgin level. These levels were both above the recommended limit of 40% of the virgin spawning biomass and were considered adequate in 2002.

Non-Retained Species

Bycatch species impact: **Low**

As a result of the catching capacity of the gear and the marketability of most species caught, there is a limited quantity of non-retained bycatch in this fishery. The most common bycatch species is the starry triggerfish, *Abalistes stellatus*, but the numbers taken are not considered to be significant, and most are released alive.

Protected species interaction: **Negligible**

Trap fishing in deep water does not create any significant opportunities for the gear to interact with protected species.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Low**

As a result of the gear design, the fishery has little impact on the habitat overall, although there may be some interaction with coral habitats. 'Ghost fishing' by traps is unlikely to be significant, as similar fish species have been observed on video to be able to exit traps if left undisturbed.

Social Effects

5 vessels fished during the 2006 season, with an average crew level of 3 people per vessel, indicating that 15 people were directly employed in the NDSF.

Economic Effects

Estimated annual value (to fishers) for year 2006 **$4.6 million**

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 801 t of demersal scalefish in 2006, for a catch value of approximately $4.6 million. This estimate is based on the landed weight of each species recorded in the CAES system and the average price per kilogram of whole weight of each species as supplied by fish processors (note value is calculated based on a price survey undertaken in 2005).

Fishery Governance

Target catch range: **600 – 1,000 tonnes**

In the 8 years since the introduction of management controls (1998 – 2005), the fleet has only achieved its 800 t notional TAC in Zone B in 2005.

In 2005, a large amount of the allocated effort remained unutilised. As such, industry and fishery managers agreed to remove all unutilised effort from Zone B of the fishery for the 2006-fishing season. Thus for the 2006 calendar year, the total allowable effort in Zone B of the fishery was set at 1,144 standard fishing days. This allocation resulted in a total of 741 t being attained in Zone B with only a minimal amount of effort being unutilized.

Thus for the 2007 calendar year, the total allowable effort in Zone B of the fishery has been set at 1,144 standard fishing days, distributed equally among each of the 11 licences in the fishery. At this level of effort and at recent catch rates, the catch is expected to be in the range 600 – 1,000 t.

A further 616 standard fishing days has been allocated to fishers to facilitate the exploration and development of Zone A of the fishery where 60 t was caught, and there is further scope for fishers to develop Zone C (the deep slope area).

In addition to the overall catch target, performance measures state that the annual catch of each of the key target species/groups (red emperor, goldband snapper and the cod/grouper complex) by the fishery should not increase by more than 20% above the average for the previous 4 years.

Thus in 2006, the acceptable level of catch (average + 20%) for red emperor was less than 167 t, for goldband snapper less than 327 t, and for the cods/groupers less than 101 t. 2 of these individual trigger points were exceeded in 2006, with 1 being only marginally below the trigger level.

The level of catch and the high CPUE being maintained in Zone B of the NDSF and its possible impact on the stocks needs to be assessed and discussed with industry. A stock assessment review of the fishery is in progress, in association with the collection of additional age data for each of the key species.

Current fishing (or effort) level: **Not Acceptable**

The reduction in the effort allocated in 2006 translated into a level of catch equivalent to the notional TAC with very little unutilised effort. Catches have either exceeded, or are close to, the trigger levels. The current level of fishing is therefore considered to be not acceptable. A stock assessment review of the fishery is in progress.

New management initiatives (2006/07)

The zoning arrangements for the fishery need to be incorporated into the management plan.

External Factors

The impacts of environmental variation on the fishery are not considered to be large. There are no data to indicate significant variation in recruitment amongst years for either of the 2 key species.

Fishers within the fishery are concerned about the increasing numbers of charter vessels operating in the offshore waters of the NDSF, which could generate resource-sharing issues in the future.

The level of catch in the NDSF is controlled through a complex time-gear unit management system. Any additional level of catch from this fishery may adversely impact on the stock assessment models for this fishery and thus future effort allocations.

NORTHERN DEMERSAL SCALEFISH TABLE 1

Recent annual catches of major target and by-product species or species groups by the NDSF.

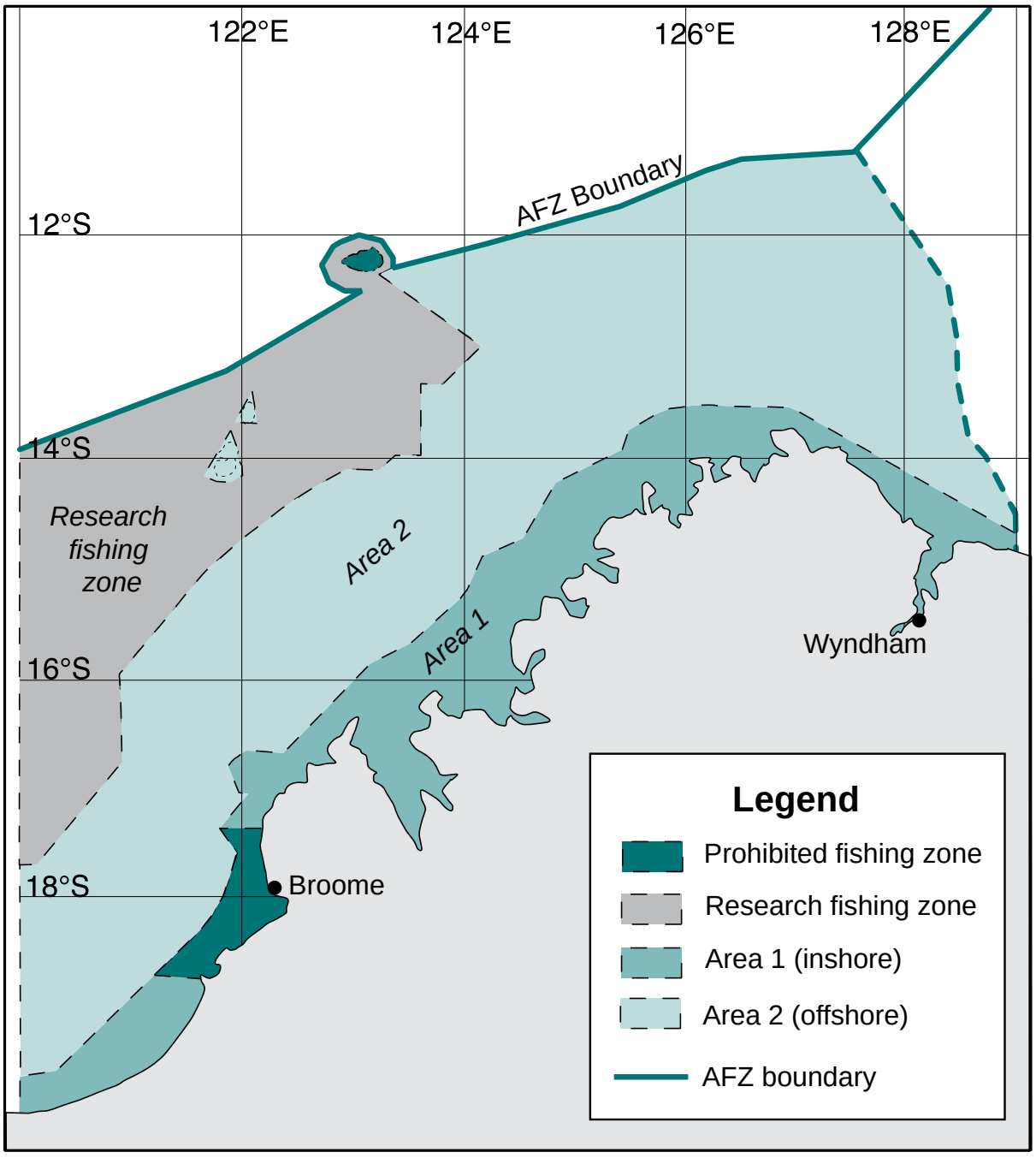
Species	NDSF annual catch (tonnes)				
	2002	2003	2004	2005	2006
Goldband snapper (*Pristipomoides* spp.)	152	226	283	429	336
Red emperor (*Lutjanus sebae*)	101	118	144	192	166
Scarlet perch (*Lutjanus malabaricus*)	61	48	68	92	79
Spangled emperor (*Lethrinus nebulosus*)	35	39	33	21	28
Cod/grouper (Serranidae)	49	74	103	110	129
Other species	36	47	59	78	63
Total demersal scalefish catch	**434**	**552**	**690**	**922**	**801**

NORTHERN DEMERSAL SCALEFISH TABLE 2

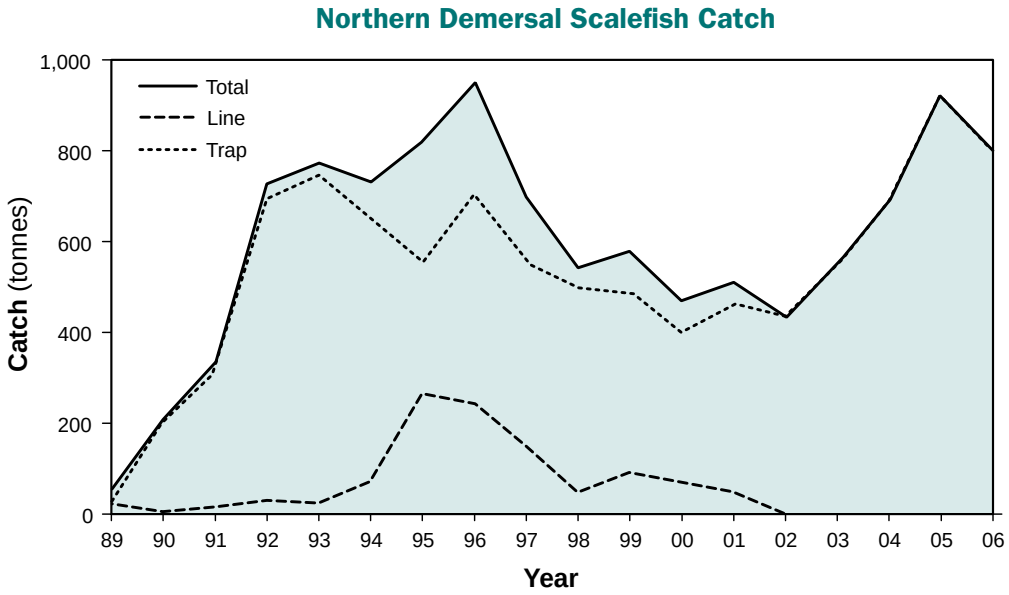
Total catches (tonnes) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

Year	Total allowable effort (days)	Line catch (t)	Line catch (days)	Trap effort (t)	Trap catch (days)	Total (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	690	1,300	690
2005	1,760	0	0	922	1,318	922
2006	**1,144**	**0**	**0**	**801**	**1,193**	**801**

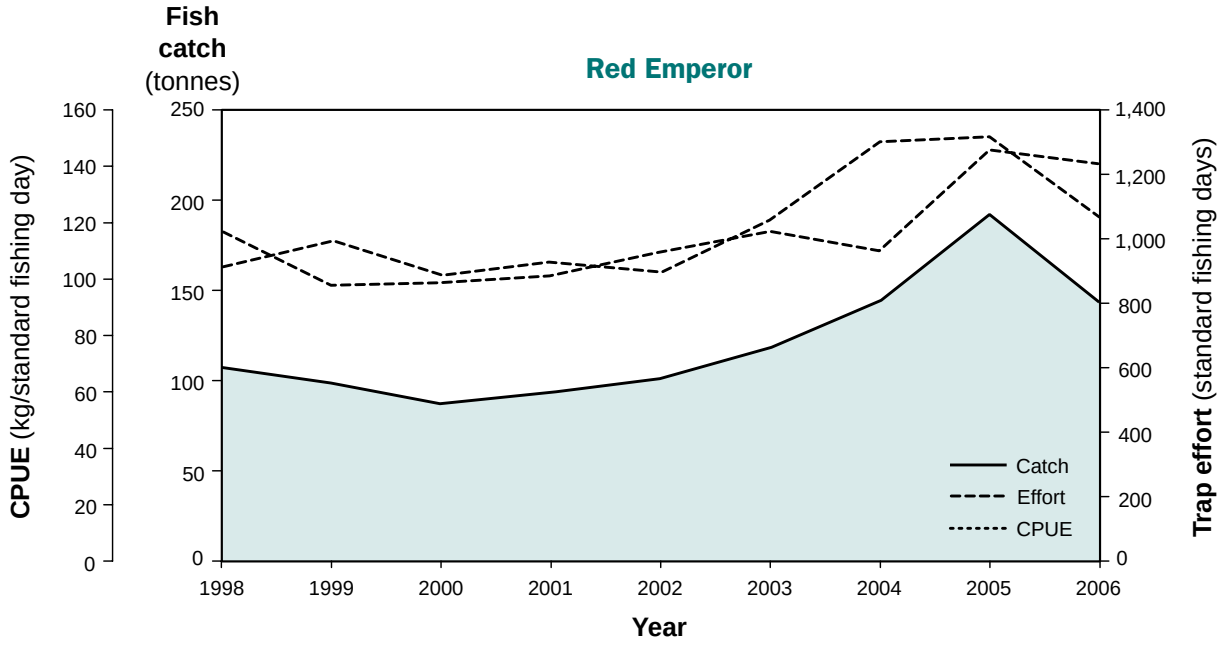
(Estimated Catch: Zone A = 60 t, Zone B = 741 t; Estimated Effort: Zone A = 127 SFDs, Zone B = 1,066 SFDs)



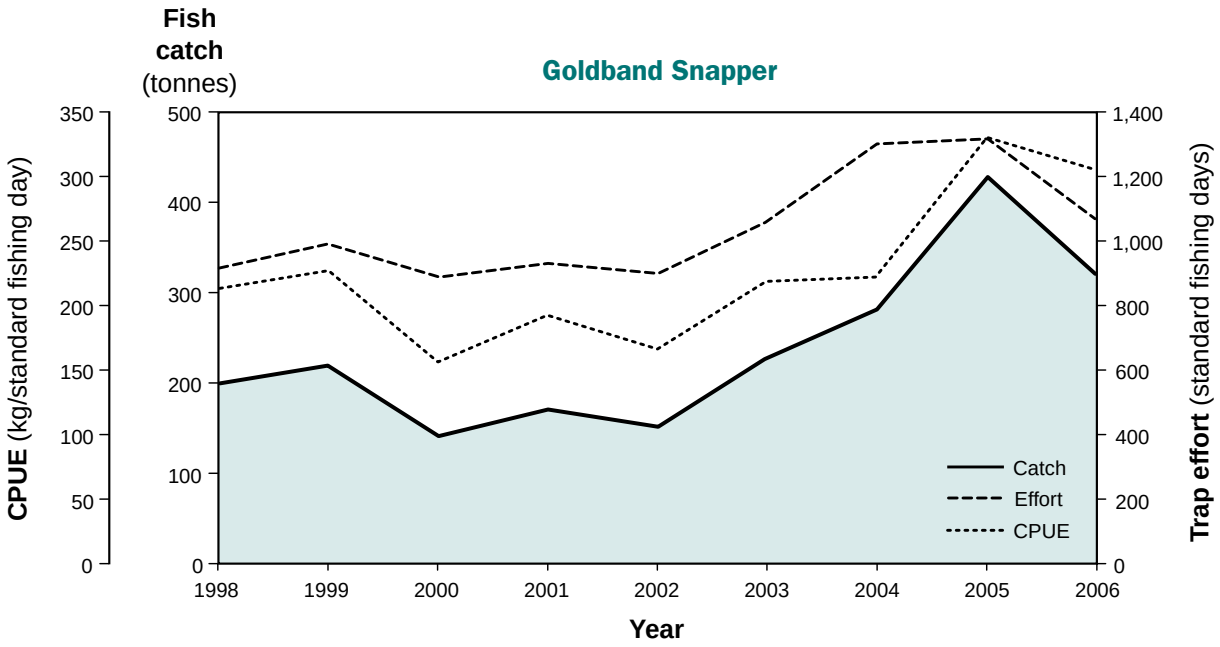
NORTHERN DEMERSAL SCALEFISH FIGURE 1
Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



NORTHERN DEMERSAL SCALEFISH FIGURE 2
Catch levels of demersal finfish in the NDSF by line and trap, 1989 – 2006.



NORTHERN DEMERSAL SCALEFISH FIGURE 3
Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998 – 2006.



NORTHERN DEMERSAL SCALEFISH FIGURE 4
Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998 – 2006.

Pilbara Demersal Finfish Fisheries Status Report

P. Stephenson and S.J. Newman
Management input by R. Green

Fishery Description

The landed catch by operators in the Pilbara Fish Trawl (Interim) Managed Fishery dominates the demersal finfish landed from the commercial fisheries in the Pilbara region, with a lesser quantity taken by the Pilbara Trap Managed Fishery. In addition, a limited number of line operators take demersal scalefish with a fishing boat licence, entitling them to unrestricted access across the fishery.

The trawl fishery targets 10 main species, namely bluespot emperor (*Lethrinus* sp), threadfin bream (Nemipteridae), flagfish (*Lutjanus vitta*), crimson snapper (previously known as red snapper) (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), saddletail snapper (previously scarlet perch) (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frypan snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

The main catch in the trap fishery comprises 6 of these same species – bluespot emperor, spangled emperor, red emperor, Rankin cod, crimson snapper and goldband snapper.

Governing legislation/fishing authority

Commercial

Pilbara Trap Limited Entry Fishery Notice 1992
Offshore Constitutional Settlement 1995, amendment 1998
Prohibition on Commercial Fishing for Demersal Scalefish (Pilbara Area) Order 1997
Pilbara Fish Trawl Fishery (Interim) Management Plan 1997
Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order)

Recreational

Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry for the fish trawl and trap fisheries

Recreational

Recreational Fishing Advisory Committee (RFAC)
Pilbara Regional Recreational Fishing Advisory Committee (Karratha)

Boundaries

The boundaries of the Pilbara Fish Trawl (Interim) Managed Fishery are the waters lying north of latitude 21°35′ S and between longitudes 114°9′36″ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 50 m isobath (Pilbara Figure 1).

The trawl fishery consists of 2 zones. Zone 1, in the west of the fishery, is currently not being trawled. In Zone 2, the interim management plan introduced in 1998 set down boundaries for 6 management sub-areas. The exact latitudes and longitudes delineating the areas are listed in the Pilbara Fish Trawl Fishery (Interim) Management Plan 1997.

The Pilbara Trap Managed Fishery (Pilbara Figure 1) lies north of latitude 21°44′ S and between longitudes 114°9′36″ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath. The exact latitudes and longitudes delineating the fishery are listed in the Pilbara Trap Management Plan 1992 as amended in 2000.

Management arrangements

The fish trawl and trap fisheries are both managed primarily by the use of input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel monitoring system (VMS).

The trawl fishery came into a formal management framework in 1998, with effort levels determined (Fisheries Research and Development Corporation (FRDC) project 93/125) to achieve the best yield from the fishery while keeping exploitation rates of the key indicator species (red emperor and Rankin cod) at sustainable levels.

This involved a number of areas being closed to trawling, namely Zone 1, Area 3, Area 6, and the area inshore of the 50 m depth isobath. Since then, effort has been reduced and redistributed on the basis of annual assessments of the main target species and age-structured modelling of red emperor, Rankin cod and bluespot emperor.

There are 11 licence units with varying time allocations throughout the various areas, with the allocation being used by the equivalent of 4 full-time vessels.

The Individually Transferable Effort (ITE) management arrangements introduced into the trap fishery in January 2000 dealt with the issue of latent effort in the fishery and proved effective at holding the fishery within its acceptable 300 t limit. However, the ability of the fishery to target long-lived species like red emperor may require limits on the catch of specific species in the future. There are 6 licences in the fishery, with the allocation used by 3 vessels in 2005.

Plans for future management of line fishing in the Pilbara are being considered through the state-wide wetline fishing review. As an interim measure, the number of line boats allowed to fish in the Pilbara has been restricted (*Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*).

Comprehensive Ecologically Sustainable Development (ESD) assessments were submitted in 2004, namely "Application to the Department of Environment and Heritage (DEH) on the Pilbara Fish Trawl Interim Managed Fishery" and "Application to the Department of Environment and Heritage (DEH) on the Pilbara Trap Managed Fishery".

These ESD assessments determined that performance should be assessed annually for breeding stock levels, protected species interactions and habitat effects. As a result, the Pilbara Trap Fishery was declared an approved Wildlife Trade Operation in November 2004 for a period of 3 years.

The Pilbara Fish Trawl Interim Managed Fishery is an approved Wildlife Trade Operation through several extensions until August 2007 provided that a bycatch action plan is developed, there is an observer program, and steps are taken to mitigate catches of protected species.

Research summary

The monitoring of the Pilbara fishery consists of the collection of spatial data on effort and catch of 10 major target species in the trawl and trap fisheries from log books, VMS pollings, and weighed catches from unload data. Otoliths (ear stones) are collected each year for 1 of the indicator species (which are red emperor, Rankin cod, bluespot emperor, and goldband snapper).

The status of the Pilbara stocks is determined annually using catch and catch rates of the 10 major species, and every 3 to 4 years using an age-structured model and the age-composition data collected in the previous year.

An FRDC-funded bycatch mitigation project determined that acoustic pingers were not effective in reducing accidental catches of dolphins. However, a semi-flexible separation grid appeared promising in reducing the accidental capture of dolphins, turtles, and large sharks and rays.

Retained Species

Commercial landings (season 2006): Trawl 2,222 tonnes
Trap 473 tonnes
Line 105 tonnes

Catches of the major species for 2006 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2005 are shown in Pilbara Table 2 and illustrated in Pilbara Figure 2. Demersal scalefish catch by fish trawl, trap and line were 2,222 t, 473 t and 105 t respectively.

The trawl catch decreased slightly in 2006 and is now within the target range. The decrease is due to a decreased catch of the smaller short-lived species.

The major target species landed in 2006 (2005 catch in brackets) were bluespot emperor 435 t (451 t), threadfin bream 257 t (236 t), flagfish 153 t (192 t), crimson snapper 240 t (328 t), red emperor 92 t (96 t), saddletail snapper 62 t (72 t), goldband snapper 81 t (78 t), spangled emperor 27 t (26 t) and Rankin cod 46 t (34 t). The total retained by-product was 46 t (80 t) including shark, bugs, cuttlefish and squid.

The ESD performance indicator based on landed catch was triggered for Rankin cod, crimson snapper, goldband snapper and saddletail snapper in 2006.

The trap fishery catch increased to 473 t in 2006 from 408 t in 2005. Major species taken by the trap fishery in 2006 (2005 figures in brackets) were bluespot emperor 68 t (76 t), red emperor 85 t (90 t), Rankin cod 89 t (48 t), crimson snapper 47 t (39 t) spangled emperor 37 t (24 t) and goldband snapper 29 t (51 t).

The trap catch was again outside the target catch range, due to increased catches of Rankin cod and spangled emperor. The ESD catch-based performance indicator was triggered in 2006 for Rankin cod, crimson snapper, goldband snapper and saddletail snapper by the catch exceeding the 4-year average by 120%, 21%, 49% and 95% respectively. There is no by-product in this component of the fishery.

Demersal scalefish catches taken by line fishing decreased in 2006, with a total catch of 105 t compared to 260 t in 2005. The catches in 2006 (2005 figures in brackets) were mainly goldband snapper 22 t (97 t), red emperor 5 t (9 t), saddletail snapper 6 t (16 t), spangled emperor 10 t (19 t) and Rankin cod 6 t (7 t). The decrease in the catches of several species is due to implementation of measures to reduce the number of licences and restricting the length of the fishing season. The Pilbara shark catch is reported in the Northern Shark Fisheries Status Report, elsewhere in this volume.

Recreational catch: **< 2%**

While there is a major recreational fishery in the Pilbara and the charter sector is an increasing user of the resource, the inshore closures to the commercial sector provide a high degree of separation between the user groups. These 2 groups do not catch significant quantities of most species targeted by the commercial Pilbara fish trawl, trap and line fisheries.

Fishing effort/access level

The fishing effort in the trap, line and trawl sectors of the commercial fishery is shown in Pilbara Table 3. The source of effort in days is the monthly catch and effort returns. However, for the trawl fishery the effort from 1991 to 2006 is also recorded as the net bottom time (hours) taken from skippers' voluntary log book data, validated by VMS data.

In the trawl fleet, there is the equivalent of 4 full-time vessels. The number of hours allocated to the fleet in each area of the fishery, the number of hours used (verified by VMS), and the percentage of the allocation used over the period 1998 – 2006 are shown in Pilbara Table 4. The effort allocation is for a financial year (July 1 to June 30) but the effort is reported here in calendar years. Trawling was not allowed in either Area 3 or Area 6 during 2006.

The number of trap days allocated, the number of days used and the percentage of the allocation used for the period 2000 – 2006 are shown in Pilbara Table 5. In 2006, the 3 trap boats were allocated 5,867 trap units (days multiplied by number of traps), with the number of these units used calculated from VMS being 5,867 (100%). This number of units equates to 464 days fished with an average of 12.6 traps per day – the same as last year.

In 2006, line fishers reported operating for 397 days, compared with 985 days in 2005. This effort does not include trolling, which is reported in the Mackerel Fishery Status Report, nor the dropline and longline effort in the Northern Shark Fisheries (see elsewhere in this report).

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

There has been a small decrease in the trawl catch rates of 5 species, including the long-lived species of spangled emperor, red emperor and saddletail snapper. This decrease did not occur in the trap fishery and no action is required at this time.

Although the catch of Rankin cod increased again, otoliths collected in 2006 showed a marked improvement in the age-composition compared to that in 1998 (Pilbara Figure 6) with considerable numbers of old fish building-up in the population, a sign that the stock is probably not being over-exploited.

The goldband snapper catch was reduced to 60% of that in 2005, due to line fishing effort being reduced.

The major performance measures for the fish stocks in the Pilbara demersal fisheries relate to breeding stock levels of the long-lived and short-lived finfish indicator species.

The target level of spawning biomass is 40% of the initial level when the catch was first recorded. The limit level is 30% of the initial spawning biomass.

The spawning biomass levels of the target species were assessed as adequate in 2002 by synthesizing the available data in an age-structured model.

The age-structured model assessment for red emperor and Rankin cod will be updated in 2007.

Non-Retained Species

Bycatch species impact: **Moderate**

The observer program and the FRDC bycatch mitigation project confirmed the level of scalefish bycatch in the trawl fishery at about 30%, similar to that reported in Stephenson and Chidlow (2003). The trap and line fisheries have minimal bycatch.

Protected species interaction: **Moderate**

The trawl fishery has an incidental capture of dolphins, turtles, sea snakes, pipefish and seahorses. Turtles and sea snakes are generally returned to the water alive, but dolphins, pipefish and seahorses are generally dead when landed.

The catch of these species is recorded in skippers' log books and reported every 6 months to the Australian Government's Department of Environment and Water. The 2006 reported catch of protected species is shown in Table 6.

Given the area of distribution and expected population size of these protected species, the impact of the trawl fishery on the stocks of these protected species is probably minimal. There is a small catch of green sawfish, a species that is protected in WA waters.

An FRDC-funded project to evaluate methods of reducing bycatch found that acoustic pingers were not effective in reducing the dolphin numbers in the trawl net, but that a semi-flexible separation grid appeared to reduce the capture of dolphins, turtles and sharks and rays.

There is no indication of interactions between the line fishery and protected species. Similarly, the trap fishery has a negligible impact on protected species.

The performance measures for the impact of the trawl fishery on protected species: skippers are required to record incidents of capture and to minimise mortality. In 2006, the dolphin mortality recorded was about half the limit set and the turtle catch was acceptable at one-tenth of the limit set. Sygnathid, sawfish, and seasnake catches were all below their maximum levels and therefore their catch level is considered acceptable (Pilbara Table 6).

Ecosystem Effects

Food chain effects: **Low**

The current fish trawl fishery operates with standard stern trawling gear (single net with extension sweeps) within an area previously trawled by a Taiwanese fleet. Historical research by the CSIRO has suggested that the extensive Taiwanese pair trawl fishery caused a significant decrease in the biomass of finfish on the North West Shelf, and a change in species composition towards smaller species.

The current Australian trawl fishery, which developed when the fish stocks had somewhat recovered, uses a much larger mesh size and much lighter ground gear, and operates at lower exploitation rates. At the present levels of trawl, trap, and line effort, the effect of the fishery on the food chain of the North West Shelf is considered to be at an acceptable level.

Habitat effects: **Moderate**

Impacts to the habitat are restricted to those of the trawl fishery, which is restricted to around 7% of the North West Shelf (Pilbara Figure 1). Area 3 and the waters inside 50 m are permanently closed to trawling, Zone 1 is currently closed to trawling, and Area 6 has had no trawl effort allocation since 2000.

Within the areas actually trawled, past research has indicated that approximately 10% of the sessile benthic fauna (e.g. sponges) is detached per year, with higher rates in Area 1 where the effort is concentrated. It is not known whether the detachment rate exceeds the rate of re-growth.

The performance measure for the trawl impact on the North West Shelf ecosystem was set as a maximum area of operation by the trawlers. With the current closures within the licensed area of the fishery (50 m to 200 m depth), 46% of the area is accessible to the trawl vessels. The actual area being trawled is less than this as some of this area is too rough for trawling.

Social Effects

It is estimated that 22 fishers on 4 vessels were directly employed during 2006 in the Pilbara fish trawl fishery, and 10 fishers on 3 vessels in the trap fishery. The level of employment in the line-fishing sector is not available.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$10.5 million**

This estimate is based on the landed weight and price of each species as supplied by fish processors.

There has been little overall increase in fish prices in the last 2 years. The fish trawl demersal finfish catch is dominated by lower-valued species such as bluespot emperor and threadfin bream, and its value in 2006 was $7.5 million. The trap and line catches are dominated by the valuable species such as red emperor and goldband snapper, and the demersal scalefish catch from these sectors was valued at approximately $2.5 million (trap) and $0.5 million (line).

Important components of the line catch are shark and Spanish mackerel, which have not been included in the value of the line fishery, but are recorded in the Northern Shark Fisheries Status Report and the Mackerel Fishery Status Report elsewhere in this volume. The fish trawl fishery also has a retained by-product valued at $0.2 million.

The catches from the Pilbara fisheries dominate the Western Australian metropolitan markets and support the local fish-processing sector. The exports from this fishery have been minimal due to the increased value of the Australian dollar.

Fishery Governance

Target catch range: **Trawl 2,000 – 2,800 tonnes**
Trap 160 – 360 tonnes
Line 50 – 115 tonnes

In the fish trawl fishery, the catch was within the target catch range. In the trap fishery, the catch is again above the upper limit of the target range, with the major increase being for Rankin cod.

Adjustment to the allocated effort in the trawl and trap sectors may be necessary to compensate for significant efficiency increases. The line catch is now within the acceptable catch range.

Current fishing (or effort) level: **Acceptable**

The reduction in the effort allocated in 2006 translated into a level of catch equivalent to the notional TAC, with very little unused effort. In combination with the adequate level of breeding stock for the indicator species, the current level of effort is considered to be acceptable. A stock assessment review of the fishery is in progress.

New management initiatives (2006/07)

In the Pilbara Trawl Interim Managed Fishery, outcomes of the research conducted into catches of protected species may need to be incorporated into future management arrangements. The interim management plan is due to expire in June 2009.

It is expected that an interim management plan for the Pilbara line fishery will be developed in consultation with stakeholders in 2007.

External Factors

The area available for fishers has decreased over recent years as a result of exclusion zones for gas pipelines and associated facilities. Seismic surveys also restrict the operation of fishers. However, neither of these operations is expected to significantly affect fish stocks or catches.

PILBARA TABLE 1

Commercial catches (to the nearest tonne) and the percentages (to the nearest 1%) of each major species taken by trawl, trap and line in the Pilbara in 2006.

Species		Trawl catch		Trap catch		Line catch		Total catch
		tonnes	%	tonnes	%	tonnes	%	tonnes
Bluespot emperor	*Lethrinus hutchinsi*	435	86%	68	14%	–	–	503
Crimson snapper	*Lutjanus erythropterus*	240	82%	47	16%	7	2%	294
Threadfin bream	Nemipteridae	257	100%	1	–	–	–	258
Flagfish	*Lutjanus vitta*	153	92%	13	8%	–	–	166
Goldband snapper	*Pristipomoides multidens*	81	61%	29	22%	22	17%	132
Red emperor	*Lutjanus sebae*	92	50%	85	47%	5	3%	182
Saddletail snapper	*Lutjanus malabaricus*	62	67%	24	26%	6	7%	92
Spangled emperor	*Lethrinus nebulosus*	27	36%	37	50%	10	14%	74
Frypan snapper	*Argyrops spinifer*	54	96%	2	4%	–	–	56
Rankin cod	*Epinephelus multinotatus*	46	33%	89	63%	6	4%	141
Other demersal scalefish		775	86%	78	9%	49	5%	902
All demersal scalefish		**2,222**	**79%**	**473**	**17%**	**105**	**4%**	**2,800**

PILBARA TABLE 2

Summary of reported commercial catches (tonnes) of demersal scalefish by line, trap and trawl in the Pilbara fishery, as well as by–product from the fish trawl fishery.

YEAR	DEMERSAL SCALEFISH				BY-PRODUCT*
	Line	Trap	Trawl	Total	Trawl*
1985	180	168	–	348	–
1986	65	113	–	178	–
1987	67	192	3	262	–
1988	136	243	3	382	–
1989	104	457	124	685	–
1990	157	407	421	985	4
1991	107	119	754	980	14
1992	63	148	1,413	1,624	21
1993	67	178	1,724	1,969	42
1994	79	207	2,506	2,792	102
1995	95	222	2,821	3,138	77
1996	136	302	3,201	3,639	102
1997	109	234	2,630	2,973	133
1998	78	250	2,512	2,840	119
1999	50	371	2,136	2,419	69
2000	59	257	1,995	2,314	80
2001	99	266	2,221	2,592	150
2002	90	306	2,310	2,706	180
2003	81	363	2,860	3,304	154
2004	240#	395	2,837	3,449	113
2005	260#	408	2,371	3,005	80
2006	105	473	2,222	2,800	46

* By-product consists of shark, cuttlefish, rays, bugs and tropical lobster.

Adjusted in 2006

PILBARA TABLE 3

Summary of the fishing effort in the Pilbara demersal scalefish fishery. The trap, line and trawl effort (days) is from monthly catch and effort returns. The trawl effort (hours) is nominal effort from operators' log book data.

Year	Line (days)	Trap (days)	Trawl (days)	Trawl (hours)
1985	809	709	–	–
1986	655	548	19	–
1987	614	507	17	–
1988	985	804	32	–
1989	863	1,198	310	–
1990	1,332	1,321	698	–
1991	740	472	1,132	8,660
1992	514	681	983	10,030
1993	876	696	832	10,725
1994	732	545	1,484	22,087
1995	852	608	1,571	21,529
1996	814	513	1,550	25,246
1997	809	483	1,389	19,810
1998	692	503	1,291	20,555
1999	453	842	1,139	15,963
2000	500	518	957	14,084
2001	401	446	1,162	15,330
2002	660	418	1,035	14,830
2003	715	412	1,014	14,663
2004	769	418	953	15,372
2005	985	431	886	14,721
2006	**397**	**464**	**914**	**15,792**

PILBARA TABLE 4

The number of hours allocated, the nominal number of hours used and the percentage of the allocation used in each area of the Pilbara trawl fishery.

		Area 1	Area 2	Area 3	Area 4	Area 5	Total
1998	time allocation	17,136	3,360	0	3,360	5,712	29,568
TRAWL	time used	15,076	3,842	0	3,736	4,955	27,609
	% of time used	88%	114%	–	111%	87%	93%
1999	time allocation	11,481	3,360	0	3,057	5,198	23,096
TRAWL	time used	10,237	3,767	0	3,213	4,973	22,190
	% of time used	89%	112%	–	105%	96%	96%
2000	time allocation	11,481	3,360	0	3,057	5,198	23,096
TRAWL	time used	9,438	3,928	0	3,358	4,476	21,199
	% of time used	82%	117%	–	110%	86%	92%
2001	time allocation	10,624	3,797	0	3,528	5,141	23,090
TRAWL	time used	10,428	4,091	0	3,644	4,819	23,000
	% of time used	98%	108%	–	103%	94%	100%
2002	time allocation	10,624	3,797	0	3,528	5,141	23,090
TRAWL	time used	9,040	3,848	0	3,624	4,213	20,544
	% of time used	85%	101%	–	103%	82%	90%
2003	time allocation	9,596	3,797	0	3,528	4,627	21,548
TRAWL	time used	9,562	4,303	0	3,299	2,995	20,159
	% of time used	100%	113%	–	94%	65%	94%
2004	time allocation	9,596	3,797	0	3,528	4,627	21,548
TRAWL	time used	8,802	4,159	0	4,101	4,341	21,404
	% of time used	92%	110%	–	116%	94%	99%
2005	time allocation	9,596	3,797	0	3,528	4,627	21,548
TRAWL	time used	9,328	4,367	0	3,144	3,595	20,439
	% of time used	97%	115%	–	89%	78%	95%
2006	**time allocation**	**9,596**	**3,797**	**0**	**3,528**	**4,627**	**21,548**
TRAWL	**time used**	**9,378**	**3,940**	**0**	**3,999**	**4,507**	**21,824**
	% of time used	**98%**	**104%**	**–**	**113%**	**97%**	**101%**

PILBARA TABLE 5

The number of days allocated, the nominal number of days used and the percentage of the allocation used in the Pilbara trap fishery.

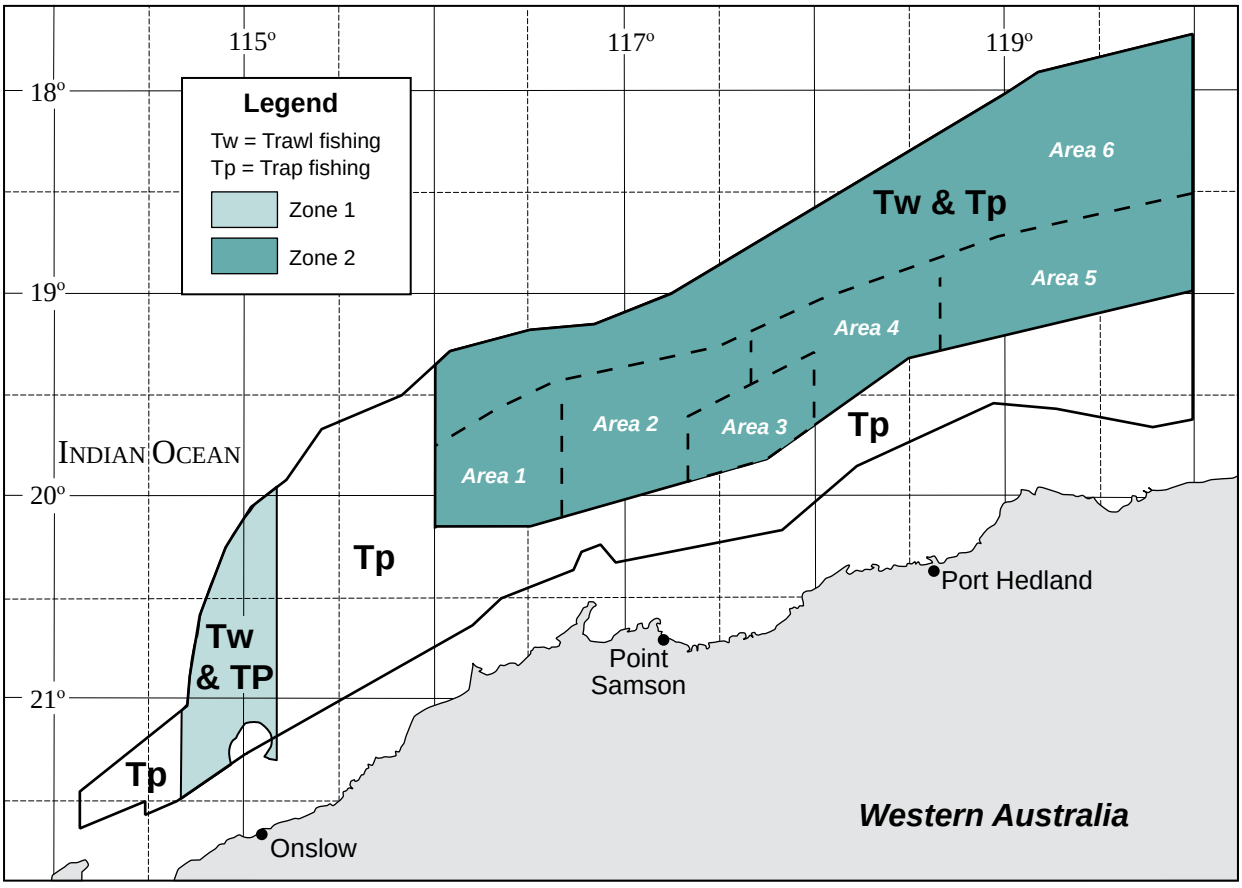
2000	time allocation	524
TRAP	time used	507
	% of time used	97%
2001	time allocation	420
TRAP	time used	414
	% of time used	99%
2002	time allocation	385
TRAP	time used	382
	% of time used	99%
2003	time allocation	399
TRAP	time used	389
	% of time used	98%
2004	time allocation	425
TRAP	time used	419
	% of time used	99%
2005	time allocation	429
TRAP	time used	403
	% of time used	94%
2006*	**time allocation**	**464**
TRAP	**time used**	**464**
	% of time used	**100%**

PILBARA TABLE 6

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2005.

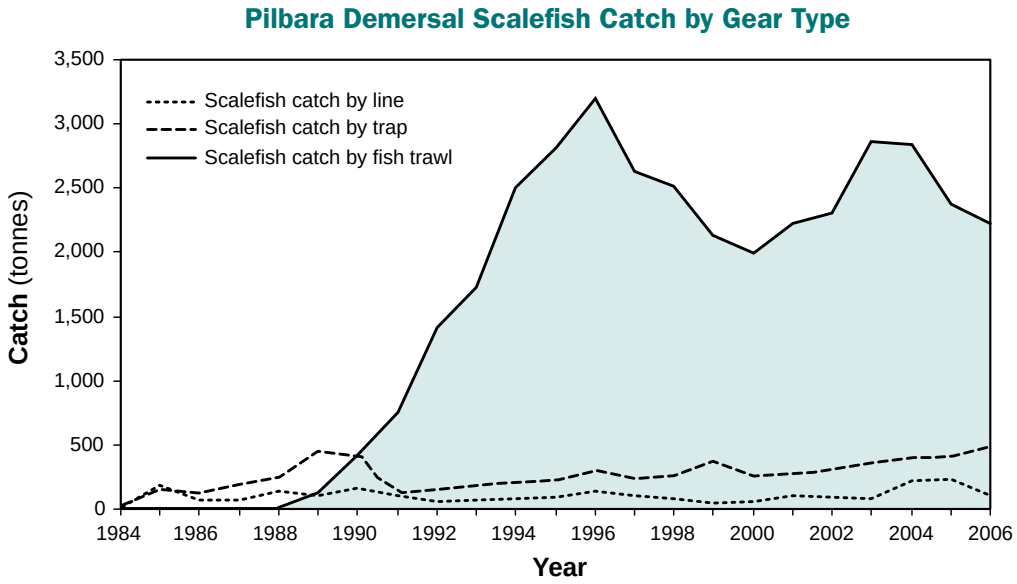
	Number Alive	Number Deceased*	Total Reported
dolphins	3	31	34
pipefish	35	134	169
sawfish, green	19	7	26
sawfish, narrow	10	6	16
seahorses	3	3	6
sea-snakes	141	23	164
turtles, green	10	1	11
turtles, loggerhead	4	0	4
turtles, olive ridley	1	1	2
Total protected species	**226**	**206**	**432**

*Where the condition was not reported, the animal was considered as deceased.

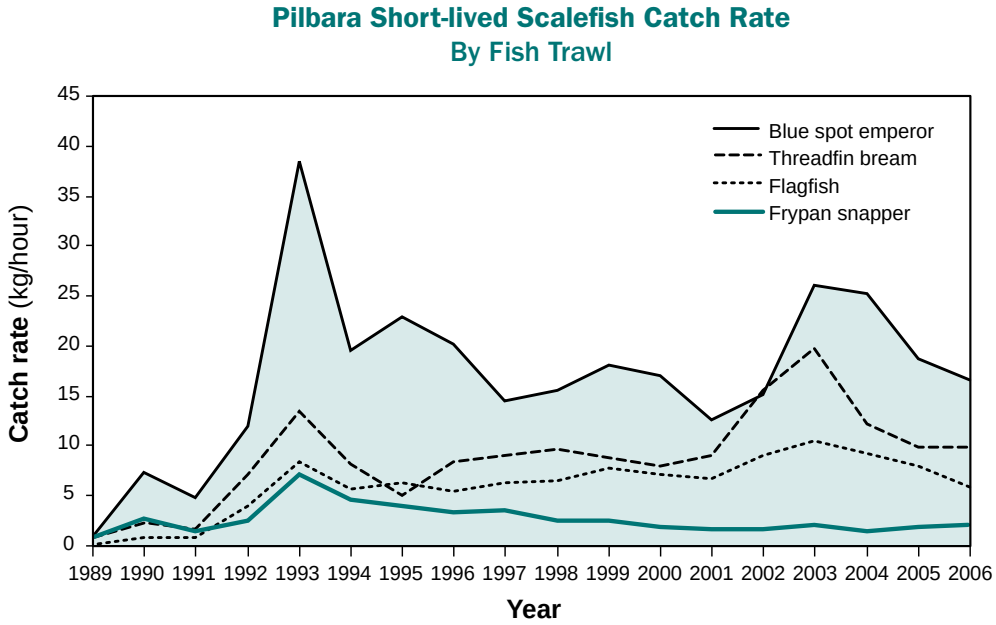


PILBARA FIGURE 1

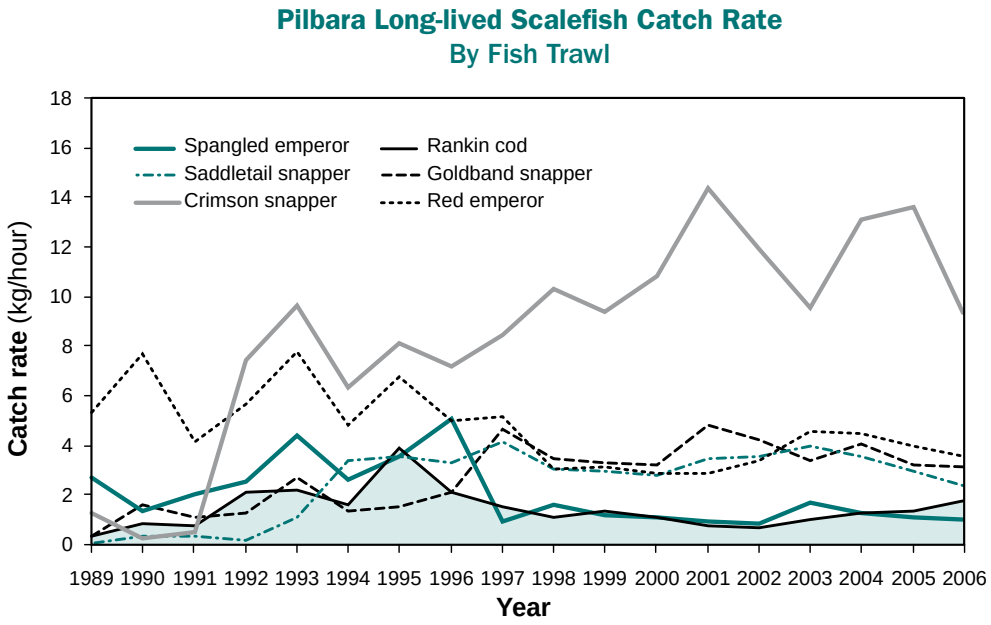
Demersal scalefish fisheries of the Pilbara region of Western Australia. Areas 1 to 6 refer to the management regions in Zone 2 of the trawl fishery. Zone 1 has been closed to trawling since 1998.



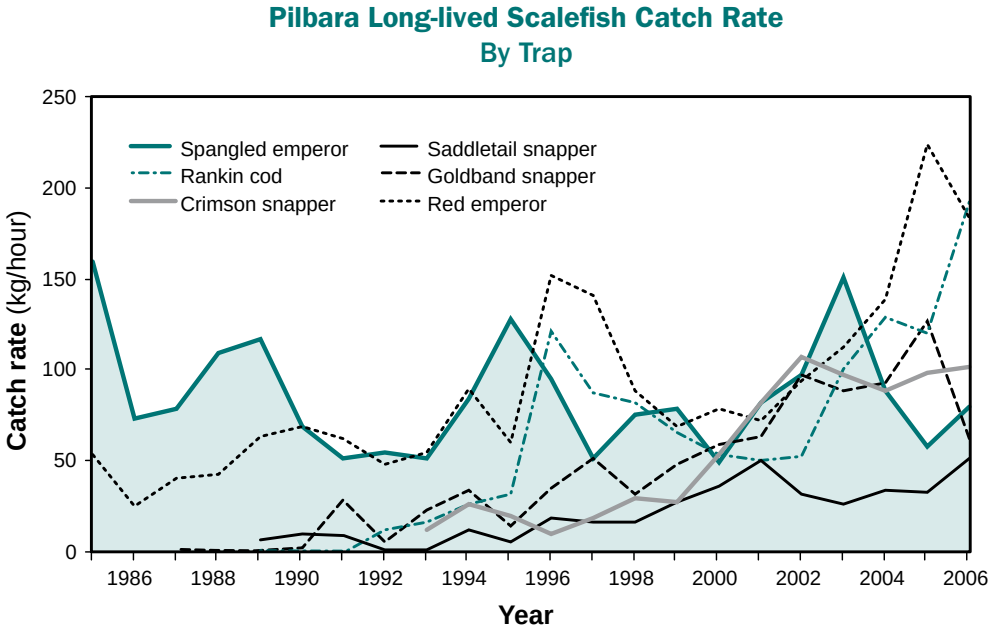
PILBARA FIGURE 2
Demersal scalefish catches by trawl, trap, and line from 1984 to 2006.



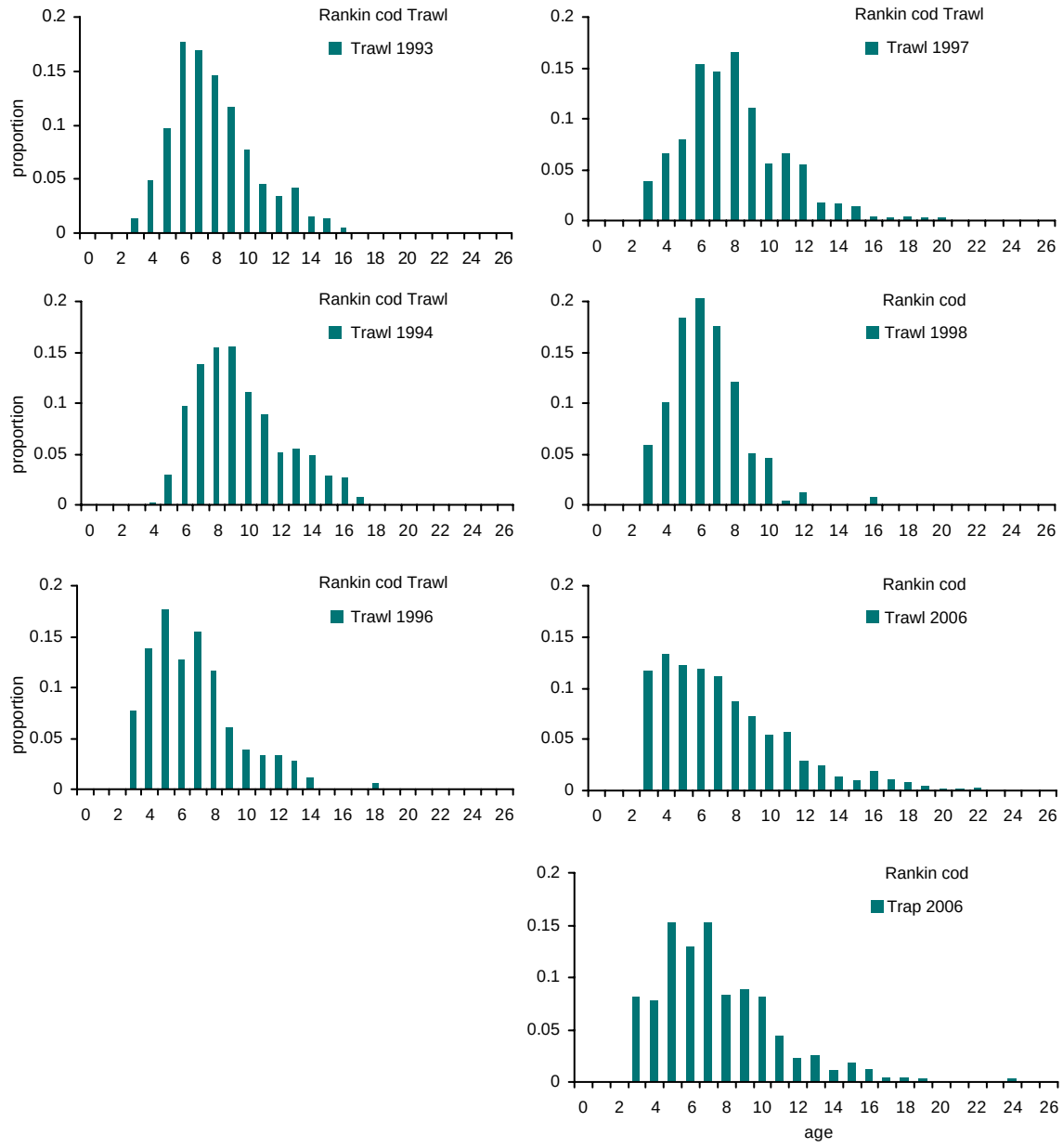
PILBARA FIGURE 3
Catch rates (kg/hour) of short-lived scalefish caught by trawl from 1989 to 2006.



PILBARA FIGURE 4
Catch rates (kg/hour) of long-lived scalefish caught by trawl from 1989 to 2006.



PILBARA FIGURE 5
Catch rates (kg/day) of long-lived scalefish caught by trap from 1985 to 2006.



PILBARA FIGURE 6
Catch rates (kg/day) of long-lived scalefish caught by trap from 1985 to 2006. Age-composition samples for Rankin cod from 1993 to 1998 from the trawl fishery and in 2006 from the trawl and trap fishery.

Mackerel Managed Fishery Status Report

M. Mackie
Management input from P. Readhead

Fishery Description

The commercial mackerel fishery includes the taking of all species of the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium*, but the main targeted species is Spanish mackerel (*Scomberomorus commerson*).

Mackerel are usually taken by trolling close to the surface in coastal areas around reefs, shoals and headlands, with jigs also used to capture grey mackerel (*Scomberomorus semifasciatus*). Recreational fishers also use methods such as shore-based drift fishing (with balloons) and spear guns to target mackerel. The commercial fishery mainly operates between Geraldton and the Western Australia/Northern Territory border, with the largest catches taken off the Kimberley and Pilbara coasts. The main area of the recreational fishery is Perth to Dampier.

Governing legislation/fishing authority

Commercial

Mackerel (Interim) Managed Fishery Management Plan 2004
Mackerel (Interim) Managed Fishery License
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational

Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)
Regional Recreational Fishing Advisory Committees

Boundaries

Catches are reported for 4 areas: Kimberley (121º E to WA/NT border), Pilbara (114º E to 121º E), Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S). The managed fishery is comprised of Area 1 (Kimberley), Area 2 (Pilbara) and Area 3 (combined Gascoyne and West Coast).

Management arrangements

The fishery is subject to an interim management plan, which commenced in August 2004 and currently includes limitations on the number of permits authorising a person to fish in the fishery and the type of gear that can be used, as well as a closed season. The full suite of management controls described in the *Mackerel Fishery (Interim) Management Plan 2004* was implemented during 2006. However, modifications to management arrangement are likely during 2007.

Permit holders may only fish for mackerel by trolling or handline. The initial number of permits issued was 19, 16 and 18 for Zones 1, 2 and 3 (respectively), of which 6, 7 and 6 (respectively) had the required amount of individual transferable quota to operate in the fishery. In 2006 the number of participants in the fishery was 6, 7 and 5 in Zones 1, 2 and 3 (respectively), with some transfer of quota occurring amongst stakeholders.

During 2006, commercial fishing for mackerel was prohibited between 16 December and 14 May in the Kimberley area, 13 November and 14 March in the Pilbara area, and 1 October and 28 February in the Gascoyne – West Coast area.

A comprehensive Ecologically Sustainable Development assessment of this fishery determined that levels of Spanish mackerel breeding stock should be used as an annual performance measure for the fishery. This assessment of annual performance is provided within boxed text in this status report.

Research summary

2 mackerel-related research projects funded by the Fisheries Research and Development Corporation (FRDC) were completed in 2002. Both projects ran for 3 years and focused on the narrow-barred Spanish mackerel, *Scomberomorus commerson*, which is the main target species in the Western Australian mackerel fishery.

Together, these projects have provided a description of the biology, spatial structure and status of Spanish mackerel stocks in Western Australian waters, and serve as a basis for management arrangements to control future catches from the fishery. This status report for the mackerel fishery is therefore based on analyses of Spanish mackerel catch and effort.

Retained Species

Commercial landings (season 2006):

Spanish mackerel 261 tonnes
Grey mackerel 17 tonnes
Other mackerel 13 tonnes

Spanish mackerel (*Scomberomorus commerson*) is the main target species in the fishery and may comprise more than 90% of the catch. Grey or broad-barred mackerel (*S. semifasciatus*) is the dominant secondary target, particularly in the Gascoyne and West Coast areas where it is sometimes captured in large numbers.

Other secondary target species of the trolling operation for Spanish mackerel include spotted mackerel (*S. munroi*) and shark mackerel (*Grammatorcynus bicarinatus*), wahoo (*Acanthocybium solandri*), cobia (*Rachycentron canadum*), tunas, smaller sharks and the occasional reef fish, such as spangled emperor and coral trout.

The reported catch of 261.3 t of Spanish mackerel in 2006 comprised 177.9 t from the Kimberley area, 48.2 t from the Pilbara area, 21.7 t from the Gascoyne area and 13.5 t from the West Coast area (Spanish Mackerel Figure 1 and Table 1). The catch of other mackerel species in 2006 was 30.2 t, including 17.4 t of grey mackerel.

Historic trends in commercial catches were detailed in the *State of the Fisheries Report 2000 – 2001.* Overall, catches of Spanish mackerel have increased through time, particularly in the Kimberley and Pilbara areas. In 2005 catches in both areas dropped substantially as a result of the new management arrangements and the fact that some quota were held by fishers who did not participate in the fishery.

In the Kimberley area, the catch of Spanish mackerel of 178 t in 2006 was just 4.5 t more than the amount caught in 2005. However, the 2006 catch of Spanish mackerel in the Pilbara area (48 t) was only about half that of the previous year. Discussion with fishers indicates that this was due to poor weather and a decline in effort and catch per unit effort. Catches in the Gascoyne and West Coast areas were similar to those in 2005 (22 and 14 t, respectively).

Historic catches of other species of mackerel (grey, spotted, shark and school mackerel) are likely to include quantities of Spanish mackerel that were reported only as 'mackerel' by fishers. However, these catches are considered more reliable since 2000, when a stock assessment of Spanish mackerel was undertaken and grey mackerel catches were recorded separately in the CAESS.

The data show that the total catch of other mackerel has steadily declined in recent years (Spanish Mackerel Table 1). This catch is comprised mainly (up to 90%) of grey mackerel, particularly in the Gascoyne area where grey mackerel are exported to overseas markets. Provision of separate quota for grey mackerel under the new management arrangements has also led to an increased focus on this species in the Pilbara area, where catches have remained relatively high since 2004.

Fishers in the Kimberley area have not targeted grey mackerel since the new management arrangements have been introduced, and few of this species were caught in the West Coast area, where catches are typically low.

Recreational catch: **West Coast 40% (approximately)**
Gascoyne 40% (approximately)
Pilbara 20% (approximately)

Recreational survey data are available for the West Coast in 1996/97 (Sumner and Williamson 1999) and 2006/07 (Sumner and Williamson, unpublished data), the Gascoyne in 1998/99 (Sumner *et al.* 2002) and the Pilbara in 1999/2000 (Williamson *et al.*, unpublished data). Data obtained during the Pilbara survey also included an estimate of recreational catches in the Broome region of the Kimberley sector.

Mackerel catch estimates from these surveys were reported in the *State of the Fisheries Report 2001 – 2002.* Of note is the similarity between the 1996/97 and 2006/07 surveys within the West Coast area, indicating that recreational anglers took 45 and 40% (respectively) of the total recreational/commercial catch.

In 2001, the National Recreational Fishing Survey collected data on the recreational catch of mackerel in all parts of Western Australia. Results of this survey indicate that 278 t of Spanish mackerel and 75 t of other mackerel were captured by recreational fishers (including charter boat fishers) in WA waters during the survey period (N. Sumner *pers. comm.*). The recreational catch was therefore about 42% and 57% of the total catch for Spanish and other mackerel, respectively, in 2001.

Reported catches of Spanish mackerel by recreational charter boats are relatively minor. In 2006, approximately 12 t of mackerel were reported by these boats (with most of this expected to be Spanish mackerel). Most (63%) of this catch was taken in the Kimberley and Pilbara areas.

Fishing effort/access level

The commercial fishing effort for Spanish mackerel recorded in the CAES database for the last 3 seasons are:

	2006	2006	2005	2004
Kimberley area	5 boats	303 days	401	612
Pilbara area	6 boats	160 days	362	475
Gascoyne area	5 boats	131 days	252	480
West Coast area	5 boats	83 days	289	795

The unit of effort recorded here is CAES fishing days, i.e. the total number of days fished by a vessel for any month during which they landed Spanish mackerel. Historic effort data has not been a reliable indicator of mackerel fishing effort because many fishers have not specifically targeted mackerel. A daily log book introduced in 2006 under the interim management plan will provide more detailed and reliable data on effort (and catch) in the mackerel fishery.

Fishing effort decreased substantially in 2006, with the number of days fished only 52% of those fished in 2005 and 9 fewer boats reporting catches of mackerel. This follows on from similar declines in effort during 2005 as a result of the new management arrangements, and highlights the fact that industry is still adjusting to these arrangements.

Only in the Pilbara area did these large reductions in effort coincide with a significant reduction in catch, with fishers elsewhere reporting high abundances of Spanish mackerel on the fishing grounds, particularly in the Kimberley area where fishers reached quota limits prior to the end of the season.

Stock Assessment

Assessment complete: **Yes**
Breeding stock levels: **Adequate**

An initial assessment of Spanish mackerel stocks (which are used as the indicator stock in this fishery) was completed in 2002. This assessment used biomass dynamics and yield-per-recruit modelling, and was presented in the *State of the Fisheries Report 2001/02.*

Since this time, catches of Spanish mackerel have provided a performance measure for the fishery, as described below, although the usefulness of this data is limited, due to the broad temporal and spatial scale at which it is reported. New daily log books introduced in 2006 as part of the new management plans will improve the value of the catch data in assessment of mackerel stocks.

Similarly, the use of catch rates (kg whole fish per day) as a measure of Spanish mackerel abundance is considered unreliable because of the schooling nature of this species and because prior to introduction of daily log books the CAESS data has not been

suitable for fine-scale temporal and spatial analyses. Furthermore, many fishers who caught Spanish mackerel were not normally targeting them, thereby confounding the effort data.

Nevertheless, the value of the catch rate data will be improved with introduction of the new log books and by basing the data on those vessels that are known to target mackerel. In the Kimberley area, these data have exhibited a steady rise since 1987, with a sharper increase during 2006 to 307.6 kg/day in accordance with the reports by fishers of good abundances of Spanish mackerel in this area (Spanish mackerel Figure 2).

The overall catch rate in the Pilbara area has also increased steadily since the mid 1980s, however in contrast to the Kimberley area there was a sharp decline in the overall catch rate in this area during 2006 to 204.5kg/day. This is considered to reflect adverse environmental factors such as rough weather, as indicated by fishers, since this can strongly influence mackerel distribution and catchability.

In the Gascoyne/West Coast area, the overall catch rate tends to be more variable than in other areas but has also shown a slow increase since the poor fishing year of 1992. In 2006 the overall catch rate in this area was 130kg/day – down slightly on the previous year. Insufficient data are available for assessment of stocks of other mackerel species.

The performance measure set for the fishery is the status of the Spanish mackerel spawning stock. As the minimum legal size of 900 mm total length is similar to the size at maturity for this species, the spawning stock is essentially the same as the exploited stock. In this context, catch rates across the major areas of the fishery are a general indicator of breeding stock levels, as reflected by catches being within target ranges. Catches in 2006 were within target range in the Kimberley area but below the target range in the Pilbara and Gascoyne/West Coast areas. This is largely due to the considerable reduction in effort in these areas as a consequence of the new management arrangements.

Non-Retained Species

Bycatch species impact: **Negligible**

Fishing for Spanish mackerel uses specialised troll lines to target the schooling fish and involves limited discarding. Species occasionally caught and generally discarded include billfish, pike, barracuda, shark, mackerel tuna, queenfish and trevally. A high proportion of the above species are expected to survive capture and release by the fishery. Consequently, it is considered likely that the fishery has a negligible impact on stocks of discarded species.

Protected species interaction: **Negligible**

The line fishing methods used in this fishery are not known to catch any protected species.

Ecosystem Effects

Food chain effects: **Low**

The effect of the fishery on the food chain is likely to be minimal because a relatively low proportion of the total mackerel biomass is caught, at least in the Gascoyne area where estimates for this are available. In addition, discards of non-retained bycatch and fish waste products are low in this fishery. A significant amount of bait (mainly garfish) is also used in the capture of mackerel. This bait is captured in other fisheries and is reviewed elsewhere.

Habitat effects: **Negligible**

The troll line fishing methods used in this fishery have minimal impact on the habitat.

Social Effects

Approximately 42 people were employed in the commercial mackerel fishery during 2006. This estimate is based on the number of vessels reporting mackerel catches within each area and the average number of crew on each boat (2 per boat in the Gascoyne and Pilbara areas, 4 per boat in the Kimberley area). These fishers were employed for approximately 6 months each year.

Because of their fighting and eating qualities, Spanish mackerel are a popular target of recreational anglers and spearfishers. They are usually captured from small boats, although shore-based fishing is popular at Steep Point (Shark Bay) and Quobba (Carnarvon). Most of the recreational catch is taken between Perth and Dampier.

Economic Effects

Estimated annual value (to fishers) for year 2006:
Spanish mackerel $2.5 million
Other mackerel $154,000

Ex-vessel prices obtained by fishers during 2006 varied from $9 to $11 per kg for Spanish mackerel, depending on how the product was landed, and from $3 to $7 per kg for whole other mackerel. These data were obtained from fishers and processors.

Fishery Governance

Target catch range: **246 – 410 tonnes**

The acceptable catch ranges are now inclusive of catches for all mackerel species except grey mackerel. This is consistent with TACC arrangements in the interim management plan, although it does not take into account the 'latent' quota held by fishers who are not eligible to participate in the fishery (in 2006 this latent effort amounted to 13, 16 and 21 t in the Kimberley, Pilbara and Gascoyne/West Coast areas, respectively).

In 2006, reported catches were within the acceptable catch ranges for the Kimberley area (110 – 205 t) but well below the acceptable catch ranges for the Pilbara (80 – 126 t) and combined Gascoyne/West Coast (56 – 79 t) areas. This is largely due to the considerable reduction in effort in these areas (44% and 40% of 2005 levels for the Pilbara and Gascoyne/West Coast areas, respectively).

As such it is not of immediate concern, although advice from fishers and catches and catch rates in the Pilbara area will be monitored closely during 2007 in light of the considerable decrease in catch rate in this area during 2006.

Current fishing level: Acceptable

Fishing effort throughout the fishery was low in 2006 compared to previous years, due to a reduction in the number of boats and the days fished by individual boats. This is the result of decisions made by individual fishers, following the complete introduction of new management arrangements, the abundance of fish in each area, and weather. As discussed previously, these factors are not considered to reflect issues associated with stock sustainability and hence are acceptable.

New management initiatives (2006/07)

In 2007 a small number of changes to the interim management plan will be considered to 'fine tune' the arrangements, as the fishery moves closer to 2009 when the next stock assessment will be conducted. In December 2009 the current plan will expire and consideration will be given to moving the fishery to full management plan status.

External Factors

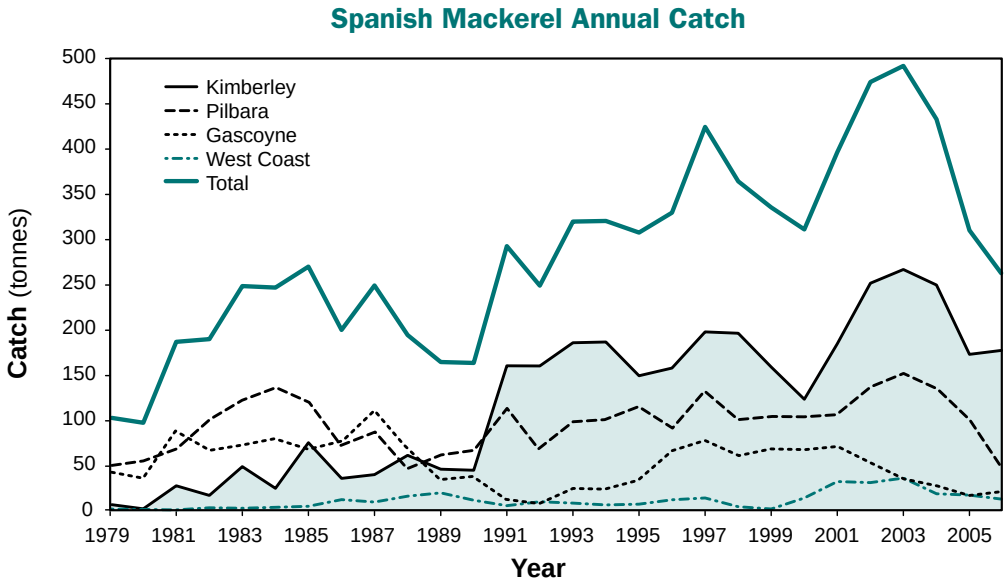
Spanish mackerel and the other mackerel species caught by this fishery are moderately long-lived, fast-growing species that exhibit annual variations in recruitment strength due to environmental fluctuations. This was exemplified by the appearance of a large number of juvenile Spanish mackerel in 1999/2000 that corresponded with increased catches in subsequent years.

SPANISH MACKEREL TABLE 1

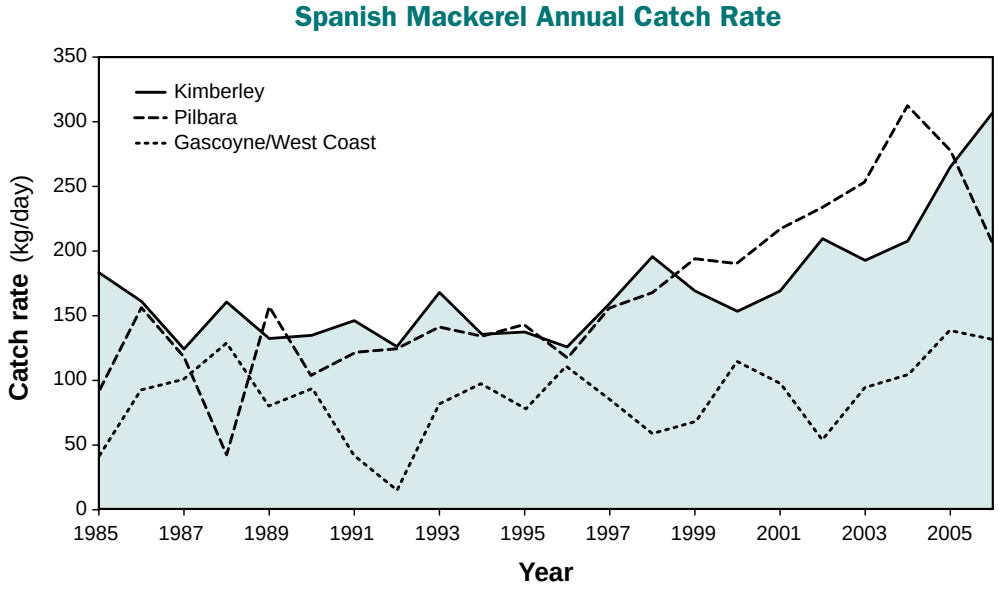
Catches of Spanish, grey and other mackerel, 1980 – 2006. 'Other mackerel' includes school mackerel, spotted mackerel and shark mackerel. Prior to 2000, catches of grey mackerel were also included in this category. Note that reported catches may differ from those reported previously due to late receival of log book data.

Year	Spanish mackerel (tonnes)					Grey mackerel (tonnes)	Other mackerel (tonnes)
	Kimberley*	Pilbara	Gascoyne	WC	Total		
1980	2.8	56.0	36.9	2.2	97.9		10.8
1981	28.3	68.7	88.5	1.7	187.2		2.5
1982	17.6	100.7	67.8	4.0	190.1		19.9
1983	49.5	123.0	72.8	3.5	248.7		3.6
1984	25.5	136.9	80.1	4.5	247.0		1.8
1985	75.9	120.4	68.3	5.7	270.3		19.4
1986	36.4	73.5	72.3	12.9	195.1		43.5
1987	40.6	87.8	110.6	10.3	249.3		23.9
1988	62.0	47.1	68.8	17.6	195.5		89.3
1989	46.6	62.7	35.1	20.4	164.8		104.5
1990	45.4	68.0	38.1	12.3	163.8		166.5
1991	160.7	116.8	12.8	6.3	296.7		116.2
1992	160.6	69.3	8.7	10.6	249.2		79.5
1993	186.1	99.3	25.4	9.1	319.9		75.0
1994	187.1	101.8	24.6	7.2	320.7		87.9
1995	149.7	115.8	34.5	7.9	307.9		56.1
1996	156.4	90.3	66.7	12.8	326.2		92.4
1997	198.2	133.2	77.6	14.9	423.9		120.7
1998	196.7	101.2	61.2	5.2	364.3		65.8
1999	159.5	104.7	68.8	2.6	335.6		72.7
2000	123.8	104.5	68.1	14.9	311.3	21.6	53.0
2001	179.3	107.0	70.5	33.0	389.9	14.7	41.4
2002	245.8	136.8	53.5	31.9	467.9	24.2	32.7
2003	267.0	152.0	36.0	36.7	491.8	22.5	19.4
2004	249.9	135.5	28.1	19.4	433.0	23.3	9.4
2005	173.4	101.0	18.0	17.9	310.4	12.4	23.1
2006	**177.9**	**48.2**	**21.7**	**13.5**	**261.3**	**17.4**	**12.8**

* Catches by Taiwanese gillnet fishers of approximately 5 to 90 t per year (mean approximately 50 t) between 1980 and 1986 (Stevens and Davenport 1991) are not included in these estimates. These gillnet catches include data east to longitude 131° E and therefore are not directly comparable with Kimberley catches.



SPANISH MACKEREL FIGURE 1
Annual catch of Spanish mackerel in Western Australia.



SPANISH MACKEREL FIGURE 2
Estimated catch per unit effort (kg/day) for vessels specialising in catching Spanish mackerel. Effort data was based on only those vessels known to target the species.

Northern Shark Fisheries Status Report

R. McAuley
Management input from G. Baudains

Fishery Description

The northern shark fisheries comprise the state-managed WA North Coast Shark Fishery (WANCSF) in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery (JANSF) in the eastern Kimberley.

The primary fishing method employed in these fisheries is demersal longline, with a small amount of pelagic gillnetting in the JANSF in recent years. The northern shark fisheries target a variety of species including sandbar, blacktip, tiger and lemon sharks, with the principal fishing method and some target species being common to both the WANCSF and the JANSF. The data have thus been combined and the 2 regions are considered as a single fishery for reporting purposes.

Governing legislation/fishing authority

Fisheries Notice no. 476 (Section 43 Order)
Fisheries Notice no. 602 (Section 43 Order)
Fisheries Notice no. 601 (Section 43 Order)
Offshore Constitutional Settlement 1995
Condition 127 and 128 on a Fishing Boat Licence
Ministerial Exemption

Consultation process

WA Demersal Net and Hook Fisheries Management Advisory Committee
Meetings between the Department of Fisheries and the Northern Shark Industry Association

Boundaries

The WANCSF extends from longitude 114°06′ E (North West Cape) to 123°45′ E (Koolan Island), and the JANSF from longitude 123°45′ E to the WA/NT border.

Management arrangements

The northern shark fisheries are input-controlled, with limited numbers of operators authorised to fish in each fishery.

A comprehensive package of new management arrangements for the northern shark fisheries was agreed with Northern Shark Industry licensees in May 2005. Regulations supporting these arrangements were introduced in their entirety for the WANCSF in June 2005. However, full implementation of complimentary management measures for the JANSF are still pending endorsement by the Commonwealth Government, which shares management responsibilities for this fishery under the terms of the Joint Authority.

The solely Western Australian-managed sector of the northern shark fishery was closed by a Section 43 order of the *Fish Resources Management Act 1994* in 2005. Those subsequently permitted to fish in the WANCSF are restricted to a small portion of the fishery's previous area under a Ministerial Exemption.

This exemption entitles the use of longlines, with metal snoods, and pelagic gillnets. Longlines are restricted to a maximum of 1,000 hooks and gillnets are limited to 2 kilometres maximum length, 160 – 185 mm stretched mesh size and a maximum drop of 100 meshes. Additionally, gillnets must be attached to vessels at all times and may not come into contact with the seabed.

The WANCSF is now zoned into 3 areas with separate levels of access. The area between North West Cape and a line of longitude at 120° E and all waters south of latitude 18° S has been closed indefinitely, primarily to protect the breeding stock of sandbar sharks.

Operators are only allowed to fish in the area between 16° 23′ S and 18° S latitude between 1 October and 31 January. Operators are allowed to fish in the remaining area (north of 16° 23′ S latitude and between 120° and 123° 45′ E longitude) throughout the year.

A total of 200 gillnet fishing days and 100 longline fishing days are permitted in the WANCSF, with no more than 100 of those days allowed in the southern area (i.e. between 16° 23′ and 18° S latitude). All vessels operating in the WANCSF are now required to report fishing activities via the Department of Fisheries' Vessel Monitoring System (VMS) and daily log books.

The commercial take of shark in Western Australian waters east of 123°45′ E longitude is jointly managed by the Commonwealth Government and the State of Western Australia, under an arrangement agreed through the Offshore Constitutional Settlement in February 1995. Under this arrangement, the State was given management responsibility for the JANSF on behalf of the WA Fisheries Joint Authority, whose members include the State and Commonwealth Ministers for Fisheries.

Permitted fishing methods are longlines and gillnets, although gillnet fishing is not permitted within 3 nautical miles of the coast. The new JANSF management arrangements agreed with industry are essentially identical to those for the WANCSF, except for total access levels of 400 gillnet and 200 longline fishing days.

Research summary

Research to monitor the status of northern shark stocks was initiated as an extension of the south and west coast shark research project. A 3-year research project funded by the Fisheries Research and Development Corporation (FRDC) has provided an age-structured demographic assessment of the status of the fisheries' principal target species – the sandbar (thickskin) shark.

Data collected from the northern shark fisheries during this project have also provided an improved understanding of the fisheries and of northern shark stocks generally. Additional information on these fisheries and those which take sharks as bycatch on the north coast was collected during a series of Department of Environment and Heritage and FRDC-funded research projects, beginning in 1999, to examine the sustainability of Australia's tropical sharks and rays.

Results from these projects have further improved our understanding of the impacts of the various fishing sectors that exploit elasmobranchs across the northern half of Australia. This work involved shark researchers from the Department of Fisheries, CSIRO, and the Northern Territory and Queensland fisheries agencies and was published in January 2007.

This status report is prepared based on research data from these projects, CAES data supplied by industry and additional knowledge of tropical shark stocks obtained from the scientific literature. CAES data from the northern shark fisheries are available from 1994/95, although the reliability of early records is uncertain due to species identification and related issues. Since July 2000, catch identification and reporting in the northern fisheries has been validated by at-sea observation of catches and voluntary research log books.

Future research will involve monitoring the catch and effort of the northern shark fisheries and will also need to focus on the biology of secondary target species.

Retained Species

Commercial landings (season 2005/06):
Northern shark fisheries: 189 tonnes
Other fisheries: 31 tonnes

All total shark catches given in this report include rays, unless specified otherwise.

The northern shark fisheries' reported catch declined to its lowest level since 1999/2000 in 2005/06 as a consequence of the introduction of new management arrangements. The fisheries' combined shark catch was 189 t – 85% lower than its record maximum of 1,294 t in 2004/05 (Northern Shark Figure 1).

Longlines accounted for the majority (84%) of this catch, which was mainly comprised of 'blacktip' (40%), pigeye* (23%), hammerhead (14%) spottail (9%) and tiger (6%) sharks (Northern Shark Table 1). Unlike recent years, the fisheries landed a negligible quantity of sandbar shark (less than 1 t) in 2005/06.

The only reported scalefish catch by the northern shark fisheries during 2005/06 was 270 kg of black pomfret (*Parastromateus niger*).

In addition to the catch by the 2 dedicated shark fisheries, sharks are also incidentally caught by other commercial operators in waters off the north coast. During 2005/06, vessels licensed in other managed fisheries operating in the area between North West Cape and the WA/NT border reported catches of sharks and rays totaling just over 24 t, which was 12 t less than the previous year.

A further 6 t of sharks and rays was reported to have been landed by 'wetline' methods (i.e. taken by vessels not operating in managed fisheries), which was 11 t less than in 2003/04. The causes of recent reductions in these non-target fisheries' shark catches are varied, but the introduction of bycatch reduction devices in the Pilbara Fish Trawl Fishery has significantly reduced shark and ray catches in that fishery.

Further reductions in non-target fisheries' shark catches are expected next year as a result of the commercial protection of sharks and rays (see new management initiatives 2006/07, below).

The total shark catch by all State-managed sectors in the north coast bioregion during 2005/06 was therefore 220 t.

*This includes a reported 18 t of the similar-looking bull shark (*Carcharhinus leucas*), which extensive research has shown does not occur in the fisheries' catch.

Recreational catch: **Not assessed**

Fishing effort/access level

There are 14 licenses that are endorsed to fish in the northern shark fisheries, 9 in the WANCSF and 5 in the JANSF. Fishing effort was restricted in June 2005 to: 100 longline days and 200 gillnet days in the WANCSF, and 200 longline days and 400 gillnet days in the JANSF.

Of the 300 permitted fishing days in the WANCSF, no more than 100 days fishing (with either gear type) are allowed in the southern zone (Broome and Cape Leveque). Furthermore, the southern zone of the WANCSF is closed to fishing between 1 February and 30 September.

Because longlining is the primary fishing method in the northern shark fisheries, effort has been standardised in terms of 'hook days', using comparative longline and gillnet catch per unit effort data from the JANSF to convert gillnet effort into an equivalent longline effort. Effort in the northern shark fisheries is therefore expressed in terms of numbers of hook days (i.e. the number of longline or dropline hooks multiplied by the number of fishing days).

Total fishing effort in the northern shark fisheries during 2005/06 was 141,923 hook days – 89% less than the level expended in 2004/05 (1.2 million hook days). The 152 days of reported fishing effort (133 days of longlining and 19 days of gillnetting) was far less than is permitted under the new effort limits (600 gillnet days and 300 longline days).

Thus, while northern shark fishing effort has been reduced substantially by the new effort management arrangements, there is still considerable latent capacity in the fisheries.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Inadequate (sandbar)**
Uncertain (blacktip)

Prior to 2005/06, sandbar shark (*Carcharhinus plumbeus*) was the primary target and indicator species for the multi-species northern shark fisheries. However, as the northern shark fisheries have now been excluded from most of this stock's range, this assessment will henceforth be reported in the temperate Demersal Gillnet and Longline Fisheries Status Report elsewhere in this volume.

The status of northern Australian blacktip shark stocks has previously been assessed using an age-structured model and time-series of CPUE data from the various Australian and

Taiwanese-operated fisheries that have exploited them. However, this assessment does not provide specific advice on the status of the blacktip stock units in Western Australian waters and the reliability of the historical CPUE data upon which the model relies is questionable.

Assessing the status of these stocks is further complicated by the potential impacts of illegal foreign fishing and unreported catches in domestic fisheries. Given these issues, the maximum sustainable yield (of at least 2,000 t per year) estimated from this model is considered to be unreliable.

The declining CPUE trend reported from the adjacent Northern Territory Offshore Net and Line Fishery during the late 1990s also suggests that the blacktip stocks have not recovered from the impacts of historical levels of exploitation and that this maximum sustainable yield estimate is overly optimistic.

Assessing the status of other targeted shark stocks is even more complicated, as these species were very poorly identified in catch returns prior to 2000 and much of the biological information needed for their assessment is lacking. Thus, monitoring the status of stocks taken by the northern shark fisheries will necessarily rely on analysis of CPUE data for the foreseeable future.

Non-Retained Species

Bycatch species impact: Low

The northern shark fisheries have a small scalefish catch, which is generally retained for sale. The intended shift of fishing effort to gillnets is expected to result in an increased bycatch of mackerel species.

Once mackerel catches can be quantified, additional measures to manage this bycatch may be necessary. There is some discarded bycatch of unsaleable species of sharks, rays and scalefish, which was rated as a low to negligible risk by the ESD risk assessment process.

Protected species interaction: Not assessed

The northern shark fisheries were rated as having a generally low risk of interacting with protected species through the Ecologically Sustainable Development risk assessment process. However, this assessment was based on the majority of fishing effort being applied by longlines.

While the intended shift of fishing effort to gillnets may pose different levels of risk to protected species, these have not been formally assessed nor are there empirical data on which to base such an assessment. Nonetheless, the low levels of fishing effort now permitted in the fisheries, restrictions on the amount of fishing gear that vessels can deploy and the requirement to attach gillnets to vessels so that they can be monitored and retrieved quickly were designed to mitigate the risks of protected species interactions.

Other implications of the new management arrangements are discussed below for individual protected species groups.

Sharks and rays: Because the northern shark fisheries generally operate some distance offshore, they pose a negligible risk to speartooth sharks (*Glyphis* sp. A and sp. C) and sawfish (*Pristidae*), which have primarily inshore, estuarine and riverine distributions. The closure of much of the WANCSF is expected to reduce the risk of interactions with white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*), as these species have primarily temperate distributions. As previously assessed, the whale shark (*Rhincodon typus*) is extremely unlikely to be caught by either longline or pelagic gillnet gear.

***Turtles*:** No turtle captures have either been observed or reliably reported in the northern shark fisheries. Although turtles are possibly more susceptible to capture by pelagic gillnets than demersal longlines, the amount of permitted gillnet effort is small relative to the fisheries' operational area and historical levels of gillnet effort in the area. Thus, the risk of interaction is expected to remain low.

***Billfish*:** The limited billfish bycatch observed in the northern shark fisheries was previously assessed as being insufficient to impact breeding stocks. This level of bycatch is unlikely to increase as a result of the new management arrangements.

***Cetaceans*:** As almost all northern shark fishery effort prior to 2005/06 was applied by demersal longlines, the risk of interaction with cetaceans was previously assessed as negligible. Although there is a perception that the intended proportional increase in the use of gillnets may result in higher levels of interaction with cetaceans, there are no empirical data from the domestic shark gillnet fisheries to verify this. However, in a precautionary context, the risk of cetacean interactions might be considered higher than previously assessed.

Ecosystem Effects

Food chain effects: Negligible

Given the smaller shark catches intended under the fisheries' new management arrangements, the associated risk of detrimental food chain effects is likely to remain negligible. However, it may be necessary to reassess this risk as and when higher levels of fishing effort resume and the new composition of catches can be determined.

Habitat effects: Negligible

The principal type of fishing gear (longline) that has been used to target sharks in the region is set so that it is only in intermittent contact with the seabed, and its physical impact on the seabed is therefore minimal. The intended shift of fishing effort into gillnets will further reduce the amount of gear that comes into contact with the benthos.

Despite fishing being constrained to a smaller area, the reduction in overall effort capacity and this intended shift in gear type are likely to reduce the risk of habitat effects further.

Social Effects

Direct: Northern shark fishing vessels employed between 3 and 7 crew (5 on average) but as the fleet only fished for a total of 152 days in 2005/06, this represents very part-time employment.

Indirect: Sharks are viewed as a menace by some members of the community, due to their perceived danger to bathers and their predation of prized recreationally-caught fish. However, others consider them to be important components of marine ecosystems that deserve to be conserved.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: **$490,000**

$235,000 (Shark and scalefish)
$255,000 (Shark fins)*

*As fishers do not separately identify the weight of fins on their catch returns, fin weight was calculated at an average of 3% of sharks' whole weight and value was estimated using an average price of $45/kg. During the 2005/06 season, shark fins maintained their value of between $25/kg and $120/kg, depending on fin size and species. Categories of shark which do not have saleable fins were excluded from fin valuation.

Fishery Governance

Target effort range: **600 gillnet days maximum**
300 longline days maximum

Target catch range: **sandbar sharks < 20 tonnes**

There were 133 days of longlining and 19 days of gillnetting reported in 2005/06, far less than the total of 900 days permitted under the new effort management arrangements. The catch of sandbar sharks was less than 1 t.

Current fishing (or effort) level: **Acceptable**

Catches and fishing effort were considerably less than the levels prescribed by the new management arrangements and were therefore acceptable. In particular, the less than 1 t catch of sandbar sharks in 2005/06 was less than the 20 t sustainable yield estimated from the demographic analysis model and should therefore have allowed the recovery of the breeding stock to begin.

New management initiatives (2006/07)

Some elements of the new management arrangements agreed with industry in 2005 are still pending agreement between Commonwealth and State governments. It is anticipated that these will be given full legislative effect in 2007.

External Factors

The northern shark fisheries share their intended target stocks of blacktip sharks with the Joint Authority target-shark fisheries operating in Northern Territory and Queensland waters. Similarly the fisheries' previous target species (sandbar shark) is the primary component of catches by the West Coast Demersal Gillnet and Demersal Longline Fishery (see the Demersal Gillnet and Longline Fisheries Status Report elsewhere in this volume).

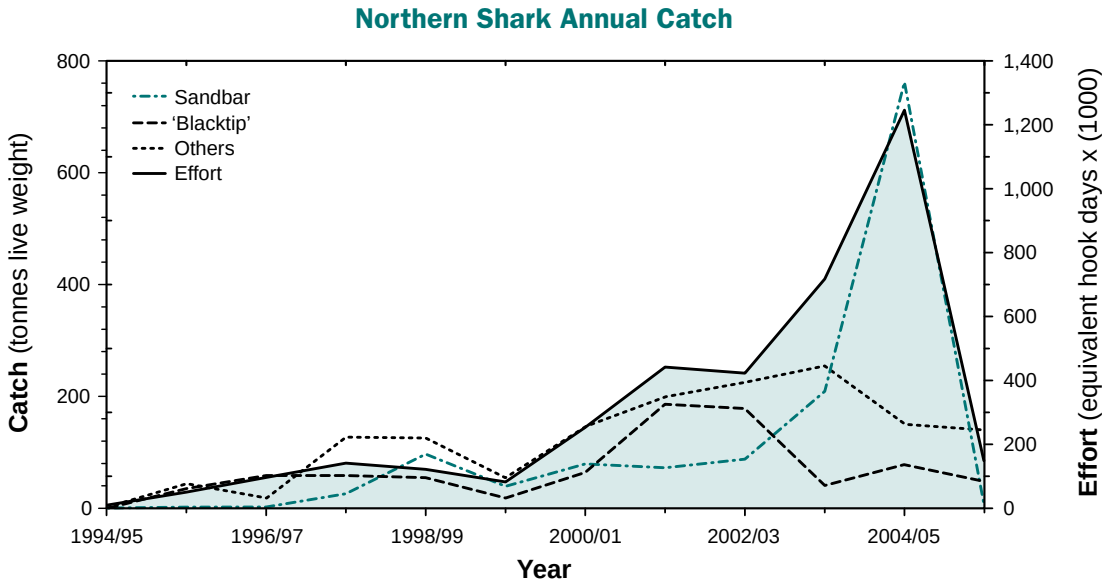
Possibly most importantly though, there has apparently been a rapid escalation of illegal foreign shark fishing in northern Australian waters, which has significant potential for impacting all of the stocks taken in these fisheries. These circumstances mean that the abundance of the stocks harvested by the 2 dedicated shark fisheries will be influenced by factors outside of their direct control.

These interactions need to be taken into account in the stock assessment and management processes.

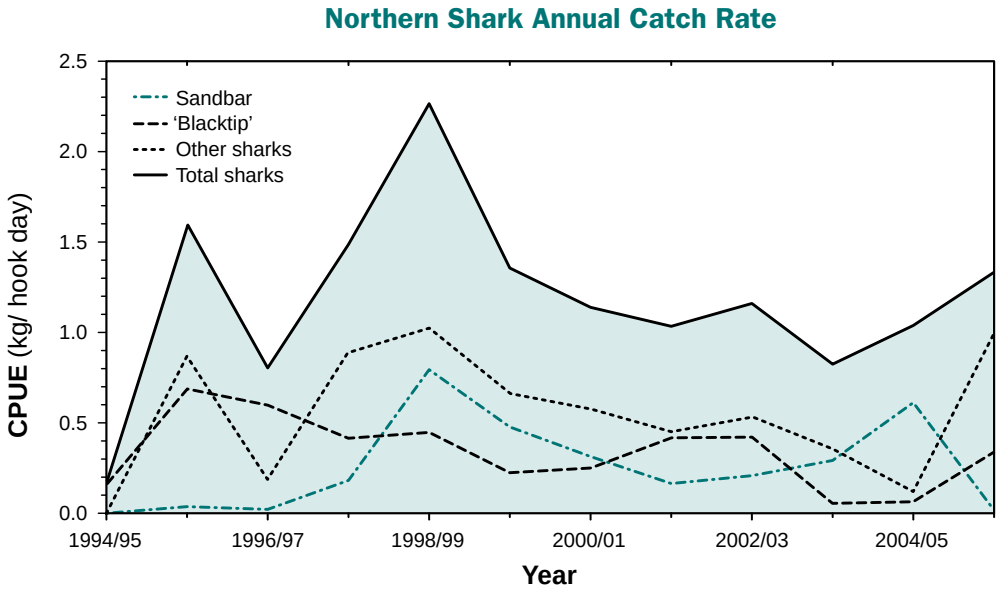
NORTHERN SHARK TABLE 1

Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2001/02 to 2005/06.

Species		Catch (tonnes)				
		2001/02	2002/03	2003/04	2004/05	2005/06
Sandbar shark	*Carcharhinus plumbeus*	72	88	209	762	<1
Hammerhead shark	Sphyrnidae	43	45	33	114	27
Pigeye shark	*Carcharhinus amboinensis*	25	32	43	83	43
Tiger shark	*Galeocerdo cuvier*	37	43	51	81	12
Blacktip shark	*Carcharhinus* spp.	185	178	40	78	76
Lemon shark	*Negaprion acutidens*	26	57	24	62	7
'Bronze whaler' shark	*Carcharhinus obscurus*	6	7	17	36	<1
Shovelnose/fiddler rays	Rhinobatidae, Rhynchobatidae	11	11	8	32	5
Grey reef shark	*Carcharhinus amblyrhynchos*	6	7	9	8	1
Other sharks/rays		45	19	156	46	18
TOTAL		**456**	**490**	**591**	**1,294**	**190**



NORTHERN SHARK FIGURE 1
Annual landings and standardised fishing effort for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2005/06.



NORTHERN SHARK FIGURE 2
Annual catch rates of target and other shark species for the northern shark fisheries (WANCSF and JANSF) for the period 1994/95 to 2005/06.

Pearl Oyster Managed Fishery Status Report

Prepared by A. Hart and D. Murphy
Management input by J. Froud

Fishery Description

The Western Australian pearl oyster fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. It is a dive fishery, operating in shallow coastal waters along the North West Shelf.

The harvest method is drift diving, in which 6 to 8 divers are attached to large outrigger booms on a trawler-style vessel and towed slowly over pearling beds, harvesting legal-sized oysters as they are seen. The species targeted is the Indo-Pacific, silver-lipped pearl oyster (*Pinctada maxima*).

Governing legislation/fishing authority

Pearling Act 1990
Pearling (General) Regulations 1991
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Pearling Industry Advisory Committee and sub-committees
Meetings between the Department of Fisheries and industry

Boundaries

The fishery is separated into 4 zones (Pearl Figure 1), as follows:

***Pearl Oyster Zone 1*:** NW Cape (including Exmouth Gulf) to longitude 119°30´ E. There are 5 licensees in this zone.

***Pearl Oyster Zone 2*:** East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3.

***Pearl Oyster Zone 3*:** West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2.

***Pearl Oyster Zone 4*:** East of longitude 125°20' E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.

There is also a 'buffer zone', which may be accessed by licensees from Zones 1 and 2; in practice, it is generally only utilised by Zone 1 licensees.

Management arrangements

The Western Australian pearling industry comprises 3 main components: the collection of pearl oysters from the wild; production of hatchery-reared pearl oysters; and grow-out of pearls on pearl farm leases. Quota limits are set for the take of pearl oyster shells from the wild to ensure the long-term sustainability of the resource.

In 1996 the WA Government granted hatchery options to licensees as part of an incentive program to encourage them to adopt new technology that enabled the production of pearls from oysters reared in hatcheries, thus reducing the reliance on the wild stocks of pearl oysters. The number of pearls produced from hatchery-reared pearl oysters is now also governed by quota limitations.

The pearl oyster fishery is managed primarily through output controls in the form of a total allowable catch (TAC) divided up into individually transferable quotas (ITQs). There are 572 wild-stock quota units and 350 hatchery quota units allocated amongst/held by 17 pearling licensees.

The value of a hatchery quota unit is 1,000 shell. The value of wild-stock quota units varies, depending on status of wild stocks, but is usually also about 1,000 shell per unit. In 2006, wild stock quota units were valued at 1,100 shell in Zone 2, and 1,000 shell in Zone 1 and Zone 3.

Wild stocks are reviewed each year by the Department of Fisheries in liaison with the Pearling Industry Advisory Committee to enable the TAC to be set for each zone of the fishery. There is a minimum legal size of 120 mm shell length, and maximum legal sizes and area-specific TACs have been set where appropriate, for example in Exmouth Gulf in Zone 1.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of pearl oysters. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on stock assessment using catch and effort statistics and recruitment and length-frequency sampling to estimate the total allowable catch.

Since 2004, data on discard rates and quality of pearl shell have been collected to assess the overall health of the fishery. In addition, the FRDC project entitled 'Management of bio-eroding sponges (*Cliona* sp.) in wild stocks of *Pinctada maxima* in Western Australia' began in 2005. The overall objective is to determine whether the incidence of *Cliona* sp. is increasing in wild stocks over time.

Management outcomes from the project may include changes to wild-shell fishing practices, shell treatment and shell discard processes, all of which will ameliorate the economic impact of *Cliona* sp. on the industry and maintain the health of the wild stocks. Detailed surveys of *Cliona* sp. in the pearl oyster habitat were conducted for the first time in 2006.

The Department of Fisheries' Research Division's Fish Health Unit also provides a comprehensive disease-testing program to the industry.

There are several other significant research projects being carried out within the pearling industry focusing on environmental management, pearl oyster health, and improved health and safety for pearl divers. The main aims of this research are to:

- demonstrate that the pearling industry operates in a manner acceptable to public standards for access to the marine environment;
- develop a culture of best practice and continuous self-improvement with regard to environmental management and health and safety; and
- enhance Australia's reputation for producing the highest quality pearls.

Retained Species

Commercial landings (season 2006): 538,882 oysters

In 2006, the number of wild-caught pearl oysters was 538,882 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 592,500 oysters (including a 2,000 special quota for tourism purposes).

The disparity between the TAC and the oysters caught was due principally to licensees electing for hatchery-produced oysters, rather than their wild-shell quota. Zone 1 operators caught 71,446 oysters from the wild fishery, and elected to obtain 20% (18,554 oysters) of their 90,000 TAC from hatchery production (Pearl Table 2).

The catch in Zone 2 was 455,676 oysters, and 11,760 oysters in Zone 3, totaling 467,436 oysters from a TAC of 502,500 oysters. This TAC was the same as in 2005 and is the upper level TAC for this region (see 'Stock Assessment' section for details).

Recreational catch estimate (season 2007): Nil

There is no recreational fishing for pearl oysters.

Fishing effort/access level

Total effort in all zones was 13,684 dive hours (Pearl Tables 1 and 2). The total effort for 2006 in Zone 2/3 was 11,992 dive hours – a 19% decrease on the 2005 Zone 2/3 effort of 14,807 dive hours, but with a similar amount of catch.

The total effort in Zone 1 during 2006 was 1,692 dive hours, which includes an additional 349 hours fishing an experimental quota on a pearl farm lease.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2006 fishing season based on catch and effort statistics, recruitment (95,500 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (18,000 shells measured), shell discard rates by size and location, and an evaluation of the predictive capacity of 0+ and 1+ spat settlement data.

These were used to generate trends in stock indicators, from which the determination of the TAC for 2007 was undertaken. Results for each zone, and issues relevant to stock sustainability, were as follows.

Zone 2/3: The catch rate achieved by the fishery is an indicator of the abundance of the 3 to 6-year-old oysters specifically targeted for pearl production. Year-to-year variations reflect changes in recruit abundance, while the long-term trend in catch per unit effort (CPUE) involves an element of effort efficiency change. In 2006, CPUE was 39 shells per dive hour – an 18% increase from the 2005 catch rate (33 shells/hour).

Recruitment to the fishery is predicted by the piggyback spat abundance index at 3 to 5 years prior to the current fishing year. A very high 0+ recruitment detected in the Zone 2 fishery in 2005 was confirmed in the 1+ year class in 2006, and is expected to enter the commercially-fished population over the 2008 and 2009 fishing years.

The 2007 stock abundance is predicted to be higher than the 2006 levels in Zone 2, but lower in Zone 3. Consequently, TAC in Zone 2/3 has been increased in 2007 (Pearl Table 1).

Zone 1: The Zone 1 fishery is still in a state of rebuilding, particularly in the middle sector after some heavy fishing years in the mid-1990s to early 2000s. In 2006, the Zone 1 catch rate has been calculated separately for the experimental quota (35,000 shell) in the lightly-exploited pearl farm lease in Exmouth Gulf (2006b in Table 2), and for the usual fishing grounds (2006a in Pearl Table 2).

Catch rates were extremely high (100 shells per hour) in the Exmouth Gulf pearl lease, and size-structure data showed that the Exmouth Gulf stocks to be dominated by larger adults, indicative of a lightly-exploited stock. Lower catch rates (27 shells per hour) occurred in other parts of the fishery (Pearl Table 2), but they were still higher than in the previous 13 years, indicating that a substantial recovery has taken place.

Catch from Onslow (Middle Section) was primarily composed of new recruits, indicating either a substantial difference in exploitation pattern of the stock or of the industry selection protocols.

***Breeding stock*:** Under normal conditions (average growth and mortality), recruitment into the pearl oyster breeding stock exceeds natural mortality, and hence breeding stocks are likely to be increasing in most years. This unusual situation is the result of the 'gauntlet' fishing strategy employed by the industry, in which the young, fast-growing shell (principally males) of 120 – 165 mm shell length are targeted for their fast pearl-producing qualities.

Animals that survive this 'gauntlet' are effectively protected from 6 to 7 years of age onward, and may live for another 15 to 20 years. With very low natural mortalities, this results in a large residual broodstock being built-up over time.

This is the case for all zones of the fishery; however, in Zone 1, breeding stock should also be increasing due to the low effort since 2002, including no fishing in 2004 (Pearl Table 2).

The performance measures for this fishery, which relate to breeding stock biomass, include the area of fishing compared to the distribution of the stock and the catch rates of young oysters within each of the fishing zones. All performance measures were met for 2006.

The area of fishing remains substantially less than 60% of the distribution of oysters within this region. The catch rates in Zones 2 and 3 were both still above their respective performance levels, with a combined catch rate of 39 oysters/hour.

Size-frequency data in Zone 1 showed that rebuilding of stocks had occurred, and fisheries were targeting smaller size animals.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target pearl oysters of choice (species, sizes and quality of *P. maxima*). Pearl oysters brought to the vessel after hand collection are young and have relatively little epiphytic growth (fouling organisms). Any such organisms are removed from the oyster and put back in the water, prior to the oysters being placed in mesh panels. A small number of over-sized or under-sized oysters are returned to the substrate.

Protected species interaction: **Negligible**

There is no interaction between the pearl oyster fishing operation and protected species.

Ecosystem Effects

Food chain effects: **Negligible**

The fishery removes only a small proportion of the biomass of pearl oysters on the fishing grounds and is considered to have negligible impact on the food chain in the fishing area.

Habitat effects: **Negligible**

Pearl divers have minimal contact with the habitat during fishing operations. The main habitat contact is by pearl oysters held in mesh panels on holding sites following capture. However, these sites cover a very small proportion of the habitat and the activity concerned is unlikely to cause any lasting effect.

Similarly, the pearl farming operation, which uses longline systems in areas of high tidal flow to culture pearls, has limited impact on the environment. Physical effects are limited to static anchoring systems in typically sand/mud habitats. Environmental management research (see 'Research summary') is also being undertaken to quantify impacts on habitat and environment.

Social Effects

Direct: Pearl oyster fishing vessels operate from the Lacepede Islands north of Broome to Exmouth Gulf in the south. The number of vessels in the fishing fleet has been slowly reducing from 12 – 16 in 1997 (overall) to 8 in 2006, due to increased fleet efficiency and increased reliance on hatchery-produced shells. Each vessel presently operating has 10 – 14 crew involved with the fishing of pearl oysters between March and June each year. These vessels also support a number of other pearl farm functions throughout the year. Fleet managers are employed by pearling companies to coordinate and support vessel operation

Indirect: The pearling industry provides employment for approximately 500 people in the northern coastal regions, including in the operation of the pearl farms.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$122 million**

Precise estimate of the value of product is difficult to achieve, owing to the variable time lags that occur between harvesting and sale to offshore buyers, and the costs incurred in marketing before sales take place – there are no current updates available. The value of cultured pearls and by-products was considered to be approximately $122 million for the year 2003/04.

Fishery Governance

Target effort range: **14,071 – 20,551 hours**

The target effort range relates to the time required to achieve the TAC in the pearl oyster fishery of 557,500 oysters (502,500 oysters in Zone 2/3, and 55,000 oysters in Zone 1).

Acceptable effort ranges for individual management zones are 11,456 – 15,819 dive hours for Zone 2/3 and 2,615 – 4,732 dive hours for Zone 1. These ranges are based on the 5-year period (1994 – 1998) following the introduction of global positioning systems (GPS) into the fishery, and reflect the typical variation in abundance of the stock under natural environmental conditions.

Zone 2/3 of the pearl oyster fishery achieved its 467,436 catch (TAC of 502,500) with 11,992 dive hours (Pearl Table 1), which was within the target range, albeit at the lower end.

Zone 1 of the pearl oyster fishery achieved its 36,566 catch (standard TAC of 50,000) with 1,343 dive hours (Pearl Table 2), which was below the target range, due partially to the entire quota not being taken, but mainly to improved catch rates and hence abundance.

The overall pearl oyster fishery effort of 13,335 hours in 2006 on the standard TAC was below the target range.

Current effort level: **Acceptable**

Fishery effort level is below the historical range, indicating a higher than average stock abundance.

New management initiatives (2006/07)

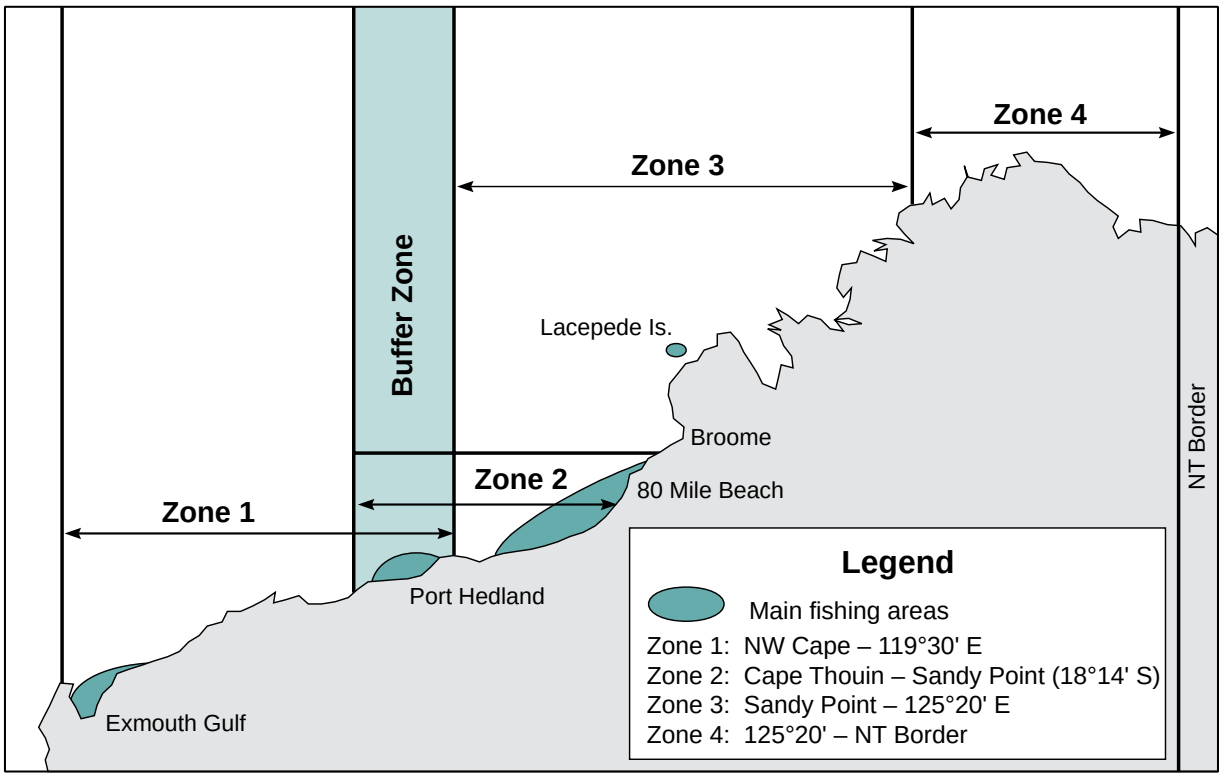
The Minister has announced that he is conducting an inquiry into the Western Australian silver-lipped pearling industry. The review will provide independent advice on public interest issues flowing from a number of pearling-related management and policy recommendations.

A number of management initiatives, including the development of the Pearling Management Bill, are subject to the review, which should be complete in late 2007.

External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide sufficient level of production to support this major Western Australian industry. However, there is a declining trend in number of vessels used to catch pearl shell, which reflects improvements in economic efficiency and the increased use of hatchery-produced oysters.

An unexplained incidence of high shell mortalities on farm sites, and in hatchery-produced spat in 2006 has prompted concerns over the possibility of disease transference to wild stocks. The matter is being investigated though a Government Taskforce to ensure impacts on wild stocks are properly mitigated.



PEARL FIGURE 1
Distribution of pearl oyster stocks and fishing zones in Western Australia.

PEARL TABLE 1

Pearl shell catch and effort – Broome area (Zone 2/3).

Year	Wild stock quota	No. of culture shells	No. of MOP[1] shells	Total shells	Dive hours	Culture shells/hr	Average depth	Total shells/hr
1979		371,806	355,599	727,405	16,068	23.1		45.3
1980		364,502	260,714	625,216	18,568	19.6		33.7
1981		481,193	210,649	691,842	23,320	20.6		29.7
1982	460,000	439,092	132,931	572,023	15,710	27.9		36.4
1983	520,000	365,381	87,049	452,430	19,019	19.2		23.8
1984	375,000	242,828	47,230	290,058	11,615	20.9		25
1985	342,000	272,869	53,831	326,700	12,423	21.0		26.3
1986	360,000	337,566	10,929	348,495	16,478	20.5		21.2
1987	380,000	365,397	0	365,397	17,476	20.9		20.9
1988	445,000	379,657	0	379,657	14,600	26.0		26
1989	445,000	445,364	0	445,364	18,625	23.9		23.9
1990	457,000	453,705	0	453,705	23,263	19.5	15.3	19.5
1991	457,000	460,608	0	460,608	21,657	21.3	16.1	21.3
1992	457,000	461,599	0	461,599	19,455	23.7	13.9	23.7
1993	457,000	457,186	0	457,186	14,733	31.0	15.7	31
1994	457,000	456,832	0	456,832	12,384	36.9	11.4	36.9
1995	512,000	511,633	0	511,633	12,217	41.9	12.4	41.9
1996	512,000	511,756	0	511,756	12,774	40.1	16.8	40.1
1997	512,000	512,314	0	512,314	16,893	30.3	12.9	30.3
1998	457,000	457,266	0	457,266	14,499	31.5	12.6	31.5
1999	457,000	457,842	0	457,842	10,300	44.4	11.6	44.4
2000	502,500	501,419	0	501,419	9,258	54.2	11.2	54.2
2001	502,500	502,484	0	502,484	12,054	41.7	12.1	41.7
2002	479,750	479,562	0	479,562	15,661	30.6	13.4	30.6
2003	457,000	456,988	0	456,988	14,242	32.1	13.6	32.1
2004	457,000	404,984	0	404,984	11,994	33.8	12.3	33.8
2005	502,500	488,303	0	488,303	14,807	32.9	12.1	32.9
2006	502,500	467,436	0	467,436	11,992	39.0	13.7	39.0
2007	**548,000**							

Notes: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies. [1] 'MOP' is an abbreviation for mother-of-pearl.

PEARL TABLE 2

Pearl shell catch and effort in Zone 1 since 1983.

Year	Wild Stock Quota	No. of culture shells	Dive hours	Culture shells/hr
1983		27,895	542	51.5
1984		45,690	827	55.3
1985	55,000	46,009	897	51.3
1986	55,000	39,663	1,104	35.9
1987	55,000	46,269	1,194	38.7
1988	55,000	43,046	1,243	34.6
1989	55,000	52,937	1,010	52.4
1990	55,000	43,711	1,146	38.1
1991	55,000	63,774	1,681	37.9
1992	55,000	53,386	1,266	42.2
1993	115,000[1]	79,465	2,395	33.2
1994	115,000[1]	132,316[2]	6,291	21.0
1995	115,000[1]	121,312[2]	6,247	19.4
1996	115,000[1]	80,163	5,013	16.0
1997	115,000[1]	110,348	9,494	11.6
1998	115,000	108,056	6,094	17.7
1999	115,000	90,414[3]	4,789	18.9
2000	115,000	66,772[3]	5,893	11.3
2001	115,000	68,931[3]	9,480	7.3
2002	55,000[6]	29,126[3]	2,729	10.7
2003	45,000[4]	22,131[3]	1,647	13.4
2004	45,000[4]	0[5]		
2005	55,000[6]	25,572[3]	1,084	23.6
2006a	55,000[7]	36,546	1,343	27.2
2006b	35,000[7]	34,900	349	100
2007	**55,000**			

1. A developmental period was introduced into the fishery from 1993 to 1997 to encourage hatchery production technology. The main undertakings were the introduction of 3 new Zone 1 pearl industry licences, and a corresponding increase in TAC of pearl shell in Zone 1 (from 55,000 to 115,000 shell).
2. Management arrangements in 1994 and 1995 allowed fishing of quota a year ahead. Licensees who utilised this option took a quota reduction in subsequent years.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell.
4. In 2003 and 2004, the 115,000 Zone 1 quota was still maintained, however only 45,000 could be caught from wild stock due to hatchery shell substitution.
5. In 2004, no wild-stock quota was taken as only hatchery oysters were used.
6. In 2002 and 2005, the wild-stock quota for management and compliance purposes is effectively 55,000, due to hatchery substitution rules.
7. A higher TAC in 2006 was the result of an additional 35,000 experimental quota (2006b) allocated for a lightly-exploited stock within a pearl farm lease, and 34,900 of this quota was caught in 349 dive hours at a CPUE of 100 shells per hour. The remainder was caught at 27.2 shells per hour.

North Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from C. Syers

Fishery Description

The blue swimmer crab (*Portunus pelagicus*) is found along the entire Western Australian coast, in a wide range of inshore and continental shelf areas, from the inter-tidal zone to at least 50 m in depth.

The majority of the commercially and recreationally-fished stock, however, is concentrated in the coastal embayments between Geographe Bay in the south and Port Hedland in the north. Crabbing activity in the North Coast bioregion is centered largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around the embayment of Nickol Bay.

Dedicated blue swimmer crab fishers in the North Coast bioregion use purpose-designed 'hourglass' traps. The Pilbara trawl fisheries target prawns, but also retain crabs as a by-product.

The majority of recreational fishers in the North Coast crab fisheries use drop nets, with a small proportion using scoop nets or diving for crabs.

Governing legislation/fishing authority

Exceptions to the Fish Traps Prohibition Notice 1990 and Fish Traps Restrictions Notice 1994
Exemptions under Section 7 of the *Fish Resources Management Act 1994*
Nickol Bay Prawn Fishery Management Plan 1991
Nickol Bay Prawn Managed Fishery Licence
Onslow Prawn Fishery Management Plan 1991
Onslow Prawn Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

One dedicated commercial crab fisher is endorsed to operate two 200-trap allocations between longitudes 115° E and 120° E (approximately Onslow to Port Hedland), from the high water mark to the 200 m isobath. The other fisher is endorsed to use a maximum of 200 traps, with boundaries that mirror those of the first endorsement other than the waters of Nickol Bay (i.e. between longitudes 115° E and 120° E, other than the waters of Nickol Bay, from the high water mark out to the 200 m isobath).

The boundaries of the Onslow Prawn Managed Fishery are 'all Western Australian waters of the Indian Ocean below high water mark lying west of 116°45′ east longitude and east of a line commencing at the high water mark on the mainland due south of the southernmost extremity of Locker Island drawn due north to the high water mark at that extremity; thence northwesterly to the high water mark at the southernmost extremity of Serrurier Island; thence northerly along the high water mark of that island on its western shore to its northernmost point; thence due north'.

The boundaries of the Nickol Bay Prawn Managed Fishery are 'all the waters of the Indian Ocean and Nickol Bay between 116°45 east longitude and 120° east longitude on the landward side of the 200 m isobath'.

Management arrangements

Commercial access to blue swimmer crab stocks in WA is governed by a series of separate management arrangements provided for under the legislative framework of the *Fish Resources Management Act 1994.*

Individual fisheries are managed under an input control system, primarily through the regulation of vessel and trap numbers. Supplementary controls cover retainable species and associated minimum size limits, gear specifications, and seasonal and daily time restrictions.

Exemptions were issued in 2001 for 2 fishers to target blue swimmer crabs in the waters off the Pilbara coast between Onslow and Port Hedland. One of these fishers was granted two 200-pot endorsements attached to his licence, making a total of three 200-pot endorsements in the fishery.

The exemption carrying the two 200-pot endorsements permitted fishing between longitudes 115° E and 120° E (approximately Onslow to Port Hedland), from the high water mark to the 200 m isobath. However, a maximum of 200 pots could be used in the waters of Nickol Bay at any one time.

The second exemption endorsed fishing with 200 pots between longitudes 115° E and 117° E (approximately Onslow to just west of Nickol Bay), from the high water mark to the 200 m isobath. A submission was received from this exemption holder in 2003 to expand the boundaries of this exemption to match the other Pilbara crab endorsement. Following consultation with the various stakeholders, the boundaries of the second exemption were expanded to mirror the first endorsement other than the waters of Nickol Bay (i.e. between longitudes 115° E and 120° E, other than the waters of Nickol Bay, from the high water mark out to the 200 m isobath).

The principal management tool employed to ensure adequate breeding stock in the North Coast crab fisheries involves maintaining minimum size limits well above the size at sexual maturity. The legal minimum sizes range of 135 mm carapace width (CW) in the Pilbara fisheries is set well above the size at sexual maturity, and should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

Management controls for the Onslow and Nickol Bay Prawn Managed Fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices

('grids'). The management system involves a total allowable effort arrangement whereby all boats have an equal allocation of headrope length for all areas.

The fleet is composed of trawlers up to 23 m; operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

The Department of Fisheries' Vessel Monitoring System (VMS) continues to monitor the activities of all boats.

Recreational fishing for blue swimmer crabs in Western Australia is managed through a series of input and output controls. As with commercial fishing, the principal management tool employed to sustain an adequate breeding stock involves maintaining minimum size limits well above the size at sexual maturity.

A minimum legal size limit of 127 mm CW applies in State waters, along with a bag limit of 20 crabs per person or 40 crabs per boat for 2006. Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures.

Research summary

Data for the assessment of blue swimmer crab stocks in the North Coast bioregion are obtained from fishers' compulsory catch and effort returns, voluntary daily log books and on-board catch monitoring conducted by Department of Fisheries' research staff.

Additional information on the biology and ecology of blue swimmer crabs has been provided by a number of projects funded by the Fisheries and Research Development Corporation (FRDC) and conducted by the Department of Fisheries and Murdoch University.

Retained Species

Commercial landings (season 2005/06): 55 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2005/06 was 896 t. Total landings for the North Coast bioregion during 2005/06 was 55 t.

The annual blue swimmer crab catch from the Pilbara Experimental Crab Trap Fishery increased by 46% during 2005/06, with total landings of 53 t compared to 34 t landed the previous year (North Coast Blue Swimmer Crab Figure 1).

While landings from the Pilbara trawl fleet dropped marginally from 4.4 t in 2004/05 to 2.6 t in 2005/06, the catch was consistent with trawl fleet landings from previous years (North Coast Blue Swimmer Crab Figure 1).

Recreational catch estimate (season 2005/06):

Recreational catch: About 25% of total catch

Most of the recreational fishing for blue swimmer crabs in Western Australia occurs in the West Coast bioregion, with minimal recreational effort in the North Coast bioregion.

A survey of recreational crabbing in Nickol Bay estimated a recreational catch of blue swimmer crabs of 20 t for the 2000 calendar year. This represented the majority of the catch from Nickol Bay in that year, as commercial operations targeting blue swimmer crabs in the area did not begin until the following year.

No further surveys quantifying recreational catch have been undertaken since the 2000 survey. If this level of recreational effort has been maintained, it would provide for about 25% of the total catch.

Fishing effort/access level

Effort in the Pilbara Crab Fishery increased during 2005/06 in line with the increase in landings of blue swimmer crabs. Commercial crab fishers reported 33,040 trap lifts from 141 fishing days, up from 19,780 trap lifts over 110 fishing days the previous year (North Coast Blue Swimmer Crab Figure 2).

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Adequate

Length-frequency data gathered from ongoing monitoring programs in the Pilbara Experimental Crab Trap Fishery suggests that management controls currently in place provide adequate measures to maintain a sustainable level of catch and effort.

Monitoring of the commercial catch in the North Coast bioregion has been conducted since 2002, with consistent size distributions being recorded between years within the fishery. The development of appropriate mesh sizes for use on commercial crab traps has eliminated the catch of juvenile crabs (< 80 mm CW) and significantly reduced the catch of crabs < 120 mm CW, without impacting on legal catches.

Improved work practices have reduced the mortality of returned under-size and berried crabs caught in commercial traps to negligible levels.

Catch rates from each fishery provide an index of abundance which can be used to assess fishery performance from year-to-year. Trap catch rates in the Pilbara Experimental Crab Trap Fishery (North Coast Blue Swimmer Crab Figure 2) have increased steadily since the commencement of exploratory fishing along the Pilbara coast. This reflects the more efficient fishing of blue swimmer stocks in the Pilbara region as the commercial operators' knowledge of the spatial distribution of resident stocks and localized environmental influences increased over time. The increase in catch rate can also be attributed to improvements to fishing gear and vessels.

The mean catch rate for the Pilbara Experimental Crab Trap Fishery during 2005/06 was 1.6 kg/trap lift, comparable to the 2004/05 catch rate of 1.7 kg/trap lift (North Coast Blue Swimmer Crab Figure 2).

Non-Retained Species

Bycatch species impact: Negligible

The pots are purpose-designed to minimise the capture of non-target species and are therefore an inefficient way to capture fish, the majority of which are able to escape through the entrance gaps when the pot is soaking or being hauled. Small numbers of fish are infrequently captured in crab pots, but the fishers are not permitted to retain them.

The low number of fish caught and returned by crab fishers is considered to pose a negligible risk to these breeding stocks.

Discarded crab bycatch from trawl fisheries taking crabs as a by-product is dealt with in those reports specific to the trawl fisheries.

Protected species interaction: **Negligible**

The crab trap longline system utilised in the targeted crab fisheries has little possibility of interacting with protected species. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species, and avoids or minimises impacts on threatened ecological communities.

Ecosystem Effects

Food chain effects: **Low**

As the commercial take of crabs represents a relatively small portion of the biomass, which is effectively renewed annually, secondary food chain effects are likely to be minimal in these fisheries.

Habitat effects: **Negligible**

Fishing with traps results in limited habitat disturbance, with only minor dragging of traps on the bottom occurring during trap retrieval. Sand and associated biota do not get brought to the surface in commercial blue swimmer crab traps, as the mesh used on traps is sufficiently large to allow the escape of any sand-dwelling macrobenthos.

Although seagrasses are occasionally brought to the surface with the trap, the infrequent nature of this occurrence, and the small amount of living seagrass removed, results in minimal habitat damage.

Social Effects

During 2005/06, approximately 6 people were employed as skippers and crew on vessels fishing for blue swimmer crabs along the Pilbara coast. Additional employment is also being created in the Pilbara region through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: $0.25 million

Despite the smaller overall state catch in 2005/06, beach prices for blue swimmer crabs remained between $4/kg and $6/kg live weight in the major fisheries, with the average price for the year around $4.50. The catch from the Pilbara region was valued at approximately $250,000 and sold through local and interstate markets.

Fishery Governance

Target catch (or effort) range

The Pilbara Experimental Crab Trap Fishery is still in its developmental stage and target catch and effort have yet to be set.

Current fishing (or effort) level: **Acceptable**

The Pilbara Experimental Crab Trap Fishery has undergone a steady expansion since exploration of the commercial viability of fishing blue swimmer crab stocks between Onslow and Port Hedland commenced in 2002.

The remote nature of much of this coastline has provided significant logistical and financial challenges to the commercial viability of accessing crabs stocks and returning the harveted catch to market in an acceptable time period. Improvements to fishing gear and vessels, along with a substantial increase in the fisher's understanding of the influences of localised environmental influences such as tide and wind, has allowed them to maintain catch levels while undertaking fewer pot lifts.

Fishing effort in this region is further limited by the extreme climactic conditions experienced during the summer months, which restricts fishing effort to the cooler months between May and November.

Consequently, the levels of fishing effort in the Pilbara Experimental Crab Trap Fishery is considered acceptable.

New management initiatives (2006/07)

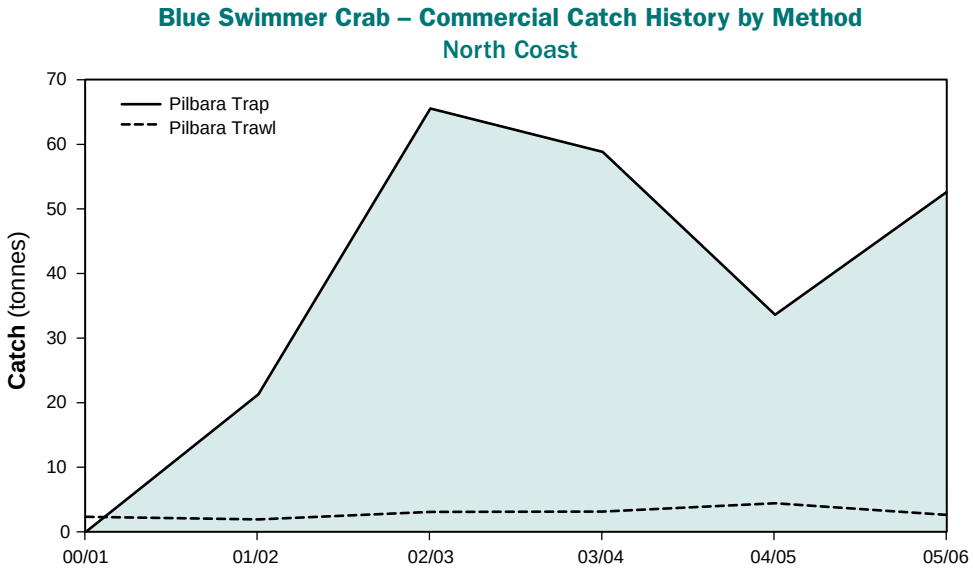
The Pilbara Experimental Crab Trap Fishery will form part of the 'Developing New Fisheries' review process that will take place during 2006 and 2007. This review will provide a framework to determine the future viability of a fishery in this region.

External Factors

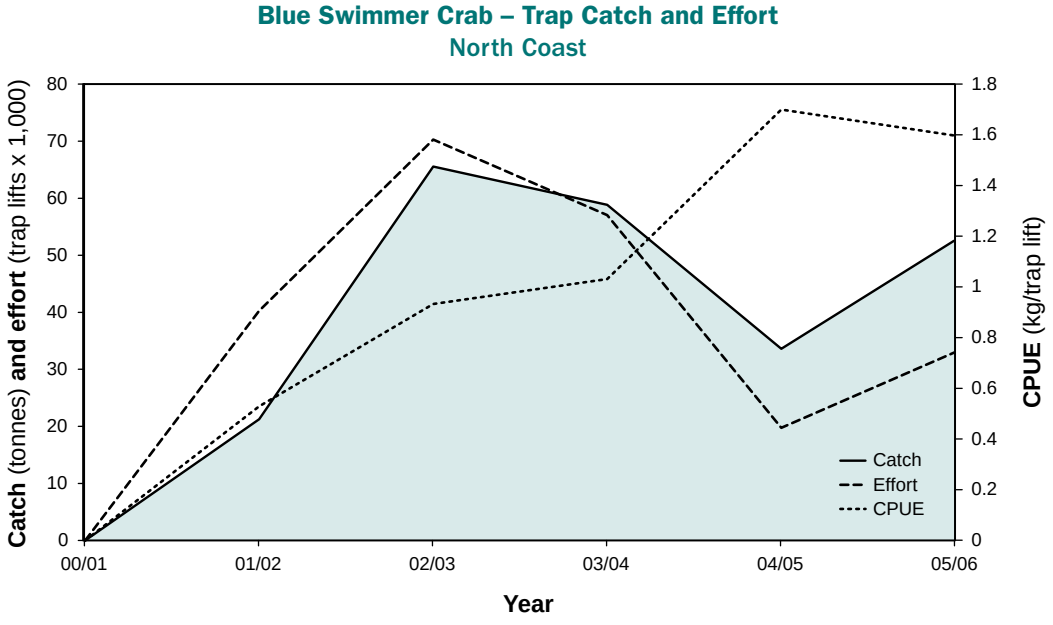
Levels of recruitment to many of the crab fisheries fluctuate considerably. While the causes of this variation are not fully understood, it is considered most likely due to environmental influences on larval survival.

Currents and water movement play a significant role in determining recruitment success, as a specific window of time is available during the megalopal larval stage of the blue swimmer crab to reach and/or select a suitable settlement site. Both temperature and salinity influence the spawning behaviour, distribution, activity and movement of blue swimmer crabs, while juvenile growth is also markedly influenced by the availability of food.

The relationship between environmental factors, recruitment and catch will be further evaluated as data becomes available.



NORTH COAST BLUE SWIMMER CRAB FIGURE 1
Commercial catch history by method for the blue swimmer crab (*Portunus pelagicus*) in the North Coast bioregion between 2000/01 and 2005/06.



NORTH COAST BLUE SWIMMER CRAB FIGURE 2
Blue swimmer crab catch (tonnes), effort (trap lifts x 1,000) and catch per unit effort (kg/trap lift) in the North Coast bioregion between 2000/01 and 2005/06 using traps.

Beche-de-mer Fishery Status Report

A. Hart and D. Murphy
Management input from J. Kennedy

Fishery Description

Beche-de-mer, also known as sea cucumbers or trepang, are in the Phylum Echinodermata, Class Holothuroidea. They are soft-bodied, elongated animals that usually live with their ventral surface in contact with the benthic substrate or buried in the substrate.

The Western Australian beche-de-mer fishery is based in the northern half of the State, from Exmouth Gulf to the Northern Territory border. It is a hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading. There are 6 target species caught commercially in Western Australia, however 99% of the catch is sandfish (*Holothuria scabra).*

Governing legislation/fishing authority

Fisheries Notice no. 366 – Prohibition for commercial fishers unless otherwise endorsed for shellfish, coral, starfish, urchins and beche-de-mer
Fishing Boat Licence Conditions
Commonwealth Government Environment Protection and Biodiversity Conservation Act 1999 (Wildlife Trade Operation)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The beche-de-mer fishery is permitted to operate throughout Western Australian waters with the exception of marine parks, reserves and sanctuaries and a number of specific closures around Cape Keraudren, Cape Preston and Cape Lambert, the Rowley Shoals and the Abrolhos Islands.

Management arrangements

The developing fishery for beche-de-mer is managed through input controls including limited entry, maximum number of divers, species-dependent minimum legal size limits, and gear restrictions. Access to the fishery is limited to the 6 operators holding a fishing boat licence endorsement to take beche-de-mer.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers who currently hold a permit and operate from a licensed fishing boat which is endorsed to take beche-de-mer. Aboriginal communities may be granted a non-transferable exemption to fish.

The maximum number of divers (per endorsed fishing boat licence) allowed to dive for beche-de-mer at any one time is 4, with a maximum number of crew (6) allowed on the vessel.

There are 6 target species of beche-de-mer harvested in Western Australia. At present, the legal minimum lengths for these commercial beche-de-mer species are based on the Northern Territory's minimum sizes, which have been set based on size at sexual maturity. The species and minimum size limits are:

Holothuria scabra (sandfish)	16 cm
Holothuria noblis (white teatfish)	32 cm
Holothuria whitmaei (black teatfish)	26 cm
Thelenota ananas (prickly redfish)	30 cm
Actinopyga echninitis (deep-water redfish)	12 cm
Holothuria atra (lolly fish)	15 cm

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of beche-de-mer. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Current research is focused on reporting of annual catch and effort statistics. A daily catch and effort log book has been tested and designed for the fishery and will be implemented in 2007.

The log book will obtain species-specific, fine-scale catch and effort data and appropriate environmental information such as depth fished.

Retained Species

Commercial landings (season 2006): **156 tonnes (live weight)**

Recreational catch estimate (season 2006): **Nil**

Landings

In 2006 the total beche-de-mer catch was 56 t live weight (Beche-de-mer Table 1), which is the lowest level of catch since the fishery began.

Prior to 2006, catch has been relatively constant since 2000, after the initial developmental years of the fishery. The maximum catch of 382 t was recorded in 1997 during the early years of the fishery.

Fishing effort/access level

3 licensed vessels fished for beche-de-mer in 2006, which was the same as 2005. This represents 50% of the potential number of vessels that have an endorsement to fish.

Total effort was 660 crew days – about 20% higher than in 2005 (Beche-de-mer Table 1). Effort has been relatively stable since 2000 (400 – 600 crew days), except for 2003 when 1,019 crew days were expended.

Stock Assessment

Assessment complete: **Preliminary**

Breeding stock levels: **Adequate**

The catch rate for beche-de-mer (diving only) was 85 kg/crew day, which was lower than all previous years. The highest catch rates occurred in the first 3 years of the fishery.

Annual catch and effort statistics show that catch rates and catch declined in 2006, however effort was comparable with previous years. Industry personnel report that much of the 2006 fishing involved exploratory surveys, hence catch and catch rates would be expected to be lower than average. However a significant number of regularly fished areas were also visited, and catch rates were lower in these as well.

The biomass dynamics model for 2005 indicated that the maximum sustainable yield (MSY) for the currently fished stocks is around 97 t. This model was updated in 2006 and estimated MSY was 65 t, which is substantially lower than 2005.

Breeding stock levels should be adequately protected by the imposed size limits; however, an analysis of size at maturity is required for sandfish (*Holothuria scabra*) stocks in Western Australia to verify that the size limits are correct. The preliminary performance indicators were met for 2006.

The initial performance measures for the fishery relate to breeding stock maintenance as indicated by catches remaining in the range 50 – 150 t and catch rate remaining above 80 kg/crew day. Both measures were met in 2006.

Non-Retained Species

Bycatch species impact: **Negligible**

There are currently no bycatch species known to be taken in this fishery. Given the selective method of fishing used (diving or wading, collection by hand only), the minimal level of interaction with other species is likely to be maintained.

Protected species interaction: **Negligible**

There are currently no protected species known to be taken in this fishery.

Ecosystem Effects

Food chain effects: **Negligible**

This fishery harvests only a small amount of sandfish per annum. The effect from this harvesting on the rest of the ecosystem, given that the catch is spread over a wide region, would be insignificant.

In addition, predation on the beche-de-mer is relatively infrequent due to the toxins present in their body tissues. It is highly unlikely these animals are a major diet for higher-order predators, due to these toxins acting as an effective defence system.

Habitat effects: **Negligible**

Divers collect beche-de-mer as they drift over the bottom; there is minimal impact on the habitat as divers are highly selective in their fishing effort and no fishing gear or lines contact the seabed. The vessels work during the day and anchor at night, usually further inshore where they are protected from the open ocean which is subject to higher seas and wind. Most fishers are mindful of the habitat they choose to anchor over, so they avoid more diverse bottom habitat.

There are some areas where fishers can access beche-de-mer by wading through the shallow water mangrove lagoons and estuaries. This is a minor component of the fishery. This method may be applied in areas of the Kimberley that are accessible and prone to extreme tidal movements. Wading usually occurs on soft sandy substrates, with minimal impact on these habitats.

Social Effects

Up to 36 fishers can be employed in the fishery, based on 6 endorsements each with a maximum of 6 crew. In 2006, 3 vessels with a total of 15 crew were working in the fishery.

Additional individuals are employed for the processing of the product. These activities are mostly located in remote areas of the Kimberley and Pilbara regions.

Economic Effects

Estimated annual value (to fishers) for year 2005: **$448,000**

The estimated annual value for 2006 was $448,000 based on an average product price of $8/kg live weight.

Fishery Governance

Target catch range: **50 – 150 tonnes**

This target catch range is preliminary, noting that this is a developing fishery.

New management initiatives (2006/07)

A daily catch and effort log book has been developed, with the intention that ultimately this will replace the compulsory monthly return. Implementation of this is planned to coincide with the 2007 review of the fishery.

External Factors

The remoteness of the currently fished stock and the large tidal ranges are natural barriers to uncontrolled expansion of fishing of beche-de-mer. Marine park planning processes may also impact on the potential extent of the fishery in the Pilbara region.

BECHE-DE-MER TABLE 1

Catch, effort and CPUE of sandfish (*Holothuria scabra*) in the beche-de-mer fishery since 1995.

Year	Live Wt (t) (all methods)	Crew Days (all methods)	Kg/Crew Day (diving only)
1995	92.7	737	212.0
1996	257.3	945	249.0
1997	382.1	1,852	222.2
1998	309.7	2,565	135.0
1999	175.7	1,757	106.4
2000	82.9	607	134.7
2001	90.1	663	137.6
2002	87.1	535	124.8
2003	122.4	1,019	146.2
2004	80.9	470	143.0
2005	77.7	545	150.0
2006	**56.0**	**660**	**85**

AQUACULTURE

Regional Research and Development Overview

Aquaculture in the north coast bioregion is dominated by the production of pearls from the species *Pinctada maxima (*'south-sea pearls'*).* This industry utilises both wild-caught and hatchery-reared oysters for the production of cultured pearls. The wild-stock fishery is reported in the commercial fisheries section in the north coast section of this volume.

The Department of Fisheries also has a major role in the management and regulation of pearl hatcheries, seeding activities and pearl oyster farm leases.

The Minister is presently conducting an independent public interest review of the pearling industry, including the Phase III Hatchery Policy. The review is expected to be completed in 2007. The outcome and implementation of the hatchery policy and industry strategy will be subject to the outcome of the independent review.

Similarly, the industry compliance plan is currently subject to an independent review. A Memorandum of Understanding (MOU) between the Western Australian and Northern Territory fisheries ministers was signed in June 2006. The MOU recognises that WA and the NT comprise the entire Australian south-sea pearling industry and that product from both jurisdictions supplies the same market.

The MOU aims to manage the industry within a total quota framework and to maximise efficiencies through the adoption of consistent policy directions in areas such as translocation and compliance. A fish farm located in Cone Bay is currently producing barramundi.

The Department of Fisheries' Research Division's Fish Health Unit is actively involved in assisting the commercial hatcheries, in terms of disease control and the annual certification of hatchery facilities as required under the *Fish Resources Management Act 1994* and the *Enzootic Diseases Regulations 1970.*

A major 'Sustainable Regions Program' project, involving the Department's research staff but managed by the Kimberley Aquaculture Aboriginal Corporation was completed. This project addressed the commercialisation of black tiger prawn (*Penaeus monodon*) farming in the Kimberley.

Broodstock surveys and collection of black tiger prawns have led to successful spawning of disease-free prawns and successful grow-out in commercial ponds. Future development of the prawn farming industry will benefit from this research, if and when the economic viability of the industry improves in Australia.

The Department of Fisheries has contributed significantly to the Native Title Working Group considering the development of a prawn farming site near Wyndham. Research and Regional Services staff have conducted on-site discussions with the proponents and Indigenous representatives relating to the viability of the enterprise and the process of acquiring licenses and other approvals.

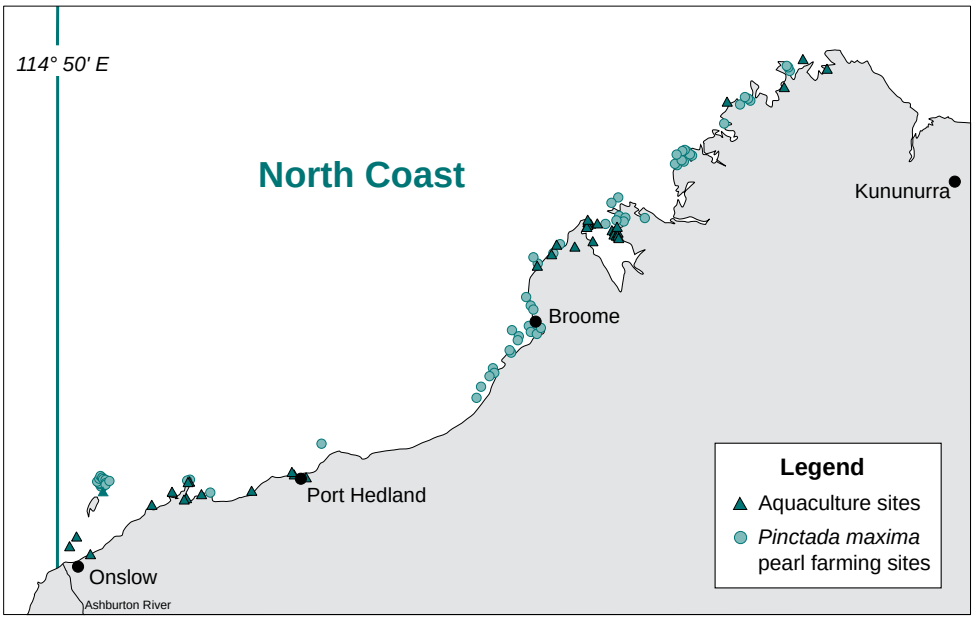
As part of its process of Ecologically Sustainable Development reporting for aquaculture, the Department is focusing on prawn aquaculture as the second sector to be considered (finfish aquaculture was the first). This process will result in a code of conduct and monitoring program for prawn farmers that should assist industry and government in achieving appropriate environmental outcomes for this sector.

The Department continues to assist the Department of Land Information in negotiations over land tenure associated with the proposed development of a prawn farm at Wyndham.

Sea-cage barramundi farming in the Kimberley grew in 2005/06, with the major operator in the area increasing its permitted

production capacity and making application for further expansion within new waters.

The Department of Fisheries is supporting the development of several indigenous aquaculture projects in this region, targeting the aquaculture of barramundi (*Lates calcarifer*) in sea-cages and earthen ponds, cherabin (*Macrobrachium rosenbergii*) and edible rock oysters (*Saccostrea* sp.). With the financial assistance of the Department of Industry and Resources, the Department obtained the services of a nationally-recognized barramundi aquaculture expert to inspect the suitability of sites for sea-cage aquaculture adjacent to 2 indigenous communities.



NORTH COAST AQUACULTURE FIGURE 1
Map showing the major licensed aquaculture and pearl farming sites of the North Coast bioregion. Note that aquaculture operations may also encompass the culture of non-*Pinctada maxima* pearl oysters

COMPLIANCE & COMMUNITY EDUCATION

The North Coast bioregion extends over the north-west of the State from Onslow, south of Karratha, to the Western Australia/ Northern Territory border. The coastline of the North Coast bioregion stretches over 2,600 kilometres.

The bioregion's marine offshore components cover an extensive area, containing numerous islands and atolls, including the Rowley Shoals, Montebello Islands and Barrow Island. The landmass of the area is roughly equivalent to half the size of Western Australia. Much of the terrain is remote, sparsely populated and very difficult to access.

Each year, tourism numbers continue to grow, with over 650,000 visitors coming in to the North Coast bioregion by road and air each year, primarily during the winter (dry season) months from May to October. This number is expected to increase by approximately 5 to 7% per annum over the next 5 years. Surveys carried out with visitors show that recreational fishing ranks highly as an activity the visitors choose to take part in whilst visiting the bioregion.

Fisheries and Marine Officers (FMOs) working out of the 2 district offices at Karratha and Broome – located 800 km apart by road – deliver compliance and community education services across the bioregion. During 2005/06 the 2 district offices maintained a permanent staff of 9 FMOs, supplemented by a 2-officer mobile patrol during peak winter months. Compliance is delivered across commercial and recreational fisheries, pearling, aquaculture, fish habitat and biosecurity areas.

To provide compliance and education services across the Pilbara and Kimberley, FMOs conduct extended remote patrols, lasting up to 2 weeks at a time. Officers use specially equipped 4-wheel-drive vehicles and a range of vessels for inshore coastal and inland waters through to large fisheries patrol vessels (23 metres in length) for offshore work.

Compliance and community education messages are delivered to inland towns such as Tom Price, Pannawonnica, Newman and Paraburdoo, as local knowledge and patrol contact statistics show that many in these towns regularly travel to coastal locations such as Onslow and Port Hedland, towing vessels for overnight and extended fishing trips.

Officers in the North Coast bioregion dive-team undertake a variety of underwater inspections including on pearling, vessels for introduced marine pests (i.e. for biosecurity purposes) and habitat monitoring.

In delivering fisheries compliance duties throughout the bioregion, FMOs use a risk-based and random approach to perform complaint investigation, catch, licence, gear, processor, retail and transport inspections. Officers utilise a range of strategies including roadside checks, dive inspections, and land-based and aerial surveillance.

Officers also play a vital role in promoting voluntary compliance by adopting a high profile in delivery of community education. An increased emphasis on community engagement was demonstrated by FMOs maintaining a presence at the FeNaClNG festival in Karratha, the Nameless Festival in Newman, the Northwest Expo in Broome, King Tide Day in Derby and the Ord Valley Muster, and at a variety of fishing competitions and community fairs.

The community education role extends to conducting children's fishing clinics and school talks. Officers also coordinate and facilitate Volunteer Fisheries Liaison Officer (VFLO) patrols, while VFLOs in turn provide advice to the community.

Activities during 2005/06

During 2005/06, the North Coast bioregion's FMOs delivered a total of 4,527 officer hours of active compliance patrol time – a significant increase from the previous year (North Coast Compliance Figure 1). FMOs also achieved 6,291 personal compliance contacts with the community and fishers.

FMOs undertook prosecution action as a result of compliance targeting in 2005/06. This resulted in 25 infringement warnings and 43 infringement notices being issued, with 17 matters resulting in prosecution action.

During 2005/06, large numbers of foreign fishing vessels illegally entered WA State waters for shark fin. This activity posed a major threat to shark species in the Kimberley.

Foreign fishing vessels were also detected in mangroves and on reefs near communities illegally removing trochus and beche de mer. The take of trochus by the illegal fishers threatened the viability of the trochus fishery enterprise at One Arm Point.

Department of Fisheries officers were involved in the apprehension of 164 foreign fishers, resulting in 116 being charged and convicted of offences against State fisheries legislation. Officers carried out specific operations to detect and apprehend foreign fishing vessels who appeared to be involved in illegal activities. An operation called 'Pandanus' was the precursor to the Bardi Marine Ranger Program.

Charges were preferred under Sections 174 and 175 of the *Fish Resources Management Act 1994* and the accused appeared before the Broome Magistrates Court.

Officers also undertook a greater role in contributing to fisheries management review, legal development, policy development and planning to ensure better coordination and practical application of management strategies.

Compliance inspections were carried out on pearl oyster fishing and seeding operations, during transportation of pearl oysters and at the various pearl oyster lease sites. Considerable travel time is required to reach many of the lease sites, due to their remote locations.

Volunteer Fisheries Liaison Officer (VFLO) groups from across the bioregion were supported with training and many new members were recruited. These activities culminated in a combined meeting of Pilbara and Kimberley VFLOs and a patrol at 80 Mile Beach. The VFLOs raised their community profile in a range of locations from Karratha through to Kununurra, where they attended the Ord Valley Muster.

Initiatives in 2006/07

2006/07 will see the introduction of the Bardi Marine Patrol pilot program operating from the One Arm Point Community. One Arm Point is approximately 200 km north of Broome, on the north-eastern tip of Dampier Peninsula at the entrance to King Sound. The community of One Arm Point supports a population of 500 people. The Bardi Jawi people, represented by Ardyaloon Incorporated, are the traditional landowners of this area of the country in the Kimberley region of Western Australia.

The pilot program is being commenced in response to the threats posed to fish resources by foreign fishing vessels coming into State waters to fish illegally for trochus, beche de mer and shark. Foreign vessels engaging in illegal fishing were operating within sight of the One Arm Point Community

The following partner organisations are working together to implement the pilot program:

- Ardyaloon Aboriginal Corporation (Bardi Jawi community at One Arm Point);
- Australian Customs Service;
- Department of Agriculture, Fisheries and Forestry (Commonwealth Government); and
- Department of Fisheries (Western Australian State Government).

Typical work of the program will consist of searching heavy mangrove forest areas considered suitable for concealment of illegal foreign fishing vessels; patrolling creeks, inlets, bays and open water for illegal foreign fishing vessels; identifying suitable covert surveillance locations; and providing on-the-job training for Bardi marine rangers.

Another important emerging issue for the North Coast bioregion is that of biosecurity. FMOs based in the north will be undertaking biofouling inspections of vessels coming into State waters for introduced marine pests such as the Asian green mussel. The Port of Dampier and surrounding areas such as Cape Lambert have seen greatly increased international vessel movement.

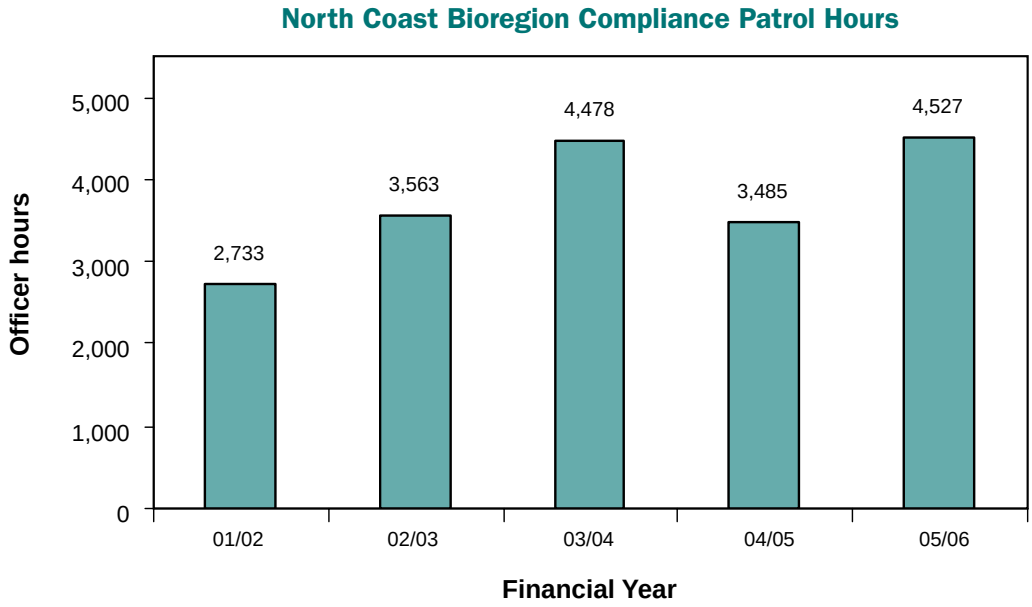
Further planned expansion to Cape Lambert and Cape Preston will see additional dredging vessels engaged to carry out the work. Dredging vessels involved in the port expansion are considered to be high risk for the introduction of marine pests such as Asian green mussel and black striped mussel.

The North Coast bioregion's FMOs are continuing to review their risk-based assessment practices to ensure areas at high risk of non-compliance are targeted. Standard operating procedures developed for the pearling industry will be employed to maintain consistent standards across this important fishery.

The Department of Fisheries' recreational mobile patrol unit ('Mobile 1') will be focussed on maximising recreational fishing compliance during peak tourism periods. Working with departmental district officers, they provide increased compliance outcomes by giving greater geographical coverage across the region and contacting greater numbers of fishers to deliver community education and compliance messages.

There is a continued emphasis on developing and supporting the Volunteer Fisheries Liaison Officer (VFLO) program, with new activities planned to promote the program in the north. Pilbara Iron and the Department of Fisheries have entered into a Memorandum of Understanding (MOU) whereby Pilbara Iron funded the purchase of a specially-designed VFLO trailer to allow Pilbara-based volunteers and new volunteers, to conduct additional 'fish for the future' community education activities.

Pilbara-based VFLOs will have access to the off-road trailer, which will be equipped with equipment to run 'hands-on' fishing clinics, carry audio visual equipment to conduct presentations at isolated locations, and offer a 'one-stop' learning centre for all Department of Fisheries volunteer initiatives. As a part of the MOU, VFLOs will also receive reimbursement for personal vehicle fuel costs incurred when conducting educational activities, new uniforms and hats and additional training from the Perth-based VFLO coordinating team.



NORTH COAST COMPLIANCE FIGURE 1

This figure gives the "On Patrol" officer hours showing the level of compliance patrol activity delivered to the North Coast bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1 and Table 2. The totals exclude time spent on other compliance-related tasks, e.g. travel time between patrol areas, preparation and planning time.

NORTH COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the North Coast bioregion during the 2005/06 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	4,527 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	86
District Office contacts	947
Infringement warnings	1
Infringement notices	14
Prosecutions	15
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	5,156
District Office contacts	2,243
Infringement warnings	24
Infringement notices	29
Prosecutions	1
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1,005
District Office contacts	2,453
Fishwatch reports***	11

* Pearling contacts are excluded from these totals and detailed in North Coast Compliance Table 2.

** Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing related contacts within the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category. This table includes contacts made by *PV Walcott*. Contacts made by *PVs Hamelin* and MacLaughlan are included in West Coast Compliance Table 1.

*** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the Northern Inland bioregion that were referred to Karratha or Broome district staff.

NORTH COAST COMPLIANCE TABLE 2

This table gives summary statistics for pearling compliance in all bioregions in the 2005/06 fishing season.

Total compliance hours*	4,272 Officer Hours
Field contacts by Pearling Officers	44
District Office contacts	1,891
Letters of Warning issued**	2
Prosecutions	1

* Includes all time spent on compliance-related tasks, e.g. investigations, prosecutions, etc.

** No legislative capacity to issue infringement notices

South Coast Bioregion

Woody Island, Esperance.

South Coast Bioregion

ABOUT THE BIOREGION

The continental shelf waters of the South Coast bioregion are generally temperate but low in nutrients, due to the seasonal winter presence of the tail of the tropical Leeuwin Current and limited terrestrial run-off. Sea surface temperatures typically range from approximately 15°C to 21°C, which is warmer than would normally be expected in these latitudes due to the influence of the Leeuwin Current.

The effect of the Leeuwin Current, particularly west of Albany, limits the winter minimum temperatures away from terrestrial effects along the beaches to about 16 to 17°C. Fish stocks in the region are predominantly temperate, with many species distributions extending right across southern Australia. The occasional more tropical species found are thought to have been brought into the area as larvae, but are unlikely to form breeding populations.

Under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) scheme, published in 1998 by the Australian and New Zealand Environment and Conservation Council, the bioregion has been divided into 2 meso-scale regions: the WA South Coast and the Eucla.

The south coast is a high-energy environment, heavily influenced by large swells generated in the Southern Ocean. The coastline from Cape Leeuwin to Israelite Bay is characterised by white sand beaches separated by high granite headlands. East of Israelite Bay, there are long sandy beaches backed by large sand dunes, until replaced by high limestone cliffs at the South Australian border.

There are few large areas of protected water along the south coast, the exceptions being around Albany and in the Recherche Archipelago off Esperance.

Along the western section of the coastline which receives significant winter rainfall, there are numerous estuaries fed by winter-flowing rivers. Several of these, such as Walpole/Nornalup Inlet and Oyster Harbour, are permanently open, but most are closed by sandbars and open only seasonally after heavy winter rains.

The number of rivers and estuaries decreases to the east as the coastline becomes more arid. While these estuaries, influenced by terrestrial run-off, have higher nutrient levels (and some, such as Oyster Harbour and Wilson Inlet, are suffering eutrophication), their outflow to the ocean does not significantly influence the low nutrient status of coastal waters.

The marine habitats of the south coast are similar to the coastline, having fine, clear sand sea floors interspersed with occasional granite outcrops and limestone shoreline platforms and sub-surface reefs. A mixture of seagrass and kelp habitats occurs along the south coast, with seagrass more abundant in protected waters and some of the more marine estuaries.

The kelp habitats are diverse but dominated by the relatively small *Ecklonia radiata*, rather than the larger kelps expected in these latitudes where waters are typically colder and have higher nutrient levels.

The major commercial fisheries of the South Coast bioregion are the abalone fishery, the purse seine fishery targeting pilchards and other small pelagics, and a demersal gillnet fishery for sharks. Other smaller commercial fisheries are the long-standing beach seine fishery for Australian salmon and herring, a trap fishery targeting southern rock lobsters and deep-water crabs, and the intermittent scallop fishery in the Recherche Archipelago.

There is also a commercial net fishery for finfish operating in a number of south coast estuaries. South coast commercial fishing vessel operators often hold a number of licences to create a viable year-round fishing operation.

As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, shark, samson fish and King George whiting.

The third major component of the recreational fishery is dinghy and shoreline fishing of estuaries and rivers, focused in the western half of the bioregion. Here the main angling targets are black bream and whiting (including King George whiting). Recreational netting, primarily targeting mullet, also occurs in these estuaries.

The predominant aquaculture activity undertaken on the south coast is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves.

Other forms of aquaculture (e.g. sea cage farming) are restricted on the south coast by the high-energy environment and the very limited availability of protected deep waters typically required by this sector. As a consequence, most recent development activity has focused on land-based 'raceway' culture of abalone, using pumped sea water.

The Department of Fisheries' Research Division's newly established Biodiversity Branch currently has 3 research initiatives on the south coast. One is a project that has been examining the spatio-temporal overlap of sea lion foraging effort and demersal gillnet fishing effort, in order to better understand the threat of gillnetting to the different populations of sea lions and fur seals along the southern coast of WA.

The Australian sea lion is a federally-listed threatened species (in the "Vulnerable" category) and the draft recovery plan identifies the threat of incidental bycatch in fishing gear as one of the concerns to the continued viability of this species. Assessment of fishery-dependent data on interactions between fisheries and all protected species, continues as part of the Ecologically Sustainable Development process for all commercial fisheries in the region.

The second project is a collaborative one with the Natural Heritage Trust-funded Marine Futures initiative, which is aimed at collecting data to develop marine resource indicators for marine habitats, biodiversity and human use patterns in south-western

Australia. Sites have been established off Albany, Broke Inlet, Fitzgerald and the eastern Recherche. Bathymetric and towed video transects have been completed for all sites and additional work is scheduled for completion in the second half of 2007.

The last project is part of a coast-wide regional project aimed at evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions. One of the objectives of the project is to determine the risk of different vessel types introducing marine species to WA waters, based on shipping patterns and the species that are likely to be translocated through those movements.

Other objectives are the establishment of a centralised introduced marine species monitoring framework that:

- uses the national monitoring approach;
- determines locations where monitoring should occur, recognising both ports and high value areas; and
- provides information for the developing national database.

The project will also analyse potential future changes to threats due to increased shipping movements and changes in vessel origins.

ENVIRONMENTAL MANAGEMENT

Regional Overview (South Coast)

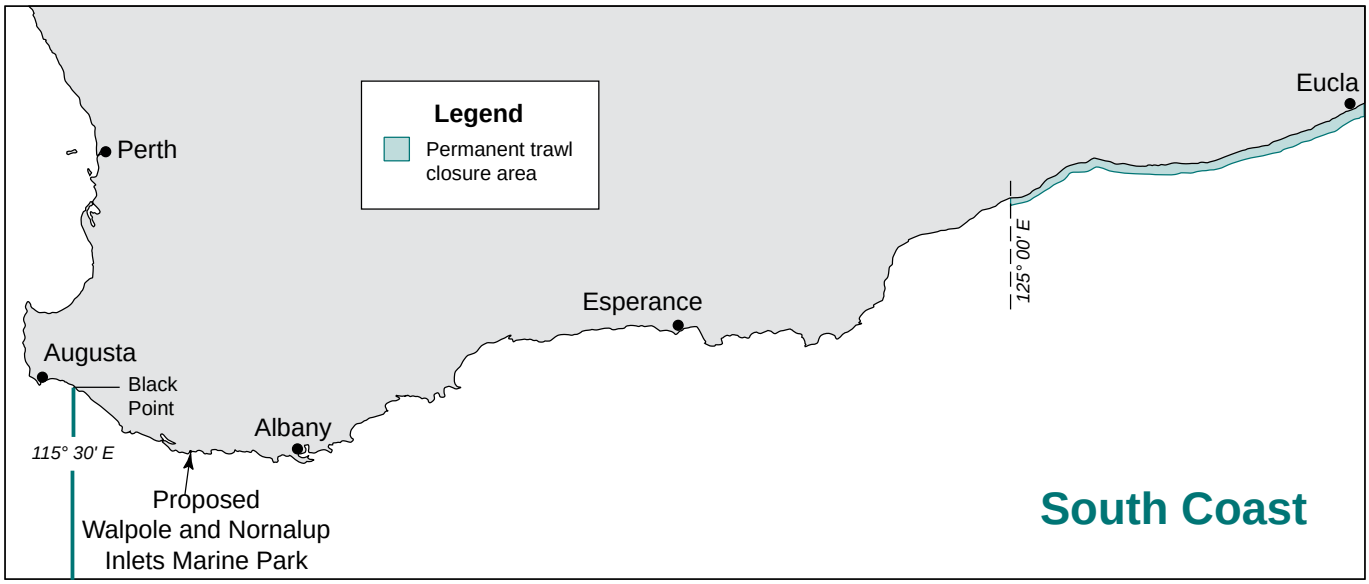
The inshore marine habitats of the south coast are largely unaffected by human activities, however estuaries and near-shore marine embayments where there is restricted water exchange, for example Princess Royal and Oyster harbours and Wilson Inlet, have experienced eutrophication events associated with high nutrient loads from adjacent land-based activity.

The only marine protected areas currently in place along the south coast are s.43 closures under the *Fish Resources Management Act 1994* surrounding the wreck of the *Perth* (Albany), wreck of the *Sanko Harvest* (east of Esperance), and Esperance Jetty. A proposed marine conservation reserve under the *Conservation and Land Management Act 1984* within Walpole–Nornalup Estuary is likely to be proclaimed in the coming year

In recognition of the increasing tourism and development pressure and associated population growth along the south coast, the WA State Government has initiated a South Coast Regional Marine Planning process along the south coast between the South Australian border and Cape Leeuwin, to develop a high-level South Coast Regional Marine Plan. A draft plan is anticipated to be completed by mid 2007, and will identify all sector interests along the coast, including areas of fishing, and make management recommendations on the long-term sustainable use of the near-shore marine environment within State waters, which will complement fishing management arrangements already in place.

The Australian Government's Department of Environment and Water Resources is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay, with a view to finalizing a South West Marine Bioregional Plan (MBP), which will contain individual marine protected areas.

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals which have the potential to impact on the aquatic environment, and continues to actively engage with the natural resource management groups for the south coast to promote sustainable use of the aquatic environment. New proposals currently being progressed for the South Coast include ones for mineral resource development and associated port facilities, and for petroleum exploration.



SOUTH COAST HABITAT PROTECTION FIGURE 1
Map showing areas permanently closed to trawl fishing and areas of protected fish habitat in the South Coast bioregion.

FISHERIES

South Coast Crustacean Fisheries Status Report

R. Melville-Smith
Management input by P. Shaw

Fishery Description

The south coast crustacean fisheries are pot fisheries which operate from Windy Harbour to the South Australian border. They include the Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery (ERLF), the rock lobster pot fishery (a Regulation fishery) operating in the Albany and Great Australian Bight (GAB) sectors, and the deep sea crab fishery (a Section 43 Order fishery).

The fisheries are multi-species and take southern rock lobsters (*Jasus edwardsii*) and western rock lobsters (*Panulirus cygnus*) as well as deep sea crab species including giant crabs (*Pseudocarcinus gigas*), crystal crabs (*Chaceon bicolor*) and champagne crabs (*Hypothalassia acerba*).

Southern rock lobsters comprise the majority of the catch in the eastern areas of the fishery, with crab species becoming more prevalent in the south-western region. Western rock lobsters are a significant component of the catch in the Windy Harbour fishery (not reported here due to confidentiality provisions relating to the small number of licensees).

Governing legislation/fishing authority

Esperance
Esperance Rock Lobster Management Plan 1987
Esperance Rock Lobster Managed Fishery Licence

Windy Harbour/Augusta
Windy Harbour/Augusta Rock Lobster Management Plan 1987
Windy Harbour/Augusta Rock Lobster Managed Fishery Licence

Other south coast endorsements
Fish Resources Management Regulations 1995
Regulation Licence granted under Regulations 125 and 126.
Condition 105 on a Fishing Boat Licence

All areas
Australian Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Order)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

Management boundaries for the south coast crustacean fisheries are shown in South Coast Crustacean Figure 1. The boundaries of the deep sea crab component of the fishery (Condition 105) include all the waters of these fisheries excluding those of the ERLF, where crabs may only be taken by the holders of an ERLF Licence.

Management arrangements

These commercial fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

In 2005/06, 2 vessels were licensed to fish for rock lobsters in the Windy Harbour/Augusta Rock Lobster Managed Fishery, 11 were licensed to fish in the ERLF and 31 vessels were endorsed to fish in the GAB and Albany zones.

The season for fishing for rock lobsters throughout the south coast crustacean fisheries mirrors the West Coast Rock Lobster Managed Fishery season (15 November to 30 June). Fishing for deep sea crabs can currently occur all year, but during the rock lobster season, operators must only use the number of pots endorsed on their rock lobster authorisation/licence.

Recreational fishers only target rock lobsters, not deep sea crabs. They are restricted to the use of 2 pots per person and divers are permitted to take rock lobster by hand, or with the use of a loop or other device that is not capable of piercing the rock lobster.

Size limits, bag limits and seasonal closures apply and all recreational fishers are required to hold a current recreational fishing licence authorizing them to take rock lobster.

A comprehensive Ecologically Sustainable Development assessment of this fishery determined that performance should be measured annually for breeding stocks of southern rock lobsters. Boxed text in this status report provides the annual assessment of performance for this issue.

Research summary

Ongoing research in this sector involves assessing the current status of the stocks based on commercial catch returns and information from south coast rock lobster fishers.

Retained Species

Commercial landings (season 2005/06): Southern rock lobster 40 tonnes

As with the 2004/05 season, the total catch of southern rock lobsters was 40 t for the 2005/06 (South Coast Crustacean Table 1). A catch of 25 t of southern rock lobsters was taken in the ERLF in 2005/06 – an increase of 56% on the catch taken in the 2004/05 season (16 t).

The combined catch for the GAB and Albany southern rock lobster fishery zones in 2005/06 was 15 t, down by 8 t to the catch taken in 2004/05 figure. The catch in the Albany zone remained similar to 2004/05, however, the catch in the GAB zone dropped by 47% to 9 t.

As a secondary target of the rock lobster fishery, a total of 15 t of deep sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 1 t of giant crabs (a decrease of 2 t over the 2004/05 season), 10 t of champagne crabs (an increase of 1 t over 2004/05 season) and 2 t of crystal crabs (an increase of 1 t over the 2004/05 season). In the ERLF, 2 t of giant crabs were landed (a decrease over the 2004/05 figure of 5 t).

Recreational catch estimate: **< 5 tonnes**

Estimates from mail surveys sent to a random selected sample of rock lobster licence holders suggest that the recreational catch of southern rock lobsters on the south coast is less than 5 t per year.

Numbers of recreational rock lobster licence holders that catch southern rock lobsters are small and estimating the recreational catch more accurately would require a dedicated survey or at least a different sampling strategy to the current mail survey.

Fishing effort

Fishing effort directed at crustaceans on the south coast is shown in South Coast Crustacean Table 1. It should be noted that effort figures are confounded in the Albany and Esperance zones, because an unknown proportion of the effort recorded may have targeted deep sea crabs rather than lobsters, particularly in the Albany zone.

The large decline in effort in the GAB Zone from 2004/05 to 2005/6 was because fewer fishers operated in that zone over the past season. There is no obvious reason for the large decline in fishing effort in the Albany Zone in 2005/06.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Uncertain**

Compulsory catch and effort returns for the commercial fishery have been used to monitor changes in catch per unit of fishing effort (CPUE) for the southern rock lobster fishery. CPUE in the 2005/06 season increased to 0.57 kg/pot lift in the 2005/06 season, compared to 0.49 kg/pot lift in 2004/05.

CPUE also increased in the GAB zone, in this case by 14%, from 0.42 kg/pot lift in 2004/05 to 0.48 kg/pot lift in 2005/06. Determining changes in CPUE in the Albany Zone is highly unreliable because as noted above, it is not possible to determine what fishing effort has been directed at lobsters as distinct from crabs. For completeness though, CPUE recorded for the Albany Zone increased from 0.08 kg/pot lift in 2004/05 to 0.25 kg/pot lift in the 2005/06 season.

The South Coast Crustacean Fishery has experienced significant declines in the past few years, especially the southern rock lobsters (South Coast Crustacean Figure 2). It is necessary to determine to what extent the downturn in landings represents natural fluctuations in catch, or just reductions in fishing effort.

Model assessments show that the biomass of legal-sized animals in the ERLF have increased in recent years since the catches have stabilised at around 20 t per year (South Coast Crustacean Figure 2), which indicates that earlier catch levels were not sustainable. Peak catches in this fishery were reached in the early 1990s after the discovery of deepwater fishing grounds and are now back to levels that were stable in the 1970s and 1980s (South Coast Crustacean Figure 2).

Catches in the GAB and Albany zones are small in relation to the vast stretch of coastline that they cover. The annual catch of rock lobsters in the Albany fishery has consistently been low (only about 6 t a season) (South Coast Crustacean Figure 2).

Landings in the GAB zone are from a number of shallow-water inshore areas which are dispersed along the coast and, as with the Esperance Zone, catches in the GAB are also down to levels that were last recorded in the early 1990s.

There is currently no specific information on biological characteristics such as growth rates and size at maturity of southern rock lobsters in WA. Given the small size of this fishery and expenses involved in the collection of data, it is not a high priority for research support. Furthermore, CPUE data are difficult to use because this is a multi-species fishery and catch rates can be biased, depending on which species is being targeted. Few fishers complete voluntary log books that would improve these data.

Insufficient information is available to provide detailed stock assessment advice for this fishery. The information that is available suggests that there may be long-term sustainability issues and excessive latent effort, which could prevent future recovery of the fishery. These issues are to be addressed within the financial constraints available for this small fishery (see 'New management initiatives' section 2006/07).

Oceanographic modelling work on possible rock lobster larval movements (David Griffin, CSIRO Hobart, pers. comm.) suggest that the source of southern rock lobster recruitment to WA waters may be from local stock as well as from the Northern Zone in South Australia.

Published assessments for the Northern Zone of South Australia estimate the broodstock to be the lowest level on record for that fishery. Modelling work based on catch per unit effort, suggests that the stock biomass (and therefore by implication the breeding stock) in the ERLF has also declined to its lowest level on record.

These low levels of egg production, combined with the larval source hypothesis, suggests that these fisheries need to be managed more cautiously than has been the case. If the recent downturn in catches continues, it could represent a potential case of recruitment over fishing.

The performance measure for the southern rock lobster fishery is that the catch in the ERLF indicator zone is to be below 40 t per annum. In 2005/06 the catch was 25 t.

For the secondary retained species, i.e. deep sea crab species, there are management measures (legal minimum sizes, return of females carrying eggs) in place which, based on current information, are considered to offer sufficient protection to the broodstock. Therefore, while the standing stock of these slow-growing and long-lived species may have been depleted by fishing several years ago, their broodstock is considered to have remained at acceptable levels.

Non-Retained Species

Bycatch species impact: **Low**

The gear used in this fishery generates minimal bycatch and the design of the pots is such that they do not 'ghost fish' if lost.

Protected species interaction: **Negligible**

The pots and ropes used in this fishery have minimal capacity to interact with protected species in this fishing area.

Ecosystem Effects

Food chain effects: **Negligible**

The rock lobster and crab catches represent a very small biomass for such a vast area of coastline, and any impact of fishing on the general food chain is expected to be minimal.

Habitat effects: **Negligible**

Rock lobster potting has a very low impact on the largely granite habitat over which the fishery operates.

Social Effects

There are a large number of licensed pots in this fishery, but not a large number of active fishers.

The nature of the fishery means that rock lobster and deep sea crab catches cannot support a stand-alone fishery. Most fishers use them to supplement income from other fishing activities, or supplement their fishing income with other non-fishing businesses or employment. In the Albany and GAB zones especially, fishers tend to vary their rock lobster and deep sea crab fishing effort according to the local abundance of stock and market prices.

If the management objective were to fish the Albany and GAB zone rock lobster and crab stocks to economically viable levels, then current effort levels would need to be drastically reduced.

A small amount of fishing for southern and western rock lobsters takes place by recreational fishers.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: **$1.2 million**

The beach value of the southern rock lobster fishery was about $1 million in 2005/06, based on a beach price of $25.50/kg. Giant crabs ($35.00/kg) crystal crabs ($13.00/kg) and champagne crabs ($11.50/kg) added an additional $246,000 to the value.

Fishery Governance

Target catch (or effort) range: **southern rock lobsters 30 – 50 tonnes**

The target catch range for the south coast rock lobster stock at 30 – 50 t is based on the assessment that the Esperance fishery is capable of sustaining production of approximately 20 t per year, with an additional allowance for catches taken from the adjacent fishing grounds discovered in the Albany and GAB zones during the early 1990s. In 2005/06, the south coast catch of 40 t is within this range.

Current fishing (or effort) level: **Acceptable**

Current fishing effort levels will need to be maintained in order to allow the stock to rebuild. In the last 4 years, the catch in the ERLF has been below 25 t and the residual biomass at the end of each fishing season, as estimated by the model for that zone, has increased each year.

New management initiatives (2006/07)

A comprehensive management plan will be developed to include all south coast crustacean fisheries. The management plan will incorporate the existing rock lobster fisheries and the deep sea crab fishery into one set of management arrangements. The plan will include spatial and temporal closures and a zoning arrangement to mirror the access in the existing managed fisheries.

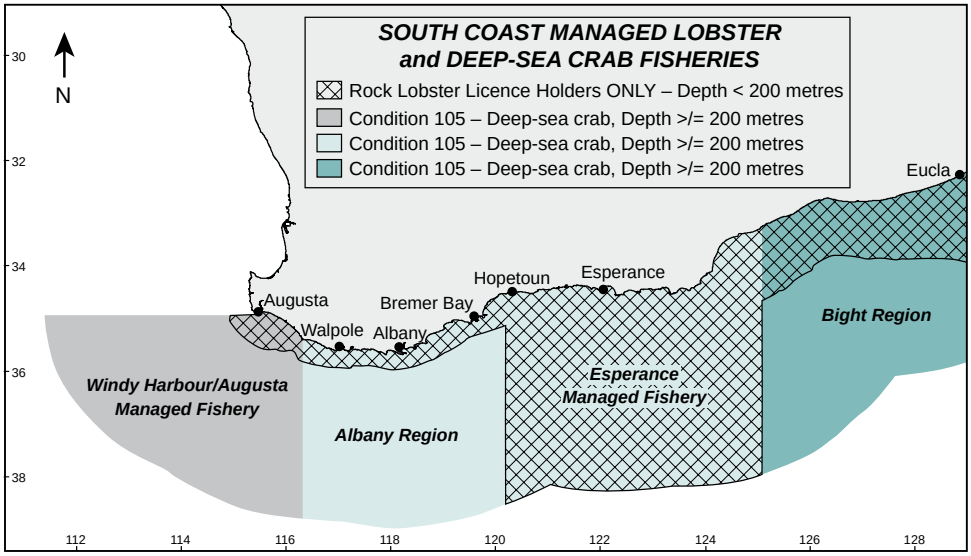
External Factors

The recruitment levels may be affected by spawning stock levels in South Australia, which have declined in recent years, and general environmental fluctuations.

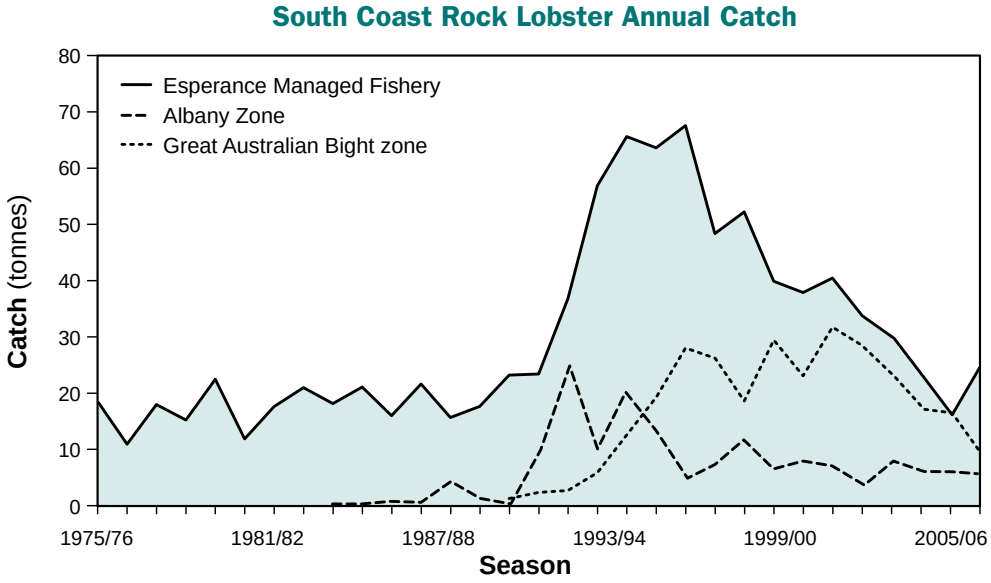
SOUTH COAST CRUSTACEAN TABLE 1

Comparisons of fishing effort and southern rock lobster catch in 2004/05 and 2005/06 in the south coast crustacean fisheries.

Management zone	Season	Pot lifts	Southern rock lobster catch (tonnes)	Deep-sea crabs catch (tonnes)
ERLF	2004/05	33,000	16	5
	2005/06	43,000	25	3
	difference	+30%	+56.2%	-40%
Albany	2004/05	73,000	6	14
	2005/06	23,000	6	12
	difference	-68%	0 %	-14%
GAB	2004/05	40,000	17	2
	2005/06	19,000	9	0
	difference	-52.5%	–47.1%	



SOUTH COAST CRUSTACEAN FIGURE 1
Management boundaries in the South Coast crustacean fisheries.



SOUTH COAST CRUSTACEAN FIGURE 2
Seasonal catches of southern rock lobster by management area since 1975/76.

Greenlip Brownlip Abalone Fishery Status Report

A. Hart, F. Fabris, T. Baharthah
Management input from K. Saville

Fishery Description

The Western Australian greenlip and brownlip abalone fishery is a dive fishery, operating in shallow coastal waters off the south-west and south coasts of Western Australia. The fishery targets 2 large abalone species: greenlip abalone (*Haliotis laevigata*), and brownlip abalone (*H. conicopora*), both of which grow to in excess of 200 mm.

The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.

Abalone divers operate from small fishery vessels (generally less than 9 m in length).

Governing legislation/fishing authority

Abalone Management Plan 1992
Ministerial Policy Guideline no. 10
Abalone Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)
Recreational Fishing Licence

Consultation process

Abalone Management Advisory Committee
Meetings between the Department of Fisheries and industry
Recreational Fishing Advisory Committee (RFAC)

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into 8 management areas.

Recreational

The recreational abalone fishery regulations relate to 3 zones: the Northern Zone (from Greenough River mouth to the Northern Territory border), the West Coast Zone (from Busselton Jetty to Greenough River mouth) and the Southern Zone (from Busselton Jetty to the South Australian border). Greenlip and Brownlip abalone are only fished in the Southern Zone.

Management arrangements

Commercial

The commercial greenlip/brownlip abalone fishery is part of the overall Abalone Managed Fishery. It is managed primarily through output controls in the form of Total Allowable Commercial Catches (TACCs), set annually for each species in each area and allocated to licence holders as Individual Transferable Quotas (ITQs).

The overall TACC for 2006 was 211.5 t (whole weight). The TACC is administered through 16,100 ITQ units, with a minimum unit holding of 450 units. The licensing period runs from 1 April to 31 March of the following year.

The legal minimum length for greenlip and brownlip abalone is 140 mm shell length, although the commercial industry fishes to self-imposed size limits of 153 mm, 150 mm and 145 mm in various parts of the main stocks. In 'stunted stocks', greenlip can be fished from 120 mm under special exemptions, although such fishing is strictly controlled to pre-arranged levels of catch and effort.

Recreational

The recreational component of the fishery for greenlip and brownlip abalone is managed under a mix of input and output controls and occurs primarily on the South Coast. Recreational fishers must purchase a dedicated abalone recreational fishing licence or an umbrella licence (which covers all licensed recreational fisheries). Licences are not restricted in number, but the recreational fishing season is limited to 7.5 months – from 1 October to 15 May.

The combined daily bag limit for greenlip and brownlip abalone is 5 per fisher (formerly 10), and the household possession limit (the maximum number that may be stored at a person's permanent place of residence) is 20.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were the breeding stock levels of greenlip and brownlip abalone. Boxed text in this status report provides the annual assessment of performance for these issues.

Research summary

Abalone divers are required to provide daily catch information on the weight and number of abalone collected, the hours fished, the date and location of harvest and the name of the person(s) harvesting. The divers also supply a random selection of 10 – 20 abalone shells from each fishing day, and these are measured and used estimate fishing mortality.

All data are used to assist in research, compliance and management matters. Current research is focused on stock assessment using catch and effort statistics, meat weight indices, and length-frequency sampling. New initiatives include digital video imagery (DVI) assessment by industry divers, who survey selected sites with an underwater video camera, and fishery-independent survey data collected from 140 sites across the fishery.

A telephone diary survey estimates the catch of all greenlip and brownlip abalone on a state-wide basis. In 2006, around 480 licence holders were selected from the licensing database, with selection stratified by licence type (abalone or umbrella) and respondent location (country or Perth metropolitan area). The licence holders were sent a diary to record their fishing activity and were contacted each month by telephone for the duration of the abalone season.

Research on stock enhancement and greenlip abalone habitat continued in 2006, with the release of 12,000 hatchery-reared (from wild stock parents) juvenile abalone at 50 sites in the fishery. Results from this experiment will be used to obtain a robust estimate of growth and survival that will inform debate on the effectiveness of abalone stock enhancement as a fishery management tool.

Retained Species

Commercial landings (season 2006): 206 tonnes

In 2006 the overall greenlip/brownlip catch was 206 t whole weight (Greenlip/Brownlip Abalone Table 1), which was similar to the 2005 catch of 208 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t.

Greenlip catch at 168.7 t whole weight, from a total quota of 171.8 t, was similar to 2006. The brownlip catch of 37.3 t whole weight for the 2006 season was 94% of the quota of 38.5 t (Greenlip/Brownlip Abalone Table 1).

Recreational catch (season 2006): 7 tonnes

Recreational catch: 0 – 7% of total catch

The estimate of recreational catch of greenlip and brownlip abalone, based on the telephone diary survey of recreational licence holders in 2006, was 7 t (range: 0 t – 14 t), which was between 0% and 7% of the total (commercial and recreational) catch in the 2006 season (Greenlip/Brownlip Abalone Table 2). This is similar to the 2004 estimate of 1 to 7% of the total catch.

Fishing effort/access level

Commercial

Total effort for the main stocks in 2006 was 1,161 days. This was a 7% decrease in effort from 2005 (1,252 days), however catch declined by only 4%.

Recreational

For the 2006 season, around 21,000 licences were issued. This figure has been stable over the past 5 years (Greenlip/Brownlip Abalone Figure 2).

Effort estimates for recreational abalone fishing on the west coast (excluding the Perth metropolitan area), from the 2006 telephone diary survey, was 8,000 days (4,700 and 11,300 days), while the estimated effort on the south coast was 2,800 days (1,600 – 3,900 days) (Greenlip/Brownlip Abalone Table 2).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2006 fishing season based on catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys.

The commercial divers' catch rates are the principal indicator of the abundance of legal-sized abalone and are assessed annually.

Estimates of fishing mortality are presented for the first time in 2006 and trends in this indicator will assist future stock management.

In 2006, the catch rate for the combined greenlip stocks was 133 kg whole weight (50 kg meat weight) per diver day. This was a slight increase from 2005 (131 kg whole weight per diver day in 2004), but still at the lower end of the historical range and is the third lowest catch rate in 12 years (Greenlip/Brownlip Abalone Table 1).

However, there are still concerns with individual areas such as Hopetoun in the Area 3 fishery, where daily catch rates are the lowest on record (77 kg whole weight/day), and this has prompted a review of performance indicators across the fishery in 2007.

For brownlip, the assessment showed that the TAC was being caught at high average weights and the TACC was maintained at 39.8 t in 2007.

Fishing mortality of greenlip is stable at 0.32 on the South Coast in 2005 (Windy Harbour to Israelite Bay), but has increased on the West Coast from 0.34 in 2004, to 0.49 in 2006 (Greenlip Brownlip Abalone Figure 3), although 2006 data is very preliminary due to the low numbers of shell collected.

Fishing mortality of brownlip abalone was slightly lower and similar for 2004 and 2005, but increased in 2006 (Greenlip Brownlip Abalone Figure 3). However, as with Greenlip abalone, data are very preliminary due to the low numbers of shell collected by industry divers.

Breeding stock: Greenlip abalone mature between 80 and 110 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length. Both are below the legal minimum size limit set across the fishery (140 mm shell length), which equates to an average meat weight of 140 g for greenlip and 160 g for brownlip. At these weights, animals are expected to have spawned at least twice.

In addition, industry-imposed length limits in excess of the minimum legal limits have been set in areas of fast-growing stocks. In Area 2, there is a general 145 mm minimum length across the fishing grounds. In Area 3, fishers have an imposed a minimum size limit of 153 mm shell length for the faster-growing portions of the fishing grounds, and 150 mm for the remainder.

The main performance measures for the fishery relate to the maintenance of adequate breeding stocks in each area of the fishery. This is assessed using a combination of measures which reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2006, the average sizes of greenlip and brownlip caught were 205 g and 280 g respectively. These were well above the minimum breeding sizes of 140 g for greenlip and 160 g for brownlip. The effort days required to take the quota (1,161 days) were within the set range that indicates sufficient biomass of breeding stock for the fishery overall (907 – 1,339 days – see 'Fishery Governance').

Non-Retained Species

Bycatch species impact: **Negligible**

Divers have the ability to target abalone of choice (species, sizes and quality of abalone) and do not inadvertently harvest bycatch in their normal fishing activities.

Protected species interaction: **Negligible**

The only protected species interaction occurring in this fishery is with the great white shark (*Carcharodon carcharias*), which has been known to attack divers. Most divers now use diving cages or electronic shark deterrent devices for their personal protection. However, divers are reporting encounters with *C. carcharias*, and this will be quantified in future reports.

Ecosystem Effects

Food chain effects: **Negligible**

Commercial abalone diving occurs over a small proportion of the total abalone habitat of the Western Australian coastline. In view of the relatively low exploitation rates and consequent maintenance of a high proportion of the natural biomass of abalone, it is considered unlikely that the fishery has any significant effect on the food chain in the region).

Habitat effects: **Negligible**

The fishing activity makes minimal contact with the habitat, which typically consists of hard rock surfaces in a high wave energy environment. As abalone are drift algae feeders, their removal is considered to result in little change in algal growth cover in areas fished.

Social Effects

There are 14 vessels operating in the greenlip/brownlip commercial fishery, employing approximately 35 divers and deckhands. The dispersed nature of the greenlip and brownlip abalone fishery means that small coastal towns from Busselton to the South Australian border receive income from the activity of divers.

Recreational diving for greenlip and brownlip abalone is a small, but active sector, with dive shops and vessel manufacturers' benefiting from this activity. The recreational fishery provides a major social benefit to those sectors of the community that appreciate the abalone as a delicacy. There were 21,000 licenses issued that would have allowed fishers to participate in the recreational abalone fishery, although most of these would have targeted the Roe's abalone fishery in the Perth metropolitan area.

Economic Effects

Estimated annual value (to commercial fishers) for year 2006: **$9.0 million**

The estimated average price received by commercial fishers was $118/kg meat weight (approximately $44/kg whole weight) for greenlip and $104/kg meat weight (approximately $42/kg whole weight) for brownlip abalone, resulting in a fishery valued at $9.0 million, compared to $9.7 million in 2005.

Greenlip prices are lower than 2005 ($127/kg), and substantially lower than the high values of $163/kg meat weight for greenlip and $133/kg meat weight for brownlip abalone received in 2000.

Fishery Governance

Target effort range: **907 – 1,339 days**

To assess whether the catch quota set is appropriate (sustainable) relative to the stock available, the effort required to take the a full season's quota (211.5 t in 2006) from the main stocks should fall within the effort range (907 – 1,339 diver days) derived from the 5-year period 1994 – 1998. This range reflects the acceptable variation in catch rates for the main stocks due to weather and natural recruitment cycles.

The fishing effort in 2006 was 1,161 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

The overall greenlip/brownlip quota for 2007 is maintained at 211.5 t whole weight (Greenlip Brownlip Abalone Table 1).

Current effort level: **Acceptable**

New management initiatives (2006/07)

The main new management initiative in 2006/07 was the commencement of a review of performance indicators for the abalone fishery. This process will take place over the next 12 – 18 months.

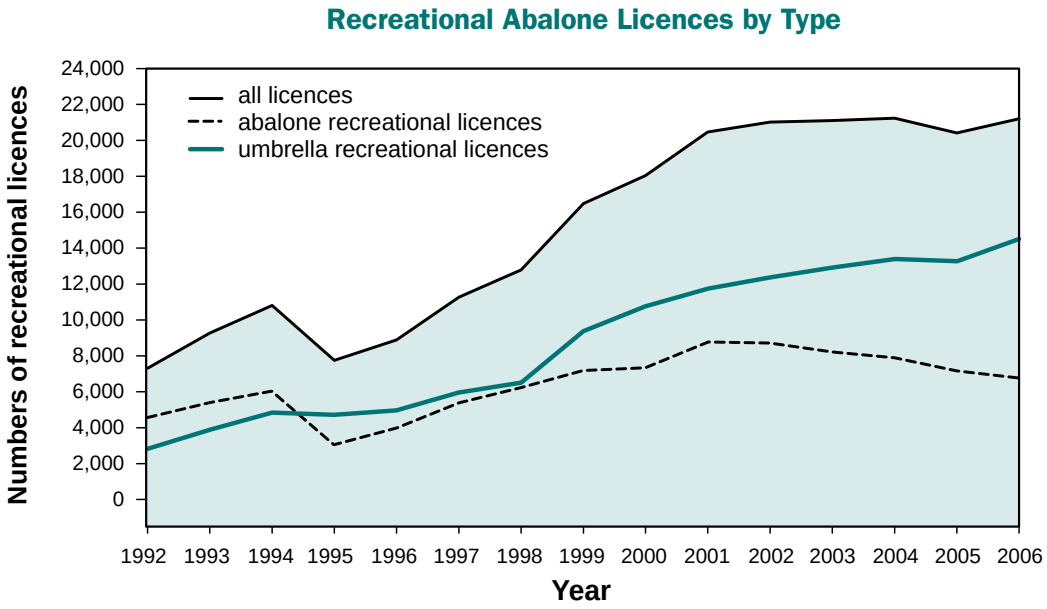
Consultation also took place with industry on relatively minor operational changes to the Abalone Management Plan 1992. These matters are currently being progressed.

External Factors

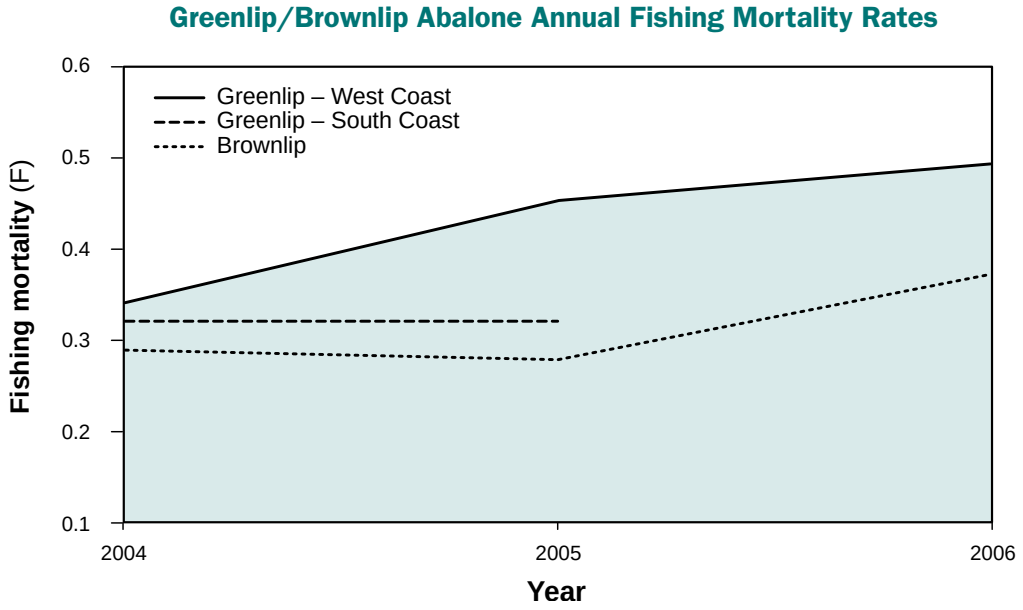
In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers are becoming more common, industry size limits have been varied substantially above the legal minimum sizes and the value of the abalone has decreased.

In addition, environmental effects, such as weather conditions, and the effect of technology changes, such as the introduction of GPS, motorised underwater scooters and accurate weather predictions on the Internet, continue to have significant effects on diver efficiency.

GREENLIP/BROWNLIP ABALONE FIGURE 1
Maps showing the distribution of (a) greenlip and (b) brownlip abalone in Western Australia, and (c) the management areas used to set quotas for the commercial fishery.



GREENLIP/BROWNLIP ABALONE FIGURE 2
The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2006.



GREENLIP/BROWNLIP ABALONE FIGURE 3
Annual Fishing Mortality (F) for greenlip and brownlip abalone in the West Coast and South Coast fisheries. Estimates of F apply only to harvest size animals, and are derived from length-converted catch-curve analysis. The data used is catch length-frequency data, and annualised growth increments based on following growth models. West Coast Greenlip: L_∞=185 mm, K = 0.30; South Coast Greenlip: L_∞=179 mm, K = 0.25; Brownlip: L_∞=200 mm, K = 0.30. Natural Mortality (M) is assumed to be 0.25.

GREENLIP/BROWNLIP ABALONE TABLE 1

Greenlip and brownlip abalone catch and effort[1] by quota period.

Quota period[2]	Greenlip TAC kg whole weight	Greenlip caught kg whole weight (all stocks)	Greenlip caught kg whole weight (stunted stocks)	Brownlip TAC kg whole weight	Brownlip caught kg whole weight	Combined catch kg whole weight	Diver days (main stocks only)	Greenlip kg whole (meat) wt per diver day (main stocks only)
1989	–	229,619	20,774	–	36,977	266,596	1,324[3]	158 (59)
1990	126,500	118,395	3,967	–	19,118	137,514	696[3]	164 (62)
1991	148,500	132,194	2,989	–	14,658	146,852	816[3]	158 (59)
1992	192,500	170,608		–	30,404	201,012	1,120	152 (57)
1993	197,450	173,397		–	31,153	204,550	1,238	140 (53)
1994	200,750	171,820		–	32,222	204,042	1,337	129 (48)
1995	187,264	145,467		–	27,061	172,528	1,087	134 (50)
1996	189,750	171,337	11,170	–	21,932	193,269	904[3]	177 (66)[4]
1997	207,350	182,317		–	26,297	208,614	1,059	172 (65)
1998	200,750	181,810	10,922	–	22,197	204,006	1,031[3]	166 (62)[4]
1999	184,023	175,765	7,781	28,000[6]	28,047	203,812	922[3]	182 (68)[4]
2000	194,691	189,511	6,709	34,875	34,179	223,690	1,029[3]	178 (67)[4]
2001	194,691	187,459	22,283	33,075	31,091	218,550	1,002[3]	165 (62)[4]
2002	194,691[6]	166,828	29,110	33,075[6]	27,458	194,286	1,027[3]	134 (50)[4]
2003	202,521[6]	180,730	25,044	37,453[6]	33,449	214,179	1,144[3]	136 (51)[4]
2004	190,520[6]	170,385	21,380	35,000[6]	34,196	204,581	1,154[3]	129 (48)[4]
2005	171,755	169,285	7,988	38,500	38,745	208,030	1,252	131 (49)
2006	171,755	168,752	15,071	39,750	37,265	206,017	1,161	133 (50)
2007	**171,755**			**39,750**				

Data source: quota returns.

1. The length of quota period has varied with management changes, and for simplicity has been recorded against the nearest calendar years.
2. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly comparable.
3. In prior years, conversion factors for meat weight to whole weight for greenlip abalone were 2.75 prior to 2000 and 2.667 for 2000+. To standardise comparison, we used one conversion factor of 2.667 across all years. The brownlip abalone conversion factor for meat weight to whole weight is 2.5.
4. Brownlip allocations not fixed across Areas 2 and 3 (ex-Zone 1 and 2) prior to 1999. Brownlip TAC fixed for the first year in 1999.
5. TACC for greenlip/brownlip after 2001 raised by 4% to reflect changes in processing, but does not represent an increase in actual allowed catch.

GREENLIP/BROWNLIP ABALONE TABLE 2

Summary of telephone diary surveys of recreational effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the greenlip and brownlip abalone fisheries in 2004 and 2006.

Location	Year	Effort	Greenlip		Brownlip	
			Catch Rate	Catch (tonnes)	Catch Rate	Catch (tonnes)
West Coast	2004	10,100 (6,500–13,600)	0.6	4 (2–6)	0.4	3 (1–5)
	2006	8,000 (4,700–11,300)	0.3	2 (0–3)	0.4	3 (0–5)
South Coast[1]	2004	2,700 (1,700–3,700)	2.4	2 (1–5)	<0.1	<1 (0–1)
	2006	2,800 (1,600–3,900)	1.6	2 (0–4)	0.5	1 (0–2)

1. Survey area is South Coast bioregion (i.e. east of Black Point).

South Coast Trawl Fishery Status Report

M. Kangas
Management input from P. Shaw

Fishery Description

The South Coast Trawl Fishery principally targets scallops (*Amusium balloti*) and associated by-products, although in years of low scallop catches, licensees have an option to use other trawl gear to target fish species. The main fishing method is by twin-rig otter trawl.

Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the fishery has theoretical access to a large section of the coastal waters, it is effectively restricted to small areas of higher scallop abundance.

Governing legislation/fishing authority

Trawling Prohibition (Whole of State) Notice 1992 (Order)
Surface Trawl Net Fishery (South Coast) Notice 1992
Trawling for Scallops (South Coast) Notice 1992
Condition 73 and/or 79 on Fishing Boat Licences

Consultation

Meetings between the Department of Fisheries and industry

Boundaries

There are currently 4 fishing boat licences that specify conditions intended to constitute 'endorsements' for the purposes of an exception to the governing legislation (orders). These endorsements are defined in 2 fishing boat licence conditions – Condition 73 provides for the use of trawl nets off the south coast of Western Australia in state waters east of 115° E longitude (Cape Leeuwin), while Condition 79 provides for the use of demersal trawl nets for taking scallops within the Recherche Archipelago. All 4 fishing boat licences have both conditions.

Management arrangements

The South Coast Trawl Fishery is managed primarily under an input control system, limiting numbers to only 4 fishing vessels. There are also seasonal closed areas in certain parts of the fishery.

The Australian Government's Department of Environment and Heritage has assessed the fishery under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, and has conditionally granted a special exemption, allowing product from the fishery to be exported from Australia until August 2008. The Department of Fisheries is developing more comprehensive management in the form of an interim management plan for the fishery.

Retained Species

Commercial production (season 2006):
< 1 tonne (whole weight)

Landings

The scallop catch was less than 1 t (whole weight). No other species were reported as being landed.

Fishing effort/access level

The annual effort expended in this scallop fishery is affected by scallop recruitment levels, which are determined in fishing surveys completed by operators to estimate the stock abundance of scallops and the likely benefits of continued fishing.

As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels. In 2006, only 8 fishing days were recorded for 1 boat and indicated extremely low stock levels.

Recreational component: **Nil**

Stock Assessment

Assessment complete: **Not assessed**

Exploitation status: **Not assessed**

Breeding stock levels: **Not assessed**

Non-Retained Species

Bycatch species impact: **Low**

The large-mesh (100 mm) trawl gear used in scallop fisheries takes minimal bycatch. The areas trawled by the fleet also represent a very small percentage of the fishing area within the legislated boundary, therefore impact on bycatch species is considered to be minimal.

Protected species interaction: **Negligible**

Protected species susceptible to capture by trawling do not occur significantly in this fishing area.

Ecosystem Effects

Food chain effects: **Low**

The extremely variable recruitment and resultant fluctuating biomass of the scallops which occur in this area preclude the fishery having any significant impact on the general food chain in the region.

Habitat effects: **Low**

Trawling has minimal impact on the benthic sand habitats in this scallop fishery.

Social Effects

The estimated employment in the fishery for the year 2006 was 3 – a skipper and 2 crew.

Economic Effects

Estimated annual value (to fishers) for year 2006: Nil

Fishery Governance

Acceptable catch range for next season: Not available

New management initiatives (2007/08)

The interim management plan will include a set of gear restrictions/limits, and a number of temporal and spatial closures around the main population centres in the fishery. The draft management plan will be sent out for a final round of consultation prior to the implementation target date of August 2007.

External Factors

The level of fishing activity and quantity of catch within the south coast trawl is highly variable. This variability has largely been driven by the level of scallop recruitment to these grounds and also by the product price paid to fishers and, in recent times, the cost of fishing. Scallop catches in 2006 were negligible, with 1 boat searching for scallop stocks for a week and then ceasing, indicating low scallop abundances in the region.

South Coast Estuarine Managed Fishery Status Report

K. Smith and J. Brown
Management input from P. Shaw

Fishery Description

Thirteen estuaries and inlets located between Cape Beaufort and the Western Australia/South Australia border are conditionally open to commercial fishing as part of the South Coast Estuarine Managed Fishery (SCEF).

The SCEF is a multi-species fishery targeting many finfish species, with the main fishing methods being gillnet and haul net.

Governing legislation/fishing authority

South Coast Estuarine Fishery Management Plan 2005
South Coast Estuarine Managed Fishery Licence

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The fishery encompasses 'the waters of all estuaries on the south coast of Western Australia between Cape Beaufort and 129º east longitude, including Princess Royal Harbour and Oyster Harbour, and all the rivers, streams and all the tributaries that flow into those estuaries.' The areas that are open to commercial fishing are (from west-to-east) Broke Inlet, Irwin Inlet, Wilson Inlet, Princess Royal Harbour, Oyster Harbour, Waychinicup Inlet, Beaufort Inlet, Gordon Inlet, Hamersley Inlet, Culham Inlet, Jerdacuttup Lakes, Oldfield Inlet and Stokes Inlet.

Management arrangements

The South Coast Estuarine Fishery Management Plan 2005 came into effect on 1 July 2005. Catch and effort in the fishery is managed by input controls including limited entry, gear controls and spatial and temporal restrictions. These arrangements are designed to ensure that permitted fishing methods and times are well-defined, and that the maximum potential effort in the fishery is limited.

Research summary

Historically, monitoring of fisheries and fish stocks in south coast estuaries has been based on monthly catch and effort statistics (CAES) provided by commercial fishers. The CAES database has provided a valuable and consistent long-term source of information for monitoring estuarine fish, including recreationally-important stocks where they are harvested by both sectors.

However, levels of commercial fishing activity have been declining since 1992 as a result of voluntary buy-back of commercial access, making CAES data less useful in assessing the status of certain estuarine species. CAES is still an important source of data for stock assessments, but it is now being used for this purpose in combination with increasing amounts of data from other sources, namely recreational fisheries and fishery-independent surveys.

Comprehensive assessments of fish stocks in south coast estuaries will require data from both the commercial and recreational sectors and from independent surveys. The Research Angler Program (including recreational fisher log books) and annual fishery-independent surveys of juvenile fish recruitment (including cobbler, herring, whiting, mullet and several other species) are among the strategies now being employed by the Department of Fisheries to meet future data requirements.

While commercial fishery catch levels in south coast estuaries are determined annually from data reported in compulsory commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. Recent estimates of recreational catch in south coast estuaries are available from a national phone survey in 2000/01 and a creel survey in 2002/03. Both surveys included shore- and boat-based recreational fishing.

A considerable amount of knowledge on the biology of estuarine fish is available from many previous and ongoing research projects conducted on the south coast by universities and the Department. This knowledge assists in interpreting trends in monitoring data described above and provides a basis for management decisions.

This report presents specific data for 3 fish stocks that are important in south coast estuaries, namely cobbler (*Cnidoglanis macrocephalus*), black bream (*Acanthopagrus butcheri*) and King George whiting (*Sillaginodes punctata*).

Retained Species

Commercial landings (season 2006): 170 tonnes

The 2006 SCEF catch contained approximately 36 different species, including finfish, sharks, rays, molluscs and crustaceans. The majority of landings were finfish including cobbler, black bream, sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*), leatherjackets (Monocanthidae), flathead (Platycephalidae) and King George whiting.

In 2006, 3 species (cobbler, black bream and sea mullet) comprised nearly 50% of the total catch of 169.8 t (South Coast Estuarine Table 1).

Total annual commercial landings in south coast estuaries steadily increased from approximately 200 t during the early 1980s to a peak of 501 t in 1992 (South Coast Estuarine Figure 1). Total landings declined sharply between 1992 and 1994, but were then relatively stable until 2003, averaging 282 t for this period (1994 – 2003). In 2004, the total catch dropped to 180 t and remained relatively low in 2005 (227 t) and 2006 (170 t).

The 2006 catch was the lowest on record and was well below the 10-year average annual catch (1996 – 2005) of 263 t. This downward trend in catch since 1992 reflects a similar decline in total effort due to a buy-back of licences in south coast estuaries.

The 2006 catches of many species were well below their 10-year (1996–2005) annual average, including cobbler (22.1 t lower), sea mullet (17.6 t), King George whiting (16 t), blue swimmer crabs (*Portunus pelagicus*) (10.7 t), yellow-eye mullet (*Aldrichetta forsteri*) (8.8 t), Australian herring (6.9 t) and leatherjackets (Monacanthidae) (6.3 t). Only black bream, trumpeter (Teraponidae) and Australian salmon (*Arripis truttaceus*) landings in 2006 were substantially above their 10-year annual averages (3.0 t, 2.3 t and 2.1 t higher, respectively).

Of the 13 individual estuaries permitted to be fished by SCEF licensees in 2006, 4 estuaries were not fished (Waychinicup Inlet, Hamersley Inlet, Culham Inlet and Jerdacuttup Lakes). Of the remaining 9 estuaries, Wilson Inlet recorded the highest catch (81.5 t or 48% of total SCEF landings).

Combined landings from Oyster Harbour, Princess Royal Harbour, Beaufort Inlet, Irwin Inlet and Stokes Inlet contributed a further 49% of total SCEF landings in 2006. Only minor catches were recorded in Broke Inlet, Oldfield Inlet and Gordon Inlet.

While Wilson Inlet recorded the highest catch (81.5 t) in 2006, this catch was well below the 10-year (1996 – 2005) average annual catch (117.3 t) for this estuary. 2 other estuaries, Oyster Harbour and Broke Inlet, also produced total landings in 2006 that were significantly below their respective 10-year averages.

Annual catches have followed a declining trend since 2001 in Oyster Harbour and since the late 1990s in Broke Inlet.

In 2006, while Beaufort Inlet recorded a lower catch than in 2005, it was the only estuary on the south coast to produce commercial landings that were higher than the 10-year annual average for the estuary.

Cobbler: Cobbler is the most dominant species in the SCEF catch, comprising 25% of the total catch over the past 10 years (1996 – 2005). In 2006 the total SCEF cobbler catch was 44.1 t, which was 5.3 t lower than the 2005 catch, and 22.1 t lower than the 10-year (1996 – 2005) average annual catch.

The 2006 catch was mainly taken in Wilson Inlet (78%), with small catches in Oyster Harbour (9%), Irwin Inlet (7%) and Princess Royal Harbour (6%).

Traditionally, the majority of cobbler landings on the south coast have been taken in Wilson Inlet. Annual catches in this estuary have fluctuated considerably since 1980, reaching peaks of nearly 80 t in 1985, 2002 and 2003 (South Coast Estuarine Figure 2).

The annual cobbler catch declined markedly from 78 t in 2003 to 28 t in 2004. Catches were also relatively low in 2005 (37.4 t) and in 2006 (34.6 t). These recent landings were well below the 10-year (1996 – 2005) average cobbler catch (50.1 t) in Wilson Inlet.

Black bream: Over the past 10 years, black bream has made the third highest contribution by weight to total SCEF landings, averaging 30.7 t per year. Black bream is also important because it has a widespread distribution and is a significant component of commercial landings within each estuary (unlike cobbler which is essentially only caught in Wilson Inlet).

Total bream landings on the south coast are highly variable, in response to environmental factors in individual estuaries. In particular, higher catches of black bream can be associated with higher rainfall in the estuary catchments. In 1992, total landings peaked at 97 t after favorable environmental conditions in Culham Inlet led to strong recruitment and high catches in that system.

In 2005, sharp increases in the catch of black bream in Beaufort Inlet, Wilson Inlet and Oyster Harbour followed unusually high rainfall in the Albany region. The higher catches (and catch rates) of bream that occur after rainfall must be interpreted with caution – they may reflect an increase in stock abundance due to strong recruitment but they may also just reflect a higher catchability where floodwaters have 'flushed' fish in the tributaries downstream into commercial fishing areas.

Annual black bream catches have increased significantly in numerous south coast estuaries recently, and the combined effect has been a steady rise in total annual SCEF landings over the past 10 years. Total landings peaked at 63.5 t in 2005.

In 2006, the total SCEF black bream catch was 33.8 t, which was lower than in 2005 but still 3.1 t more than the 10-year (1996 – 2005) average catch (South Coast Estuarine Figure 3). In 2006, Beaufort Inlet, Stokes Inlet and Wilson Inlet contributed 86% of total black

bream landings, while Oyster Harbour, Oldfield Inlet, Irwin Inlet, Gordon Inlet and Princess Royal Harbour contributed the rest.

King George whiting: In 2006, the total SCEF King George whiting catch was 4.7 t, most of which (63%) was taken in Wilson Inlet, with Irwin Inlet, Princess Royal Harbour, Oyster Harbour and Broke Inlet contributing the remainder. The 2006 catch from Wilson Inlet was 2.9 t – around 7.3 t lower than in 2005 and 13.5 t less than the 10-year (1996 – 2005) average catch in this estuary (South Coast Estuarine Figure 4).

However, the 10-year average of 16.4 t is inflated by very high catches of whiting from 1997 to 2000, which resulted from high juvenile recruitment into Wilson Inlet by the 1995 year-class.

Other key species: Over the past 10 years, sea mullet has made the second highest contribution by weight to total SCEF landings, averaging 33.6 t per year. Like black bream, sea mullet is also important because it has a widespread distribution and is a significant component of commercial landings within many individual estuaries.

The 2006 catch of sea mullet was 16.1 t, 7.3 t less than 2005 and 17.6 t below the 10-year average catch. This continues the declining trend in sea mullet landings since 1995. Sea mullet is caught in numerous south coast estuaries, but in recent years the majority has been caught in Wilson Inlet, Oyster Harbour and Beaufort Inlet.

The 2006 SCEF catch of leatherjackets (11.5 t) was below the 10-year average catch (17.8 t), mainly due to relatively low catches in Oyster Harbour, where leatherjacket landings have been declining since the late 1990s. Leatherjackets are also caught in Princess Royal Harbour, where landings have been stable over the last 10 years.

The annual SCEF catch of southern sea garfish experienced a marked increase between 2004 and 2005. The 2005 catch of 8.8 t was well above the 10-year average (4.1 t). The 2006 catch declined 5.3 t from 2005 levels to 3.5 t, returning to more typical catch levels.

Recreational catch: 29% of total catch (approx)

2 surveys of recreational fishing in south coast estuaries have been conducted in recent years. The first was the National Recreational Fishing Survey, which was conducted over 12 months from May 2000 to April 2001 (Henry and Lyle 2003). The second, more recent survey was conducted by the Department of Fisheries from December 2002 to November 2003 (Smallwood and Sumner 2007).

During the 2000/01 survey, the most commonly reported species in the recreational catch were black bream, King George whiting, blue swimmer crabs, pink snapper, skipjack trevally, prawns, Western Australian salmon, mullet, Australian herring, mulloway, tailor, squid and tarwhine. The recreational catch of these species was estimated to be approximately 40% of the combined recreational and commercial catch (by weight) of these species from south coast estuaries during the survey period.

The 2002/03 survey involved 16 estuaries, including 11 of the 13 estuaries open to commercial fishing (no commercial catches were taken in the remaining 2 estuaries during the study period). The most commonly reported species were King George whiting, black bream, Australian herring, skipjack trevally, pink snapper, flathead and garfish, comprising approximately 80% of all fish (by number) retained by recreational fishers during the survey.

In the commercially-fished estuaries, the recreational catch of these species was estimated to be approximately 29% (by weight) of the combined recreational and commercial catch of these species during the survey period.

A total of 48 species were reported in the recreational catch from south coast estuaries. The total recreational catch (by weight) of all species could not be estimated in 2002/03 due to uncertainties associated with small samples of less abundant species and limited data on the average size of fish in the catch.

In 2003, the highest recreational fishing catch and effort of any south coast estuary was reported from the Walpole/Nornalup Inlet, which is closed to commercial fishing.

Fishing effort/access level

Commecial fishing effort

Commercial fishing effort has traditionally been recorded here as the average number of boats fishing per month. This measure of effort gives only a very general indication of effort changes.

The number of days fished is also now reported, providing a better indication of where effort is concentrated (i.e. in which estuaries) and how that effort has varied over time. However, effort targeted towards individual species from this measure is still difficult to ascertain.

The average number of boats fishing per month peaked at 42.9 in 1992, and has subsequently followed a declining trend. Declines in SCEF effort over the past decade reflect a reduction in the number of units of access in the fishery, which fell from 51 in 1994/95 to 25 in 2006 – a level that has been maintained since 2002. In 2006, the average number of boats fishing per month was 16.1, up slightly from the 15.8 boats per month in 2005.

The total annual reported fishing days also peaked in 1992 – at 6,747 days – and has since been progressively declining to reach a record low of 3,276 days in 2006 (South Coast Estuarine Figure 1). A decrease in the number of days fished occurred between 2005 and 2006, despite the slight increase in the average number of boats fishing per month.

In 2006, SCEF fishing effort was primarily focused in Wilson Inlet (65.4% of fishing days), Princess Royal Harbour (10.9%) Oyster Harbour (7.4%) and Irwin Inlet (6.3%). In Princess Royal Harbour, Stokes Inlet and Broke Inlet, fishing effort in 2006 was higher than in 2005.

The only estuaries to record levels in 2006 above the 10-year average were Wilson Inlet, Beaufort Inlet and Irwin Inlet. In contrast, Oyster Harbour, Beaufort Inlet and Irwin Inlet each experienced a substantial decrease in reported effort in 2006 from 2005 levels.

In comparison with the 10-year average, Oyster Harbour, Princess Royal Harbour and Broke Inlet all displayed marked decreases in fishing effort in 2006. Effort in Oyster Harbour in particular has shown a rapid decline since 2001, where effort dropped from 917 days fished to a record low in 2006 of 244 days fished. The long-term average (1981 – 2005) for Oyster Harbour is 790 days fished.

The lower levels of effort in Oyster Harbour and Princess Royal Harbour largely reflects attempts by commercial fishers to avoid interactions with fur seals, which have increased in numbers in recent years and have become problematic to the fishers due to damage to gear and the removal of fish from nets.

Recreational fishing effort

Recreational fishing effort in 17 south coast estuaries was estimated by a creel survey conducted by the Department in 2002/03. Total effort during the survey period was estimated at 254,171 fisher hours or 86,482 fisher days. This total included boat-based (202,658 hours), shore-based (47,816 hours) and house boat (3,698 hours) fishing. Recreational netting and charter boat effort was not quantified in this survey but was considered to have been negligible (less than 2% of total effort).

In the 2002/03 survey, recreational fishing effort was estimated to have occurred mainly in Walpole/Nornalup Inlet (33% of total effort), Oyster Harbour (29%), Princess Royal Harbour (12%), Wilson Inlet (12%) and Wellstead Estuary (6%).

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

The annual abundances of the individual species that contribute to fishery landings in south coast estuaries are highly variable. Despite this, the total annual CPUE of the commercial fishery was relatively stable from the mid-1980s until approximately 2000 (South Coast Estuarine Figure 1).

This suggests that the total biomass of the suite of species in the catch was relatively constant over this 20-year period. Historically, the targeting of multiple species has ensured consistent total annual landings and contributed to the viability of the commercial fishery. However, a declining trend in overall CPUE since 1998, and particularly since 2003, suggests a decline in the overall availability of target species within south coast estuaries in the past decade.

The reason(s) for the apparent decline in total fish abundance in south coast estuaries is unclear. Fish abundances in south coast estuaries are influenced by many factors, including climate, oceanography, human-induced catchment processes and fishing pressure. The complex interactions between these local and remote factors make it extremely difficult to explain changes in the composition of fish communities in each estuary.

Despite an apparent recent decline in the total commercial catch rate (which presumably reflects a decline in estuarine fish abundance), the stock levels of the key target species (discussed below) are considered adequate at this time.

Cobbler: Wilson Inlet is the State's major cobbler fishery. The breeding stock for the cobbler fishery in Wilson Inlet is contained within the estuary.

Although cobbler stocks exhibit different growth rates and attain maturity at slightly different lengths, the size at maturity in most south-west estuaries is less than the legal minimum length of 430 mm total length, thus affording protection to estuarine breeding stocks. In Wilson Inlet, the length at maturity is approximately 425 mm, which is attained at an age of 3 to 4 years (Laurenson *et al*. 1993a).

This important species is also afforded some additional protection in Wilson Inlet from an area near the estuary mouth which is permanently closed to commercial fishing. Since the introduction of the interim SCEF management plan in 2002, special regulations specific to the targeting of cobbler have been in place to protect spawning aggregations and spawning areas in a number of estuaries.

Trends in CPUE suggest that cobbler abundance increased in Wilson Inlet between 1990 and 2003, when landings peaked at the second highest annual catch on record. In 2004, CPUE declined sharply and the annual catch fell to its lowest level since 1983. In 2005 and 2006, the catch and CPUE remained relatively low.

The rapid decline in CPUE at a time of relatively low and stable fishing effort suggests a decline in stock abundance after 2003, probably due to several consecutive years of low recruitment as a result of environmental factors.

In late 2006, in response to the recent decline in CPUE, the Department of Fisheries undertook a fishery-independent survey of cobbler in Wilson Inlet. High numbers of juveniles were observed throughout the estuary. Whilst these data are only preliminary, they suggest strong recent recruitment which is expected to have a positive effect on catch rates in the next few years.

Fishery-independent surveys of cobbler using catch-and-release methods will now be repeated annually by the Department in this estuary. Ongoing annual data from these surveys will greatly improve our understanding of cobbler recruitment in Wilson Inlet.

Black bream: Black bream stocks are independent and genetically distinct within each south-west estuary. Each population exhibits a different growth rate and attains maturity at a different size in each estuary.

Within each estuary, size-at-maturity may also vary slightly from year-to-year, in response to environmental factors. In the vast majority of cases, the size at maturity is lower than the legal minimum length (250 mm total length), affording protection to each breeding stock.

Stock levels within each estuary tend to follow different annual trends, although environmental factors that are common among estuaries (e.g. rainfall, eutrophication) can lead to similar long-term trends in stock levels. For example, higher river flows seem

to increase the spawning and recruitment success of bream, although the mechanisms for this are unclear.

Water temperature, salinity and oxygen levels are probably important physical factors that interact to control recruitment success in each estuary.

Trends in both catch and CPUE suggested that black bream abundance in Beaufort Inlet, Oyster Harbour, Irwin Inlet and Wilson Inlet simultaneously increased from the mid-1990s until 2005. In 2006, the CPUE of black bream in these estuaries declined from 2005 levels, but were still high compared to historic levels.

Annual rainfall was very high in 2005 along much of the south coast. High flows after heavy rain can cause bream in tributaries to move downstream into the open fishing waters of estuary basins, where they are vulnerable to capture by commercial fishers. An increase in catchability probably contributed to the pronounced 'spike' in CPUE seen in many estuaries in 2005.

Overall, trends in catch and CPUE suggest that the abundance of black bream in many south coast estuaries has been steadily increasing over the past 10 years. This trend indicates that breeding stock levels are adequate to maintain recruitment in each estuary.

King George whiting: King George whiting are spawned in ocean waters and recruit as juveniles into estuarine and protected inshore areas which function as nursery habitats. Juveniles remain in nursery areas to an age of approximately 3 years and then migrate offshore.

Over the last 10 years (1996 – 2005), over 81% of the south coast commercial catch of King George whiting was taken in Wilson Inlet. Successful recruitment by juvenile whiting to this estuary is determined by the complex interaction of many factors, including the availability of marine-spawned larvae during openings of the sandbar and the quality of estuarine nursery habitats for the duration of the juvenile period.

High catches in Wilson Inlet from 1997 to 2000 reflected a substantial increase in recruits entering the estuary, and not changes in the overall fishing effort level in this estuary. In other words, the stock abundance in Wilson Inlet over the last decade has varied independently of fishing effort within the estuary. In 2006, King George whiting catches were at the more typical pre-1997 levels, reflecting more typical recruitment levels.

Recruits to Wilson Inlet belong to the same stock as King George whiting caught elsewhere on the south coast. Apart from Wilson Inlet, there is little commercial fishing pressure for this species along the south coast. Available data suggest that the combined recreational and commercial King George whiting catch on the south coast is relatively low (< 25 t per year), which should ensure that the oceanic breeding stock remains at an adequate level.

Non-Retained Species

Bycatch species impact: **Low**

The commercial fishery employs selective fishing methods, including specific mesh sizes. As a result, bycatch levels in this fishery have historically been low.

Protected species interaction: **Negligible**

The SCEF has occasional interactions with New Zealand fur seals and Australian sea lions. These animals are primarily open-ocean foragers and only occasionally enter estuaries. However, the abundance of fur seals on the south coast has steadily increased over the last 15 years, resulting in an increasing level of interaction with fishers especially in the Albany region (R. Campbell, Department of Fisheries, personal comments).

There have been no reports of incidental mortalities of seals in this fishery and it is believed that the present level of interaction (direct and indirect) is not a significant threat to the populations of fur seals and sea lions. An assessment of the impact of interactions is performed on an annual basis and, if required, appropriate management plans will be devised to mitigate these interactions.

It is compulsory for commercial fishers to report all interactions with protected and listed marine species.

Ecosystem Effects

Food chain effects: **Low**

The abundance of fishery target species in south coast estuaries can vary markedly and is primarily recruitment-driven, independent of fishing within each estuarine system. Food chain effects due to fishing are likely to be insignificant compared to the effects of recruitment-driven variations in fish abundance.

Habitat effects: **Low**

The operation of the nets used is unlikely to have any significant impact on the benthic habitats in these estuaries. Gillnets are hung in open water and do not interact with benthic habitats.

Haul nets may be deployed over bare sand or low- to medium-density seagrass. This type of net tends to 'roll' over the surface of seagrass beds without removing attached leaves or uprooting plants. At times, haul nets may collect floating vegetation including seagrass leaves or algae.

Social Effects

Catches from the SCEF are an important source of fresh local fish to regional centres. During the 2006 fishing season, the SCEF employed an average of 20 fishers per month and generated additional regional employment in associated industries such as fish processing.

Recent phone surveys estimated that approximately 12% of the State's total recreational fishing effort occurs in the south coast region (Henry and Lyle 2003, Barharthah 2006). Within the south coast region, approximately 21% of the recreational fishing effort is estimated to occur in estuaries and rivers.

A high proportion of people who fish in each south coast estuary are non-residents, travelling from Perth, other WA regions or interstate.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$925,571**

Fishery Governance

Target catch range: **200 – 500 tonnes**

To determine a target catch range, annual SCEF catches from 1983 to 1998 were subject to double exponential smoothed forecasting. The range was then derived from the difference between the predicted catch and reported catch in each year. The confidence intervals were set at 80%. The resulting target catch range was 200 – 500 t (rounded to the nearest 50 t).

The total catch in 2006 of 170 t was below the lower part of the target range. This is consistent with the continuing trend of reduced effort (and hence catch) in this fishery, mostly due to buy-backs funded through a Voluntary Fisheries Adjustment Scheme. The target catch range will need to be recalculated when effort stabilises.

Current fishing level (2006) **Acceptable**

SCEF effort levels have gradually declined since 1992, due to a Voluntary Fisheries Adjustment Scheme, and the current total annual effort is low relative to historic levels. This process has reduced catch levels and eased fishing pressure on key stocks.

Recent changes in stock abundance are thought to be primarily due to environmental factors rather than fishing. Current fishing levels are considered acceptable.

New management initiatives (2006/07)

A range of minor amendments were made to the SCEF management plan to enable Fisheries and Marine Officers to more efficiently ensure that industry members are complying with fishery rules. The minimum size for pink snapper in Wilson Inlet will be increased from 28 cm to 41 cm, in line with existing minimum size in all other areas.

External Factors

Variation in the abundance of target species in south coast estuaries is largely driven by environmental factors, independent of fishing. These factors, which are outside the control of the Department of Fisheries, often have a dominant influence on the commercial catch and effort from year-to-year. For example, high annual rainfall probably contributed to higher catches of black bream in several estuaries in 2005.

Catchment processes, such as clearing of vegetation, flow regulation and nutrient input, can have major downstream effects on estuary 'health' and on fishery production. Attempts to quantify the influence of these complex, interacting factors on fishery production are difficult with the limited biological and environmental monitoring data that are available from south coast estuaries.

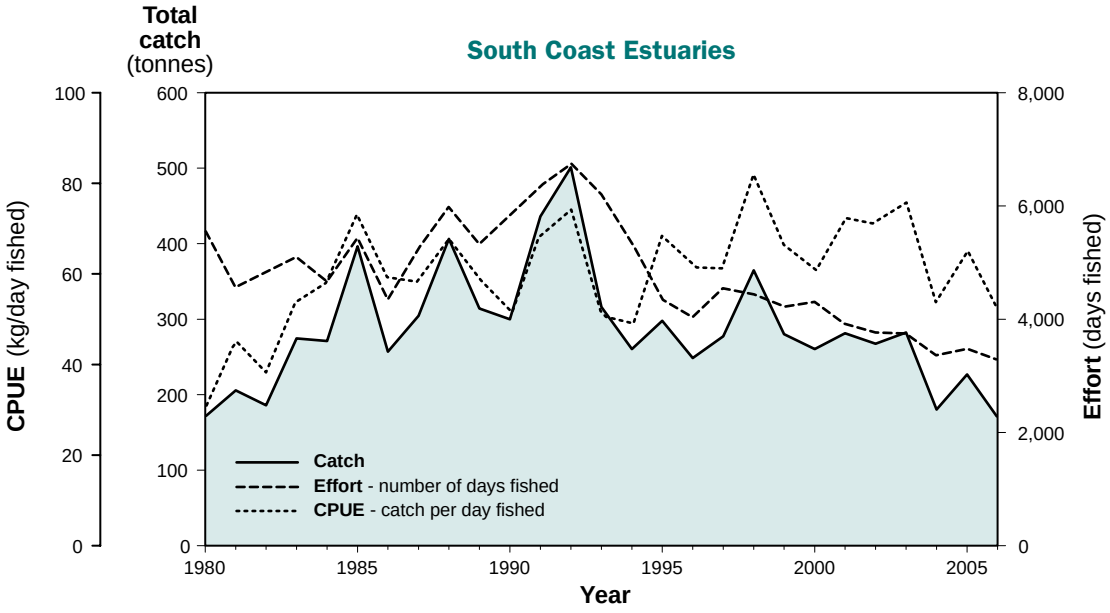
The influence of environmental factors on recruitment to estuaries is further complicated by the practice of human intervention to breach estuarine sandbars, mostly for reasons related to estuarine amenity coupled with ecosystem 'health'.

Increased predation by the expanding fur seal population along the south coast may be impacting on the abundance of some target species.

SOUTH COAST ESTUARINE TABLE 1

The catch from the South Coast Estuarine Managed Fishery for the year 2006.

Species	Scientific name	Catch (tonnes)
Cobbler	*Cnidoglanis macrocephalus*	44.1
Black bream	*Acanthopagrus butcheri*	33.8
Sea mullet	*Mugil cephalus*	16.1
Australian herring	*Arripis georgianus*	15.0
Leatherjacket	Monocanthidae	11.5
Flathead	Platycephalidae	8.5
King George whiting	*Sillaginodes punctata*	4.7
Southern sea garfish	*Hyporhamphus melanochir*	3.5
Yellowtail scad	*Trachurus novaezelandiae*	3.5
Trumpeter	Teraponidae	3.4
Other species		25.8

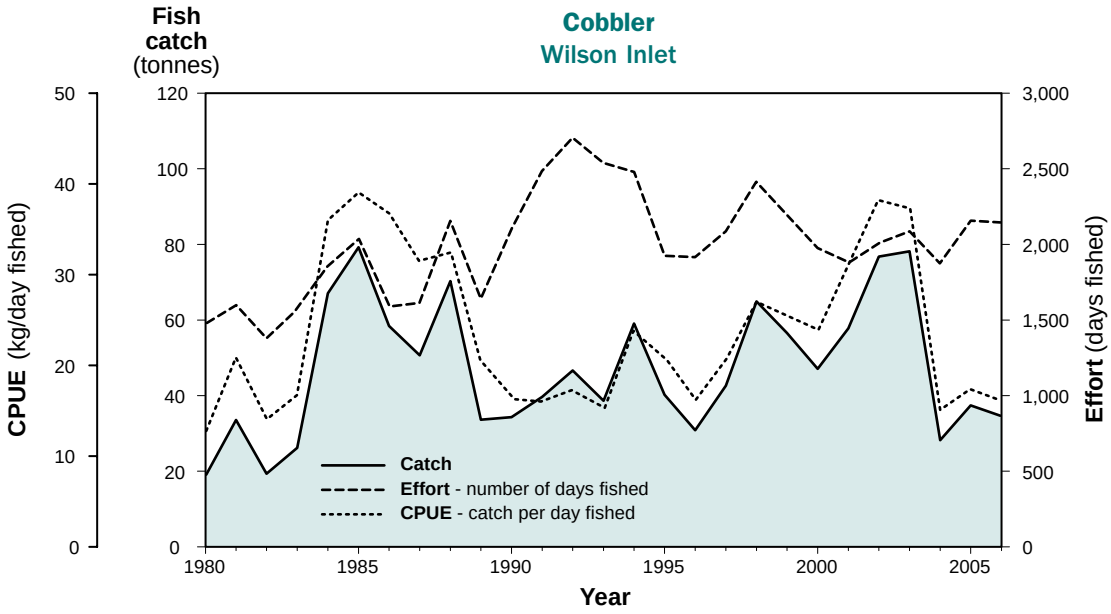


SOUTH COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980 – 2006.

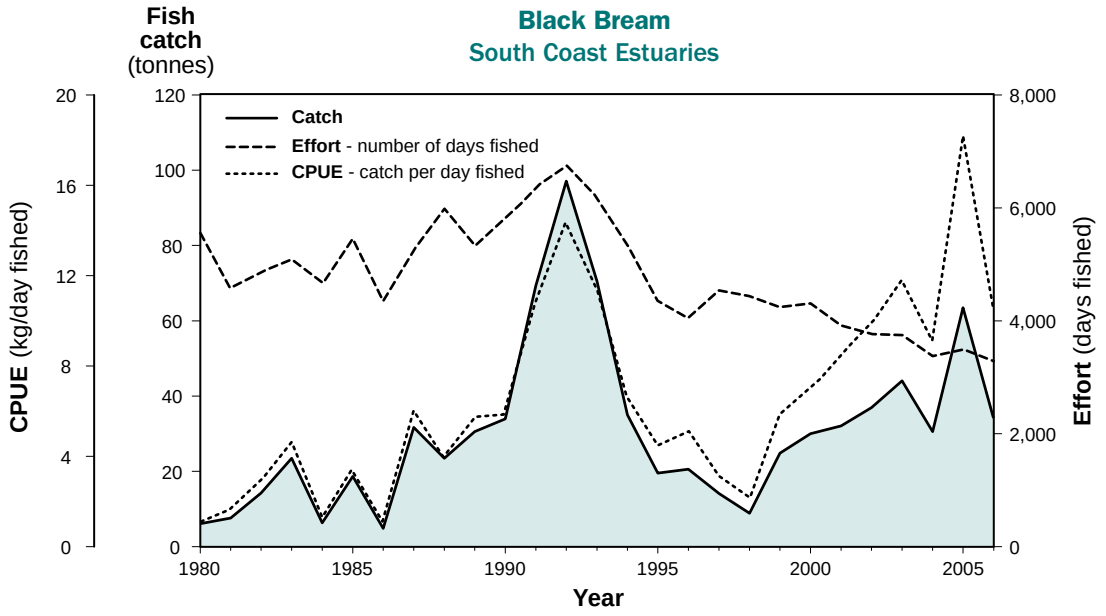
Note 1: Prior to 1993, the South Coast estuarine catch figures included King George Sound, which was not part of the SCEF. From 1993, when a separate fishing block was created for Princess Royal Harbour, the catch figures include Princess Royal Harbour but not King George Sound.

Note 2: Owing to an improvement in methodology, South Coast Estuarine Figures 1 – 4 now show effort in terms of days fished, rather than in mean monthly fishing units as previously. Similarly, CPUE is shown as catch per day fished, rather than as mean monthly catch per fishing unit.



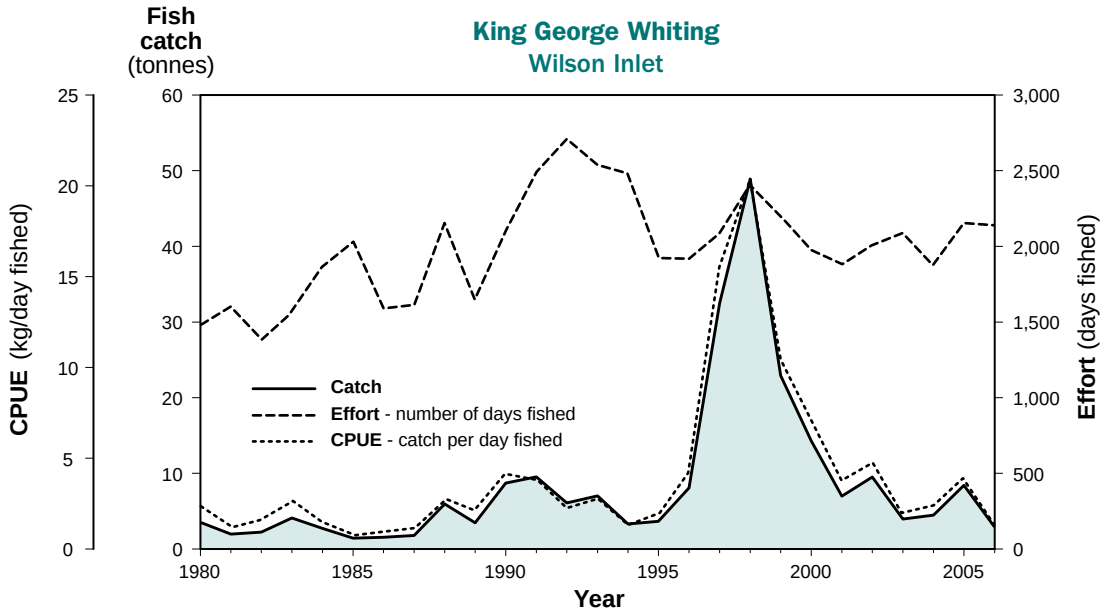
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the cobbler (*Cnidoglanis macrocephalus*) fishery of Wilson Inlet over the period 1980 – 2006.



SOUTH COAST ESTUARINE FIGURE 3

The annual catch, effort and catch per unit effort (CPUE) for the black bream (*Acanthopagrus butcheri*) fishery in South Coast estuaries over the period 1980 – 2006.



SOUTH COAST ESTUARINE FIGURE 4

The annual catch, effort and catch per unit effort (CPUE) for the King George whiting (*Sillaginodes punctata*) fishery of Wilson Inlet over the period 1980 – 2006.

Australian Salmon Managed Fisheries Status Report

K. Smith and J. Brown
Management input from P. Shaw

Fishery Description

The western species of Australian salmon (*Arripis truttaceus*) is targeted in Western Australian waters by 2 commercial fisheries – the South Coast Salmon Managed Fishery (all Western Australian waters below high water mark to the east of Cape Beaufort) and the South-West Coast Salmon Managed Fishery (all Western Australian waters to the north of Cape Beaufort). Fishers target schools of migrating salmon as they move west along the southern coastline of WA during late summer and autumn. Fishing operations are conducted by teams of fishers setting beach seine nets using either row boats or small jet-powered boats.

Recreational fishers also target this species on the south coast and lower west coast, mainly during the annual spawning migration.

Governing legislation/fishing authority

South Coast Salmon Managed Fishery
South Coast Salmon Fishery Management Plan 1982
South Coast Salmon Managed Fishery Licence
Proclaimed Fishing Zone Notice (South Coast) 1975
Salmon Block Net Prohibition Notice 1996
Salmon and Snapper Purse Seining Prohibition Notice 1987
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

South-West Coast Salmon Managed Fishery
South-West Coast Salmon Fishery Management Plan 1982
South-West Coast Salmon Managed Fishery Licence
Proclaimed Fishing Zone Notice (South-West Coast) 1975
Salmon Block Net Prohibition Notice 1996
Salmon and Snapper Purse Seining Prohibition Notice 1987
Condition 68 on a Fishing Boat Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Recreational Salmon Fishery
Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of the South Coast Salmon Managed Fishery are 'Western Australian waters below high water mark from Cape Beaufort to the waters up to the eastern boundary of the State on the south coast of Western Australia'.

In the South-West Coast Salmon Managed Fishery the boundaries are 'Western Australian waters from the eastern boundary of the State on the north coast of Western Australia to Cape Beaufort on the south-west coast of Western Australia'.

Recreational fishing for salmon can occur in all WA waters except in areas closed to recreational fishing, i.e. marine reserves.

Management arrangements

The 2 managed commercial salmon fisheries are controlled through limited entry and spatial and gear restrictions.

The South Coast Salmon Fishery management plan provides for licence holders to operate from assigned beaches between Shoal Cape and Cape Beaufort, with each fishing team having access to a single nominated beach.

In the South-West Coast Salmon Fishery, operating west and north of Cape Beaufort, licence holders can operate from any beach within the area of the fishery and share the use of beaches amongst themselves under priority of netting rules specified in the *Fish Resources Management Regulations 1995*. In practice, only a few beaches are fished.

A small number of fishers have a condition on their fishing boat licence or commercial fishing licence which has traditionally been interpreted as allowing them to fish for salmon between Busselton Jetty and Tim's Thicket, near Mandurah.

These 3 categories are the only fishers with authority to land and sell Australian salmon in WA.

Recreational fishers on the west and south coasts are subject to a daily bag limit of 4 fish and a minimum legal size of 300 mm total length. Australian salmon is listed as a category 2 (medium risk) recreational species in both regions.

As salmon is targeted by both recreational and commercial fishers, resource-sharing is an issue in the management of this fishery.

Research summary

Western Australian salmon occur across southern Australia from Kalbarri, WA, to Gippsland Lakes, Victoria and parts of Tasmania. Tagging studies have found that salmon form a single breeding stock across this range.

Spawning occurs on the south and lower west coasts of WA during autumn. Larvae are then dispersed to juvenile nursery areas in WA and South Australia. The South Australian salmon fishery catch is composed of WA-spawned juveniles that are caught prior to their migration back to WA to spawn. Landings in WA are probably a mixture of recruits from South Australian and Western Australian nursery areas.

Information to monitor the stock of this commercial and recreational target species is obtained from compulsory monthly commercial fishing returns, voluntary commercial fisher log books, recreational angler daily log books and fishery-independent surveys.

Annual fishery-independent surveys of juvenile salmon abundance are conducted at 6 sites along the south and lower west coasts of WA. These data are used to generate a relative index of annual salmon recruitment for the south-west region, which is then used to forecast adult abundance and fishery catches 3 to 4 years later.

The catch rates recorded in commercial returns and recreational log books provide indices of adult stock abundance. Fishing effort for Australian salmon in WA is timed to coincide with the autumn spawning migration and the majority of landings are mature individuals. Hence, fishery catch rates are considered to be a reasonable indicator of breeding stock level.

Commercial catch levels are determined annually from data reported in commercial returns, whereas recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. Recent surveys relevant to salmon include a shore-based creel survey on the west and south coasts in 1994 and 1995, a national phone survey in 2000/01 and 2 boat-based creel surveys on the west coast in 1996/97 and 2005/06.

The interpretation of trends in recruitment, catch and catch rates is assisted by the substantial amount of biological information already available on this species.

Retained Species

Commercial landings (season 2006): 1,986 tonnes

The total state commercial catch of Australian salmon for the 2006 season was 1,986 t, which was 502 t more than in 2005 but 506 t less than in 2004 (Salmon Figure 1). The 2006 catch was slightly below the average catch of 2,304 t for the past 10 years (1996 – 2005) but fell within the long-term catch range for this fishery (1,200 – 2,800 t).

On the south coast, the commercial catch of salmon was 792 t in 2006, which was 101 t more than in 2005. The 2006 catch was mainly taken from the western (Windy Harbour to Albany) and central (Albany to Cape Riche) regions of the fishery (49.5% and 46.4% of total catch, respectively). A small proportion (4.2%) was taken from the eastern sector of the fishery (from Cape Riche eastwards).

The 2006 south coast catch was the fourth lowest catch recorded in this region over the past 40 years. The lowest catch was recorded in 2005.

The monthly distribution of landings in 2005 and 2006 was also atypical. Traditionally, almost the entire south coast catch (approximately 97%) is taken between February and May each year, which coincides with the time of the spawning run along the south coast. However, in 2005 and 2006 only 60% and 73%, respectively, of the total annual catch was taken during this period, with the remainder being taken during the 'back run' (June to December).

The south-west coast catch for 2006 was 1194 t, which was 400 t more than in 2005 and 690 t above the 10-year average (1996 – 2005) for the south-west coast. This is the third highest catch on record for this region.

For the second consecutive year and the second time in the history of the WA commercial salmon fishery, the south-west coast catch exceeded the total south coast catch. The Geographe Bay and Capes regions contributed nearly all (99%) of the south-west coast catch.

Recreational catch: 6% of total state catch (approximately)

The most comprehensive recent recreational fishing survey to include salmon was the National Recreational and Indigenous Fishing Survey, conducted between May 2000 and April 2001 (Henry and Lyle 2003), which estimated a total Western Australian recreational catch of 136 t for Australian salmon. Most of this catch came from the south coast (111 t from the ocean and 6 t from estuaries) and the remainder from the west coast (17 t from the ocean and 2 t from estuaries).

The recreational component was estimated to be approximately 6% of the total salmon catch in the 2000/01 survey period (i.e. the 2000/01 recreational catch plus commercial catches from the 2000 calendar year). An earlier survey, conducted in 1994 and 1995 (Ayvazian *et al.* 1997), also indicated that the recreational catch share was about 6% of the total south coast catch and 8 to 16% of the west coast catch.

In the west coast region, 2 12-month creel surveys conducted by the Department of Fisheries in 1996/97 and 2005/06 provided recent estimates of boat-based recreational landings of salmon (Sumner and Williamson 1999, Department of Fisheries unpub. data). An estimated 3,241 salmon were retained by boat-based fishers in 1996/97 and 4,077 were estimated to have been retained in 2005/06. Assuming an average weight of 3.7 kg per fish, then approximately 12 t and 15 t were retained in each survey period.

However, the boat-based catch is a minor component of the total recreational catch of salmon. The national survey in 2000/01 estimated that only 22% of west coast (and 4% of south coast) recreational landings were by boat-based fishers. Recent estimates of recreational shore-based landings of salmon are not available.

Anecdotal reports from recreational fishers indicated that the abundance, and hence catch rates, during the autumn 'salmon run' was relatively high on the west coast in 2006.

Fishing effort/access level

Commercial

In 2006, there were 18 south coast and 9 south-west coast commercial fishing teams, plus 3 licensees with access only from Busselton Jetty to Tim's Thicket. The number of south-west teams was reduced from 12 in 2005 to 9 in 2006 through a voluntary Fisheries Adjustment Scheme.

The commercial salmon fishing method (i.e. beach-based netting on a restricted number of beaches) includes a considerable amount of time spent observing ('spotting') or searching for fish. Hence effort in this fishery is difficult to accurately quantify. The number of active teams per year is an approximate measure of the annual commercial fishing effort applied to the stock.

Recreational

Recreational catches of salmon are taken using line fishing methods in inshore marine waters of the south coast and west coast regions. In 2000/01, it was estimated that approximately 200,000 shore-based and 50,000 boat-based recreational line fishing events took place in inshore waters of the south coast region (Henry and Lyle 2003).

Approximately 900,000 shore-based and 300,000 boat-based recreational line fishing events were estimated to have occurred in the west coast region. However, only a small proportion of these events would have involved specifically targeting salmon.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Outputs from a preliminary biomass dynamics model indicated that the long-term catch of Australian salmon from both sectors (recreational and commercial) can be sustained at an average of about 2,500 t per year. Recent total landings have been below this level and are considered sustainable.

Spawning biomass is not estimated directly for salmon. The status of this stock is assessed by examining annual trends in fishery catch rates, catch levels and juvenile recruitment. The catch rates of commercial and recreational fishers, who target mature salmon during the spawning run, provides a relative index of breeding stock abundance.

On the south-west coast, the commercial catch rate has been increasing since 2000, which suggests that the breeding stock is currently at an acceptable level. In 2006, the average commercial catch rate on the south-west coast in 2006 was 99.5 t per active team (52.9 t in 2005) which was much higher than the 10-year (1996-2005) average of 34.2 t.

On the south coast, the commercial catch rate has been declining since the mid-1990s. In 2006, the average commercial catch rate was 60.9 t per active team (49.3 t in 2005) which was much lower than the 10-year (1996-2005) average of 111.8 t. However, the declining trend is not considered to reflect a decline in total stock level but, rather, is the result of market forces and environmental factors on the south coast affecting catchability.

Juvenile salmon recruitment in 2005/06 was equal to the average of recruitment levels measured during fishery-independent surveys over the past 10 years, suggesting that overall recruitment to the south-west region has been stable over this period.

While harvest levels are currently sustainable, Australian salmon is potentially vulnerable to over-exploitation due to the 'gauntlet' nature of the fishery – that is, most migrating schools of pre-spawning salmon pass close to shore along each of the fishing beaches, where they are highly vulnerable to capture by commercial and recreational fishers, given the right conditions.

There is also the potential for a significant reduction in recruitment due to unusual environmental effects. Without appropriate management, one or both of these factors could result in the stock falling below 30% of virgin spawning biomass, which is considered an acceptable biological reference point.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of salmon. Boxed text in this status report provides the annual assessment of performance for this issue.

The performance measure for the fishery relates to annual salmon commercial catch, which is taken predominantly during the spawning season and is therefore an indicator of breeding stock levels. In 2006, the catch was within the target range, indicating that the breeding stock level was adequate in that year.

Non-Retained Species

Bycatch species impact: **Negligible**

The fishery uses beach seine nets to specifically target schooling salmon, primarily during the annual late summer to autumn spawning migration. As a result of the fishing method, the design of the gear used and the way it is operated, the fishery captures minimal bycatch. A small quantity of other finfish species is caught with the salmon, but the risk to these species is regarded as negligible.

Protected species interaction: **Negligible**

Seals are occasionally surrounded by a beach seine net, but are released immediately by the fishers. This is possible because seine netting is a labour-intensive operation and the fishing team will immediately notice a seal in the net. Fishers are able to release seals from their seine net without injury to the seal.

Ecosystem Effects

Food chain effects: **Low**

Salmon are only one of a number of top-end predatory species in the marine food chain of the lower west and south coasts. The fishery has some potential to reduce the mortality of prey species. However, given the high natural variability in the salmon biomass, the impact of the fishery is likely to be similar in magnitude to other environmental factors contributing to the recruitment of the prey species.

Overall, the ecological impact of the fishery is assessed as low.

Habitat effects: **Negligible**

Commercial salmon fishers operate at a very small number of beaches along the Western Australian coastline. These fishers only 'shoot' their nets when fish schools are available at these sites (and also only when a market is available for the catch).

Sometimes, schools will be deemed too large or too small, or incorrectly positioned for capture, and the net will not be shot. Hence, most teams only shoot their nets a few times in a season. Finally, the beach seining method when operated over the sandy beach environments in these high-energy areas does not impact significantly upon these habitats.

Social Effects

During the 2006 fishing season there were approximately 61 commercial fishers involved in the south coast fishery and 44 in the south-west coast fishery.

The number of recreational fishers targeting salmon in recent years is not known. However, catch levels suggest that this species is targeted by a relatively small proportion of the recreational fishing sector. The national recreational fishing survey in 2000/01 estimated that salmon comprised 0.05% and 0.62% of all finfish retained by recreational fishers in the west and south coast regions, respectively (marine/estuary waters only).

In 2006, recreational targeting may have been higher than average on the west coast, in response to reports of unusually high salmon abundance.

Economic Effects

Estimated annual value (to commercial fishers) for year 2006: **$794,282**

The price paid to south coast commercial fishers for Australian salmon remained at an average of $400/t in 2006. Industry members are being encouraged to investigate ways of improving fish handling and value-adding techniques to improve the net value of the commercial fishery.

Fishery Governance

Target catch range: **1,200 – 2,800 tonnes**

The target catch range for the commercial fishery is 1,200 – 2,800 t. In 2006, the total commercial catch (1,986 t) was within the target range.

Prior to 2005, the catch range for this fishery was derived by applying an autoregressive moving average quality control procedure to 37 years of annual catches up to the year 2000. This followed a standard methodology that is applied routinely to fisheries in Western Australia.

Although the upper catch limit of 3,350 t calculated by this method was considered adequate to ensure the sustainability of the fishery, a more precautionary upper catch limit of 2,800 t was introduced in 2005 to satisfy recommendations by the Australian Government Department of Environment and Heritage, to maintain the fishery's permit to export under the *Environment Protection and Biodiversity Conservation Act 1999*.

Current fishing level: **Acceptable**

Current total catch levels of salmon are considered to be acceptable to ensure the sustainability of the stock.

New management initiatives (2006/07)

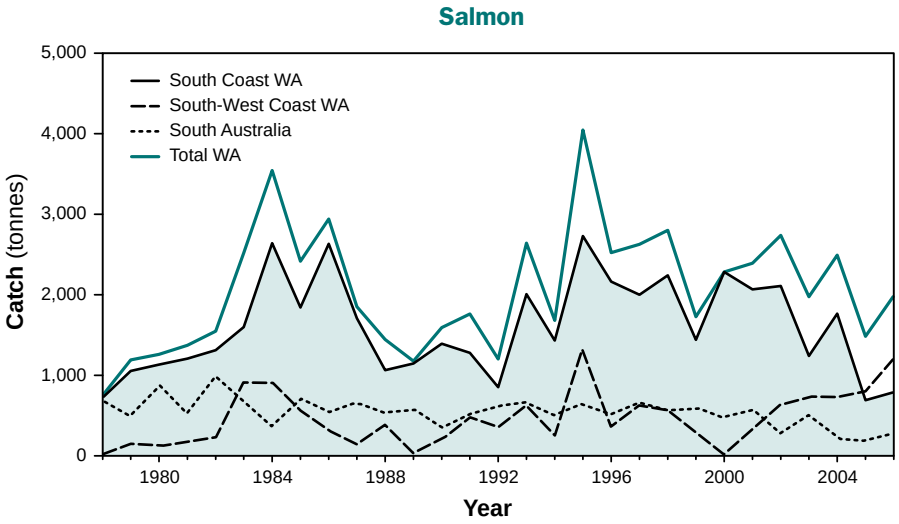
A voluntary Fisheries Adjustment Scheme remains in progress for the South-West Coast Salmon Managed Fishery. 3 licences were recently been removed from the south-west fishery under the scheme, leaving 9 managed fishery licences remaining. The scheme will run until March 2008. An extension of the Voluntary Fisheries Adjustment Scheme to include the South Coast Salmon Fishery is under consideration.

A closure to commercial salmon fishing in Geographe Bay was implemented for Easter in 2007 to reduce conflict between the fishing sectors.

External Factors

The cyclic nature of salmon catches, with peaks at intervals of about a decade, is likely to reflect changes in abundance that are related to variations in recruitment success linked to large-scale environmental influences such as the flow of the Leeuwin Current.

Fluctuations in salmon catches can also occur, due to the influence of environmental factors, without a change in stock level. For example, water temperature and the strength of the Leeuwin Current can affect the distribution and movement of spawning-run fish and their catchability for beach-based fishers. Low market demand can also result in reduced targeting and catch levels, as has been the case on the south coast in recent years.



SALMON FIGURE 1
Australian salmon catches for Western Australia and South Australia for the period 1978 to 2006.

Australian Herring Fishery Status Report

K. Smith and J. Brown
Management input from P. Shaw

Fishery Description

Most of the commercial catch of Australian herring (*Arripis georgianus*) in Western Australia is taken on a limited number of beaches along the south coast, using herring trap nets (also known as 'G' trap nets). Trap nets are used principally during the autumn migration of this species.

Seine nets, gillnets and line fishing on the south coast and west coast take the remainder of commercial landings. Overall, the south coast region typically contributes 80 to 90% of the total commercial catch each year.

On the west coast, the Cockburn Sound (Fish Net) Managed Fishery and the West Coast Beach Bait Managed Fishery is responsible for most of the commercial landings of Australian herring.

A large number of recreational anglers in WA target Australian herring on the west and south coasts.

Governing legislation/fishing authority

Fisheries Notice no. 478 of 1991 (Section 43 Order) (Herring 'G' nets)
Fishing Boat Licence Condition 42 (Herring 'G' nets)
Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

Australian herring can be taken commercially by holders of an unrestricted fishing boat licence along the lower west and south coasts, which is the distributional range of this species in WA. The use of trap nets is restricted to holders of fishing boat licenses with Condition 42, who operate at 10 specific beaches along the south coast.

Recreational fishing for herring can occur in all WA waters except in areas closed to recreational fishing, i.e. marine reserves.

Management arrangements

The Herring Trap Net Notice (Order 478 of 1991) prohibits the use of herring trap nets except by licensed commercial fishers using a fishing boat with the appropriate fishing boat licence condition (Condition 42). Holders of fishing boat licences with this condition may take Australian herring using 'G' trap nets on 10 separately nominated south coast beaches.

There is a closed season for the use of 'G' trap nets (10 February to 25 March each year) that closely matches the peak Australian salmon migration season along the south coast.

Australian herring may also be commercially caught by beach seine, set net and line methods by any licensed commercial fisher holding an unrestricted fishing boat licence, provided the use of this method is permitted in the particular area and the waters being fished are not subject to other fishery management arrangements.

A minimum legal size of 180 mm total length for Australian herring applies to all commercial fishers.

Australian herring is listed as a category 3 (low risk) recreational species on the west and south coasts. In both regions, recreational fishers are subject to a daily bag limit of 40 fish. No size limit applies to recreational fishers.

As Australian herring is considered a prime recreational species, resource-sharing issues are a major consideration in future management arrangements for this fishery, particularly on the west coast.

Research summary

Australian herring occur from Shark Bay, WA, to the Gippsland Lakes, Victoria. Evidence from studies of otolith microchemistry, tagging and genetics indicates that herring form a single breeding stock across this range.

Spawning occurs on the west and south coasts of WA during autumn. Larvae are then dispersed to juvenile nursery areas in WA and South Australia. The South Australian herring fishery catch is composed of WA-spawned juveniles that are caught prior to their migration back to WA to spawn.

Western Australian landings are believed to comprise a mixture of recruits from nursery areas in South Australia and WA. For the west coast sector especially, it is believed that protected local habitats such as Geographe Bay are important nursery areas and a source of recruitment.

Information to monitor the stock of this commercial and recreational target species in WA is obtained from compulsory monthly commercial fishing returns, recreational angler daily log books, fishery-independent surveys and sampling of the age structure of the recreational catch.

Annual fishery-independent surveys of juvenile herring abundance are conducted at 6 sites along the south and lower west coasts of WA. These data are used to generate a relative index of annual herring recruitment for the south-west region, which is then used to forecast adult abundance and fishery catches 2 to 3 years later.

The catch rates recorded in commercial returns and recreational log books provide indices of adult stock abundance. The majority of fishing effort for Australian herring in WA is timed to coincide with the autumn spawning migration and the majority of landings are mature individuals. Hence, fishery catch rates are considered to be a reasonable indicator of breeding stock level.

Commercial catch levels are determined annually from data reported in commercial returns, whereas recreational catch levels are estimated only occasionally when recreational fishing

surveys are conducted. Recent surveys relevant to herring include a shore-based creel survey on the west and south coasts in 1994 and 1995, a boat-based creel survey on the west coast in 1996/97, a national phone survey in 2000/01 and a boat-based creel survey on the west coast in 2005/06.

Age-based sampling of the recreational catch recommenced in 2005 (it was last sampled in 1996 to 1998) and is now ongoing. Samples of fish are caught by volunteer anglers at various sites on the lower west coast. Fish are donated to researchers who age the fish using validated methods.

Retained Species

Commercial landings (season 2006): State 345 tonnes South coast 301 tonnes

The total commercial catch of Australian herring reported in 2006 was 344.9 t. This was an increase on the previous year, when a total of 287.1 t was landed (please note that this amount is an increase on the catch reported in the previous *State of the Fisheries* report and is due to monthly returns not being submitted on time by some fishers). The 2006 catch, while up on 2005, is the second lowest on record and well below the 10-year average of 722.6 t.

The low catch in 2006 is a continuation of the declining trend in the commercial catch of Australian herring since the early 1990s. The total state catch peaked at 1,537 t in 1991, followed by a period of lower, but stable, annual catches of approximately 800 to 1,000 t during the mid-1990s. Since 2000, the total annual catch has steadily declined each year, until a slight increase in 2006 (Herring Figure 1).

In 2006, the south coast catch was 301.4 t, which comprised 87.4% of the total commercial catch. This was the fourth consecutive year in which the south coast catch was below the target catch range for this region (475 – 1,200 t).

These historically-low catches are partly attributable to the recent low marketability of this species, resulting in lower effort expended by fishers. Only 8 of the 11 licensed trap net teams reported fishing for herring in 2006.

The majority (90.1%) of the south coast catch in 2006 was caught using trap nets, with gillnets, haul nets and beach seine nets comprising equal shares of the remainder of the catch. Approximately 95% of the south coast landings were from ocean waters, with the remainder from estuaries and embayments.

In 2006, the west coast catch of herring was 43.5 t. This is the lowest catch on record for this region and was well below the 10-year (1996 – 2005) average of 104.4 t. The majority (66%) of these landings were from embayments (Geographe Bay and Cockburn Sound), with the remainder from estuaries (21%) and from ocean waters (13%).

The 2006 west coast catch was below the target catch range of 70 – 185 t for this region. This drop can be attributed to a large reduction of the catch in the Geographe Bay region (38 t below the 10-year average) and the Bunbury region (20 t below the 10-year average).

The vast majority of commercial herring landings are taken between January and May each year. In 2006, 90.5% of the total WA catch occurred in this period. May is traditionally the end of the trap net fishing season and marks the end of the main pre-spawning migration for this species.

Recreational catch: 40% of total catch (approximately)

An estimate of the total state recreational herring catch is not available for the current year (2006). The most recent state-wide estimate (all areas, all methods) is available from the National Recreational and Indigenous Fishing Survey conducted between May 2000 and April 2001 (Henry and Lyle 2003).

The recreational share of the total WA herring catch (i.e. the recreational catch in 2000/01 combined with the commercial catch from the calendar year 2000) was estimated to be approximately 40%. However, there were marked differences in catch shares between regions. On the west coast, the recreational share of the herring catch was estimated to be about 80%, whereas on the south coast it was estimated to be 11%.

In 1994 and 1995, the recreational catch shares were estimated to be approximately 60% and 10% on the west and south coasts respectively (Ayvazian *et al.* 1997).

Preliminary estimates from the boat-based creel survey undertaken by the Department of Fisheries in 2005/06 suggest that the number of herring retained by boat-based recreational fishers in the west coast region was 306,000 fish during the 12-month survey period. This was 28% less than the 425,000 fish that were estimated to have been retained by boat-based recreational fishers in 1996/97, during a similar creel survey by the Department.

The national survey in 2000/01 found that only 32% of the recreational herring catch in the west coast region was taken by boat-based fishers. Therefore, the majority of the recreational catch in this region is from shore-based fishing. No recent estimate of the catch by this sector is available.

Fishing effort/access level

Commercial

As the majority of the commercial catch of Australian herring is caught by trap netting, the number of herring trap net teams that operate during each fishing season provides an approximate index of fishing effort for the south coast herring trap net fishery. The total number of licensed teams reached a peak of 30 in 1984, and has since been reduced by 63% though a series of Government buy-back initiatives to the current level of 11.

In 2006, 11 teams (most of whom are also Australian salmon fishers) were entitled to take Australian herring using trap nets set on 10 nominated south coast beaches. However, only 8 teams recorded effort during the season. This was an increase from the 5 active teams in 2005. These historically-low effort levels were in response to the lack of markets and low wholesale prices paid for herring.

Recreational

In 2000/1, it was estimated that 28% of the WA population aged 5 years or over fished (Henry and Lyle 2003). This was in close agreement with an earlier survey in 1987, which estimated that 26% of the WA population aged 15 years or over fished (Van Bueren *et al*. 1999). It was estimated that 30 to 39% of anglers target herring, but the proportion who actually catch herring is probably much higher due to the high vulnerability of this species to capture by recreational line fishing methods.

The vast majority of recreational catches of herring are taken using line fishing methods in inshore marine waters of the west coast and south coast regions. In 2000/01, it was estimated that approximately 900,000 shore-based and 300,000 boat-based recreational line fishing events took place in inshore waters of the west coast region (Henry and Lyle 2003). Approximately 200,000 shore-based and 50,000 boat-based recreational line fishing events were estimated to have occurred in the south coast region.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Uncertain**

Spawning biomass is not estimated directly for herring. Instead, the catch rates of commercial and recreational fishers, who mainly target mature herring during the spawning run, are used as relative indices of breeding stock abundance. Fishery-independent surveys of juvenile fish are used to monitor annual recruitment.

The Australian herring stock appeared to be at satisfactory levels in all regions when assessed in the late 1990s – and above a conservative biological limit reference point of 40% of the total virgin biomass. However, several independent data sources suggest that the breeding stock level has since declined.

In 2000 and 2001, localised peaks were evident in catch rates by commercial trap netting and also by some other commercial methods. This followed relatively high juvenile recruitment that was observed in 1998. Australian herring recruit to the fishery at approximately 2 years of age, which explains the 2-year lag between recruitment and catch rate.

Recruitment has progressively declined since 1998 and the annual catch rate of the south coast trap net fishery has been declining since 2001. In 2005/06, recruitment was at the lowest level measured since fishery-independent surveys commenced in 1994/05. This suggests that overall fishery catch rates will continue to decline and will be very low in 2007/08 and 2008/09.

The estimated number of herring retained by boat-based recreational fishers on the west coast declined from approximately 425,000 fish in 1996/97 to 306,000 fish in 2005/06 (i.e. a decline of 28%).

The average age of herring in recreational catches on the west coast appears to have declined slightly since the late 1990s. In 1996 to 1998, the maximum observed age in recreational catches was 7 years. In 2005, the maximum observed age was 5 years.

The status of the Australian herring stock is uncertain at this time. Historically, this stock has been assessed primarily using data from the commercial south coast trap net fishery. However, there has been a significant reduction in effort and targeting by commercial fishers since 1990 and commercial CPUE is increasingly unreliable as an index of herring abundance.

Alternative data to monitor annual recruitment and stock abundance is now being collected by fishery-independent surveys and from the recreational sector, mainly on the west coast. It is expected that recreational CPUE from log books will provide a more reliable index of abundance than commercial CPUE. However, log book data have only been available since 2005 and are difficult to interpret in the absence of comparable historical data.

A more recent estimate of the total catch by shore-based recreational fishers, who catch the majority of herring on the west coast, would also reduce uncertainty about the current stock status. Despite these uncertainties, the available information suggests that declining commercial CPUE in recent years is not solely the result of declining effort and market forces, but is also partly the result of a lower abundance of herring in recent years.

A decline in the fishery-independent recruitment index, a 28% decline in west coast recreational boat-based catches and a decline in the average age of fish in west coast recreational catches since 1998 strongly suggest that the abundance of herring in WA is lower than in the late 1990s, due to several consecutive years of low recruitment. The reasons for low recruitment are unclear but are probably related to environmental factors.

Non-Retained Species

Bycatch species impact: **Low**

The main south coast fishery operates primarily through fixed trap nets on a maximum of 10 beaches during the main autumn fishing season. Overall, the ecological effect of this fishery is assessed as low.

Protected species interaction: **Negligible**

While there is occasionally some interaction with protected species such as fur seals and sea lions, the operation of the fishing gear allows these animals to be removed and returned to the water safely and hence does not result in a negative impact on these species.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The fishing methods used in this fishery do not impact on the habitat.

Social Effects

Approximately 34 fishers participated in commercial trap net fishing in 2006. Numerous other commercial fishers participate in the capture of Australian herring using other fishing methods, such as estuarine haul and gillnets, but the quantities caught

by other methods are minor compared to the trap net fishery. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

The use of large 'G' trap nets on beaches may temporarily impact on beach access by members of the public.

Herring is relatively abundant and is readily caught by recreational line fishing methods in south-west inshore waters. Consequently, it is a very popular target species. The national recreational fishing survey in 2000/01 estimated that herring was the second most common finfish retained by recreational fishers in WA (after whiting), and comprised 22% (by number) of finfish in the retained recreational catch (marine/estuary waters only). In 2000/01, herring were estimated to comprise 23% and 15% of finfish retained by recreational fishers in the west and south coast regions, respectively.

Economic Effects

Estimated annual value (to fishers) for year 2006: $138,000

The estimated value to fishers of the total state commercial catch for the year 2006 is $138,000.

Fishery Governance

Target catch range: South coast 475 – 1,200 tonnes
West coast 70 – 185 tonnes

Target catch ranges for the south coast herring trap net fishery and the west coast commercial fishery were derived by applying an autoregressive moving average control quality procedure to the annual catches from 1976 to 2000. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions from 1983 to 2000.

In 2006, the south coast catch was 301 t. This was the fourth consecutive year in which the south coast catch was below the target catch range (475 – 1,200 t) for this region.

It must be noted that the target catch range assumes that all licensees participate in the fishery each year. Under conditions of relatively full effort expenditure, consecutive catch values that occurred outside of the target range may indicate that management changes are required to protect the stock. However, the relatively low south coast catches in recent years were at least partly due to the low effort expended by fishers. Only 8 of the 11 licensed trap net teams fished for herring in 2006.

In 2006, the west coast commercial fishery catch was 44 t, which was below the target catch range (70 – 185 t) for this region. This reflected low catches due to low effort spent targeting herring in the Geographe Bay and Bunbury areas.

Some effort previously spent targeting herring may have been redirected towards salmon. Landings of Australian salmon have increased significantly on the lower west coast in the last 2 to 3 years.

Current fishing level **Acceptable**

Commercial catch and effort is now at a historically-low level. The commercial sector has historically taken the largest share of the total catch and so, although the recreational catch is significant, the reduction in commercial effort has probably resulted in a reduction in total fishing pressure on the stock in recent years. Hence, the total fishing level is considered acceptable at this time.

The stock level has apparently declined over the last 5 to 10 years. However, this period coincides with declining commercial effort levels, which suggests that the decline in stock level may mainly be due to poor recruitment as a result of environmental factors, rather than fishing. Nonetheless, in a period of low recruitment, relatively high catches of breeding fish, especially by recreational fishers on the lower west coast, are of concern.

No estimates of shore-based recreational catch or effort within the last 5 years are available from the west coast. Shore-based fishers take the majority of the recreational herring catch. The total recreational catch of Australian herring is essentially unconstrained under current management arrangements. Available data indicate that the current recreational bag limit of 40 fish is rarely achieved and so does not constrain catch levels. A review of the management of the recreational fishery is warranted.

New management initiatives (2006/07)

The Minister has approved the drafting of a new Order to regulate the use of herring 'G' trap nets. The new Order will list operators in the fishery in the schedule to the Order, and remove the need for fishing boat licence Condition 42.

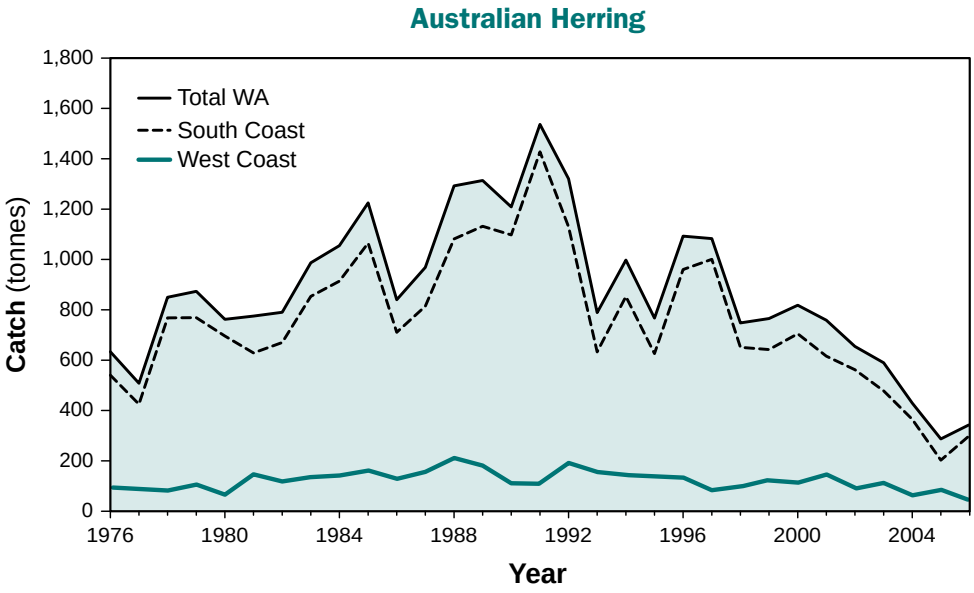
External Factors

It is likely that factors other than fishing (especially the strength of the Leeuwin Current) significantly influence the migration patterns of pre-spawning adults, the distribution of spawning and the dispersal of larvae. These factors will then affect juvenile recruitment success and the catchability and abundance of adult fish in each region, which ultimately determine the total breeding stock level.

On the south coast, an increased abundance of fur seals and Australian salmon, both of which consume herring, could have impacted on stock levels in recent years.

Market forces have a strong influence on the catch level in the commercial fishery. Low wholesale prices paid for Australian herring in recent years have limited the catch and effort levels of commercial fishers. By purchasing only a limited quantity of herring each year, fish processors effectively restrict the catch level.

Commercial trap net fishers sometimes elect not to capture a school of fish, or release part of their catch, when a market is not available.



HERRING FIGURE 1
Australian herring catches from the south and west coasts, and the total Western Australian catch, for the period 1976 to 2006.

South Coast Purse Seine Managed Fishery Status Report

A. Nardi, R. Lenanton and S.J. Newman
Management input from G. Baudains and T. Reid

Fishery Description

This fishery is based on the capture of pilchards (*Sardinops sagax*) by purse seine nets in the waters off the south coast of Western Australia between Cape Leeuwin and the WA/SA border. However, the management plan also covers the take of yellowtail scad (*Trachurus novaezelandiae*), Australian anchovy (*Engraulis australis*) and maray (*Etrumeus teres*).

Governing legislation/fishing authority

South Coast Purse Seine Management Plan 1994
South Coast Purse Seine Managed Fishery Licence

Consultation process

Purse Seine Management Advisory Committee
Meetings between the Department of Fisheries and industry

Boundaries

The South Coast Purse Seine Managed Fishery consists of 3 primary management zones. The Albany zone extends from Point D'Entrecasteaux to Cape Knob and the King George Sound zone is a subset of this area, so the 2 zones are reported together. The Bremer Bay zone extends from Cape Knob to longitude 120° E, and the Esperance zone from 120° E to the WA/SA border.

A further zone exists between Cape Leeuwin and Point D'Entrecasteaux, but has not been significantly fished to date.

Management arrangements

This fishery is primarily managed through output controls in the form of individually transferable quota (ITQ) units. Each zone in the fishery has been allocated a set amount of ITQ units whose values are reviewed annually and changed, if necessary, depending on the results of stock assessment.

The sum of ITQ holdings within each zone for any 1 year equates to an annual total allowable catch (TAC). The total quota units allocated across each of the 5 zones in the fishery amount to 890 and remained unchanged from the previous season. The quota season for the South Coast Purse Seine Managed Fishery runs from 1 July to 30 June each year.

Research summary

Monitoring of catches from each region is undertaken monthly to provide age-composition data, from which relative recruitment strengths can be inferred. Estimates from the biomass surveys and the age-composition data are integrated via an age-structured model to provide a more robust estimate of pilchard biomass in each of the 3 management regions. The model outputs, along with analyses of catches, together allow the annual review of stocks in each major zone.

A Fisheries Research and Development Corporation (FRDC) project undertaken by the Department of Fisheries' Research Division's Fish Health Unit to assess the virus disease which decimated pilchard stocks in the 1990s has been completed.

Another FRDC project to examine the recovery of the stock has also been completed.

A collaborative research project with Murdoch University, to examine the extent of interactions between the fishery and wildlife, and potential mitigation methods, commenced in 2005. This project is continuing.

Retained Species

Commercial landings (season 2005/06): 1,871 tonnes

Following the apparent recovery of the pilchard stocks from the 1999 mass mortality, pilchard TACs have been stabilised at 1,500 t for each of the 3 regions of the south coast. Landings of pilchards for the 2005/06 season were:

Albany zone:	1,342 t
Bremer Bay zone:	391 t
Esperance zone:	138 t

These figures represent a catch increase for Albany and Esperance (31% and 2% respectively) over the previous year, while Bremer Bay had an 18% decrease of catch over the same period. The presence of only variable-sized or small fish and the concomitant lack of consistent markets served to inhibit significant landings in the Albany region in some months. However, periodic influxes of larger fish allowed increased landings in other months.

The Bremer Bay fishery was similarly constrained by inconsistency in the presence of large pilchards in the fishing grounds. Consistently small fish in the Esperance region have led to low demand for product from that region.

Catches of other small pelagic species – at 3 t – were again a minor component of the catch in 2005/06.

Recreational catch: Nil

Fishing effort/access level

Fishing effort in the south coast purse seine fishery was again constrained by low availability of suitably-sized fish at times when the market was receptive, and then by competition from the rival South Australian fishery.

The Albany fleet fished 5% more days than last year, while the Bremer Bay fleet fished a significantly fewer number of days than last season (39%). For much of the season, only 1 vessel was operational out of Bremer Bay, with the second vessel recording only 35 days of fishing. The Esperance vessel fished 38% more days than the previous season.

Albany zone: The recorded number of CAES days in 2005/06 was 1,081 compared to 1,027 in 2004/05.

Bremer Bay zone: The recorded number of CAES days in 2005/06 was 169 compared to 276 in 2004/05.

Esperance zone: The recorded number of CAES days in 2005/06 was 130 days compared to 94 days in 2004/05.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The catch rate was slightly higher than the previous year in Albany, much higher in Bremer Bay and significantly lower in Esperance. Given the avoidance of small fish by vessels in each region, the year-to-year changes in catch rate, when measured as kg/day, are difficult to interpret with any certainty and are unlikely to be accurately reflecting fish abundance.

Albany zone: The 2005/06 catch rate for the Albany zone was 1,187 kg/day compared to 999 kg/day in 2004/05.

Bremer Bay zone: The 2005/06 catch rate for the Bremer Bay zone was 2,305 kg/day compared to 1,731 kg/day in 2004/05.

Esperance zone: The 2005/06 catch rate for the Esperance zone was 1,105 kg/day compared to 1,446 kg/day in 2004/06.

The fishery-independent estimates of spawning biomass and the age-composition data for each zone are analysed together within a population simulation model that provides a forecast of mature biomass. The age composition data 'feeds in' recruitment levels, the recognised primary influence on stock size, while the fishery-independent survey provides a point estimate of spawning biomass to ensure that the model outputs are as robust as possible.

The most recent assessment has shown that the fishery-independent and fishery-dependent methods applied to Western Australia's pilchard fisheries cannot currently provide precise estimates of the size of the pilchard spawning biomass in each management region. Although the trends indicated by the age-structured simulation model are reliable and provide good evidence for a strong recovery of pilchard stocks, the magnitude of changes in stock size from year-to-year are not known with sufficient certainty to allow high rates of exploitation.

A significant contributor to this uncertainty is the additional mortality of larger fish that can be attributed to the ongoing effects of the herpes virus that is now a permanent fixture in the pilchard population. The current (2006) spawning biomass in each region, and the lower and upper bounds for the estimate, were:

Albany zone:	27,061 t (5,973 – 48,149 t)
Bremer Bay zone:	24,700 t (0 – 42,966 t)
Esperance zone:	43,700 t (3,778 – 117,890 t)

The south coast population of pilchards is considered to consist of a single breeding stock, but with functionally-distinct adult assemblages at Albany, Bremer Bay and Esperance. At the end of 2006, the model indicated that the spawning biomass (i.e. the breeding stock) of pilchards in each of the 3 primary management zones was at adequate levels.

Non-Retained Species

Bycatch species impact: **Negligible**

This fishery specifically targets schools of pilchards so unwanted bycatch is insignificant. Other similar-sized pelagic fish that may be caught in small quantities and marketed include yellowtail scad, maray, anchovies and blue mackerel.

Protected species interaction: **Moderate**

A number of protected species, including seabirds, seals, dolphins and white sharks, are attracted to pilchard fishing operations to feed on the fish. Seabirds, and to a much lesser extent dolphins, can become entangled in the nets. The impact of these incidental captures is a significant issue for the fishery. A new research project to examine the extent of wildlife interactions and potential mitigation actions commenced in late 2005.

Ecosystem Effects

Food chain effects: **Moderate**

Ecosystem structure and function is reliant on flows of energy within an interconnected 'web'. Small pelagic fish occupy a pivotal role as a conduit between primary (phytoplankton) and secondary (zooplankton) production and the higher trophic levels.

The characteristics of small pelagic fish mean they are available as food for a number of populations of larger animals including predatory fish, pinnipeds, cetaceans and bird species. Catches of small pelagic fish on the south coast are carefully constrained so as to leave a large majority of the estimated biomass available to predators.

The quota for pilchards and other small pelagic species is set at a maximum of 10% of the spawning biomass, leaving more than 90% of the total biomass available to natural predators.

Habitat effects: **Negligible**

Purse seining generally has very little direct effect on the habitat. Although the purse seine gear used in this fishery can contact the sea floor in some fishing areas, the relatively light construction of the gear suggests that there is no significant impact occurring to the benthos. Areas of hard reef are specifically avoided, minimizing the percentage of ground actually touched, as it is hazardous to the fishing gear.

Social Effects

There were 8 vessels fishing in Albany in 2005/06 for at least part of the year, providing income for 21 crew members. Fewer vessels worked in Bremer Bay and Esperance (2 boats, 5 crew and 1 boat, 4 crew respectively), with concomitantly fewer onshore employees.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: **$1.87 million**

The total catch value calculated for 2005/06 was $1.87 million. Prices paid differ amongst processors, depending on the quality of the fish and the end market, and whether the licence holder has interests in the plant or vessel. Being able to supply the right-sized product, in the right quantity at the right time, is crucial.

The different product types for each zone are shown in South Coast Purse Seine Table 1. The recreational bait market remains the most common destination for south coast pilchards, mainly in block/tray form, with some individually quick frozen (IQF) fish finding interstate markets for human consumption (the potential exists for local processing for human consumption, but this requires a steady supply of appropriately sized fish).

Tuna grow-out feed, commercial trap bait and, to a lesser extent, pet food accounted for the remainder of the catch.

Fishery Governance

Target catch (or effort) range: **Not available**

Catches are governed by changes in the TAC for each of the primary management zones. For the 2006/07 season, the TAC for the Bremer Bay and Esperance zones remains at 1,500 t each, while the TAC at Albany increased to 2,683 t, giving a maximum expected catch for the fishery of 5,683 t.

The fleet and infrastructure for this fishery remain in a state of flux due to irregular availability of market-sized fish, particularly in Bremer Bay and Esperance, which will influence how much of the TAC is caught. Furthermore, the schooling behaviour of pilchards makes it difficult to detect meaningful patterns in catch rates.

These factors, combined with the variability in unit holdings within the fishery and resultant variability in fishing behaviour by different operators, mean that it is currently difficult to estimate a target effort range for the fishery.

Current fishing (or effort) level: **Acceptable**

The stock assessment model indicated that the spawning biomass (i.e. the breeding stock) of pilchards at the end of 2006 in each of the 3 primary management zones was at adequate levels. Thus, the current level of fishing activity is regarded as acceptable.

New management initiatives (2006/07)

Following reports of deaths of some seabirds and confirmed deaths of some dolphins resulting from interactions with the purse seine fishing operations, the Department of Fisheries has instigated a working group to examine this issue. Research on the mitigation of seabird bycatch is continuing.

External Factors

The unpredictable availability of market-size fish in this region continues to negatively impact on this fishery. Consequently, it cannot be predicted when the fishery, as opposed to the resource, might recover to a point where the TAC can be consistently achieved in each zone.

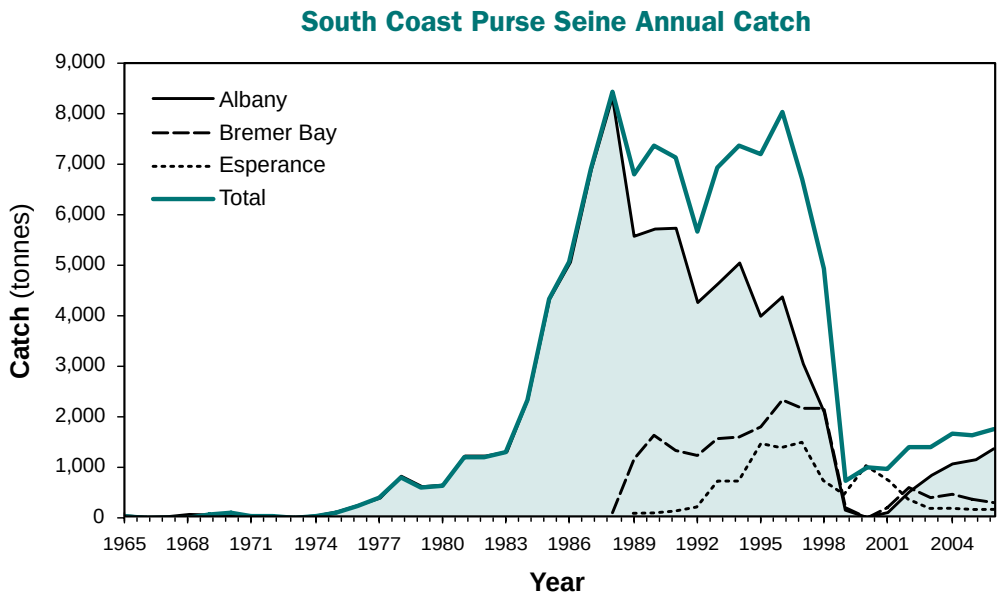
Previous research has shown that environmental factors such as variations in the Leeuwin Current flow are also likely to be affecting both the distribution and the biology of the species. Recent research on oceanographic variability undertaken by the University of Western Australia and Murdoch University appears to confirm that there is significant variability in phytoplankton productivity, even within the regions on the south coast.

Any variations in recruitment and stock size that might occur as a result of environmental effects are already accommodated within the management system. The possibility of longer-term changes, on a time scale unrelated to inter-annual environmental variations, cannot be discounted.

SOUTH COAST PURSE SEINE TABLE 1

Processing details (in tonnes) for pilchards from Albany, Bremer Bay and Esperance for 2005/06.

Product	Albany	Bremer Bay	Esperance	Total South Coast
Trays	643.3	200.2	87.0	930.5 (49.7%)
IQF	250.0	173.5	49.0	472.5 (25.3%)
Pet food/other	448.8	16.9	2.3	468.0 (25.0%)
TOTAL (tonnes)	**1,342.1**	**390.6**	**138.3**	**1,871**



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone.

Demersal Gillnet and Longline Fisheries Status Report

R. McAuley
Management input from G. Baudains

Fishery Description

The Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) employ demersal gillnets and demersal longlines with power-hauled reels along the south and lower west coasts.

The majority of operators use demersal gillnets and the fisheries primarily target sharks, with demersal scalefish also being a legitimate component of the catch. The main shark species targeted by fishers on the south coast are the gummy shark (*Mustelus antarcticus*) and dusky shark (*Carcharhinus obscurus*), while on the west coast fishers primarily target the dusky shark and sandbar shark (*Carcharhinus plumbeus*). The whiskery shark (*Furgaleus macki*) is also an important component of the catch of both fisheries.

The 2 fisheries are reported together here because extensive past research indicates that they share these key unit stocks.

Governing legislation/fishing authority

South Coast

Joint Authority Southern Demersal Gillnet and Demersal Longline Management Plan 1992

Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery License

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1999

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permit

Consultation process

WA Demersal Net and Hook Fisheries Management Advisory Committee

Meetings between the Department of Fisheries, WA Demersal Gillnet and Longline Association and industry

Boundaries

The Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery covers the waters from latitude 33° S to the WA/SA border. For the purposes of management, the fishery is composed of 2 zones.

Zone 1 extends from latitude 33° S around the coast as far as longitude 116°30´ E, and Zone 2 from 116°30´ E to the WA/SA border (129° E).

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery extends north from latitude 33° S to latitude 26° S. However, shark fishing has been prohibited between Steep Point (26°30´ S) and North West Cape since 1993, effectively making Steep Point the fishery's northern boundary.

Management arrangements

The south and west coast fisheries are regulated through 2 similar management plans.

The JASDGDLF was declared a limited entry fishery in 1988 and is managed jointly by the State and Commonwealth Governments. This fishery is managed primarily through effort controls in the form of time/gear units, which allow fishers to use one 'net' or an equivalent number of hooks for 1 month. Unit values have undergone a series of adjustments since 1992 in response to concerns about the sustainability of key shark stocks.

Generally, JASDGDLF units permit the use of either 270 m of demersal gillnet (15 or 20 mesh-drop) or 90 demersal longline hooks for 1 month, although there are a small number of units that permit the use of 378 m of net per month.

The WCDGDLF is currently managed as a limited entry fishery, under an interim management plan introduced in 1997. Under the interim plan, the fishery is managed using effort controls in the form of time/gear units, with each unit allowing a net length of 540 m or 180 hooks.

Both fisheries' management plans will be revised in 2006/07 to reduce high levels of latent effort, set more explicit effort ceilings for each management zone, and address remaining sustainability concerns for key stocks. These new management arrangements will be complemented by regulations for improved management of shark catches in non-target fisheries.

Research summary

Major Fisheries Research and Development Corporation (FRDC)-funded studies of the shark fishery on the south and west coasts of Western Australia, undertaken over the period 1993 – 2004, have provided a detailed basis for managing the fishery.

The extensive biological and fishery information gained from these studies have been reported in 3 FRDC final reports and the data incorporated into the Department of Fisheries' research records. These data have been used to develop stock assessment models for the fisheries' key target stocks to determine their likely responses to current levels of exploitation and to test alternative harvest regimes.

Research monitoring of the fishery involves analysis of catch and effort statistics (CAES) data and biological sampling of commercial catches. In 2002/03 the computer program that validates CAES records, standardises fishing effort and reapportions incorrectly reported catches from earlier seasons was rewritten using modified criteria to account for improved species identification and reporting in recent years. Thus, catch and effort data provided in status reports since 2002/03 are not comparable to those given in previous years.

Variations from previous years' catches of the key species are described below under 'Stock Assessment'. These research data are used to provide the status report on the fishery.

Retained Species

Commercial landings (season 2005/06):

Managed-shark fisheries:

All sharks (and rays) 1,357 tonnes
Key species 1,121 tonnes
Other fisheries: 108 tonnes

All catches given in this report are given in units of tonnes (estimated live weight) and total shark catches include rays, unless otherwise specified. The total shark catch of 1,357 t from these fisheries in 2005/06 comprised 909 t from the JASDGDLF and 448 t from the WCDGDLF, made up as follows:

SPECIES	JASDGDLF	WCDGDLF
Gummy	451 t	12 t
Dusky	165 t	109 t
Sandbar	13 t	185 t
Whiskery	159 t	28 t
Other sharks & rays	64 t	23 t
Total sharks & rays	**909 t**	**448 t**

In addition to the shark catch, between 11 and 17% of the total demersal gillnet and longline catch from each zone was composed of scalefish (teleost) species that were retained for sale. In 2005/06, scalefish landings totaled 148 t in the JASDGDLF and 88 t in the WCDGDLF.

For a detailed breakdown of the species composition of catches in the fisheries' different management zones, see Demersal Gillnet and Longline Tables 1 and 2.

The fisheries' total shark catch peaked at over 1,800 t between 1988/89 and 1991/92 before management measures to reduce fishing effort brought catches down to around their current level. While total shark catches have been stable since the early 1990s, the contribution of individual species to the total catch has varied considerably, according to changes in their relative abundances (Demersal Gillnet and Longline Figure 1).

Gummy shark: The total catch of gummy sharks decreased by 9 t (2%) in 2005/06 to 463 t, continuing the 3-year trend of record high catches. Zone 1 catches continued their increasing trend to their fifth consecutive record level of 98 t (a 78% annual increase). Zone 2 catches decreased by 13% to 353 t, however this was in response to a larger decline in fishing effort (see Fishing effort/access level below).

While the WCDGDLF gummy shark catch was identical to the relatively small catch reported last year (12 t), this still represents a near trebling of this species' catch over the last 5 years.

Dusky shark: The total catch of dusky shark (which is recorded as 'bronze whaler') in the JASDGDLF and WCDGDLF during 2005/06 was 274 t – 3% lower than last year. The catch in Zone 1 of the southern fishery was 121 t (32% more than last year) and in Zone 2 was 44 t (38% less than last year).

While the Zone 1 catch was consistent with recent years, the Zone 2 catch was the lowest since 1977/78. Although the WCDGDLF dusky shark catch dropped by 8% in 2005/06, the 109 t catch was higher than its average since the introduction of the WCDGDLF (interim) management plan in 1997 (91 t).

Sandbar shark: The total catch of sandbar shark in the demersal gillnet and longline fisheries during 2005/06 was 197 t – which was 41 t (27%) more than was caught last year. Over 93% (185 t) of the fisheries' sandbar catch was taken in the WCDGDLF, approximately half of which (51%, 94 t) was taken by longlines. The 13 t catches reported by the JASDGDLF over the last 2 years were less than half the southern fishery's 10-year average.

Whiskery shark: The combined catch of whiskery sharks in the JASDGDLF and WCDGDLF during 2005/06 was 187 t – a 22% increase from the previous year. Landings in Zone 1 were up by 97% on last year, were stable in Zone 2 and were 19% lower in the WCDGDLF.

Catches by method: As in previous years, almost all of the JASDGDLF shark catch was taken by demersal gillnets (99% in 2005/06). The proportion of the total WCDGDLF shark catch taken by gillnets has been more variable and, over the last few years, longlines have been increasingly used to target larger sharks off the west coast. The total longline shark catch in the WCDGDLF increased by 61% in 2005/06 to its highest-ever level of 191 t.

Other fisheries' shark catches: Sharks are also caught off the south and west coasts in a variety of other commercial fisheries and these catches are summarised here to provide a complete report on shark catches in the area. During 2005/06, vessels operating in other managed fisheries in the same overall area (i.e. between North West Cape and the South Australian border) reported catches of sharks totaling 13 t. An additional shark catch of 95 t was taken by vessels using 'wetline' methods.

Recreational catch: less than 5% of total catch

The estimated recreational catch between Augusta and Kalbarri, from a Department of Fisheries recreational trailer-boat survey conducted in 1996/97 (Sumner and Williamson 1999[1]) was 3,700 sharks, with a further 3,500 released. This total catch included wobbegong species, of which 1,000 were kept.

Assuming that the remaining recreationally-caught species were similar to those taken by the commercial fishery, at an average weight of 5 kg per shark, then the west coast recreational take of sharks at the time of the survey would have been about 15 – 20 t, or approximately 4% of the west coast commercial shark catch in that year.

Recreational effort on the west coast has increased since 1996/97 so it is likely that the catch of shark has also increased. A recreational fishing survey of the west coast region that commenced in 2005 will determine whether the catch of sharks and rays has increased since 1996/97.

[1] Sumner, N. R. and Williamson, P.C., 1999. A 12-month survey of coastal recreational boat fishing between Augusta and Kalbarri on the west coast of Western Australia during 1996-97. Fisheries Research Report No. 117. Western Australian Marine Research Laboratories, Fisheries Western Australia.

Fishing effort/access level

There were 57 licences in the JASDGDLF in 2005/06 – 24 in Zone 1 and 33 in Zone 2. However, only 7 Zone 1 vessels (1 more than in 2004/05) and 14 Zone 2 vessels (4 less than in 2004/05) reported active fishing returns during the year. There were 26 licences in the WCDGDLF in 2005/06, although only 10 (5 less than in 2004/05) reported active fishing returns during the year.

As gillnetting is by far the dominant method employed in the fisheries, effort is expressed in standardised units of kilometre gillnet hours by converting the historically-small amount of longline effort into the equivalent gillnet effort on the basis of comparative longline and gillnet catch per unit effort data.

On this standardised basis, effort in the JASDGDLF decreased by 18% in 2005/06, while that in the WCDGDLF increased by 17% (Demersal Gillnet and Longline Figure 2).

The effort expended in 2005/06 was:

JASDGDLF:	143,131 kilometre gillnet hours (Zone 1: 46,011; Zone 2: 97,412)
WCDGDLF:	80,384 kilometre gillnet hours

While combining gillnet and longline effort into a single standardised measure of effort will continue, increased use of longlines on the west coast has altered the composition of the fisheries' overall effort. Therefore, the trends in catch and effort by each method are also provided separately in this report (Demersal Gillnet and Longline Figures 3 and 4).

Gillnet fishing effort peaked during the late 1980s and early 1990s, before successive unit reductions steadily reduced effort to 42% (in 2001/02) of its peak level (Demersal Gillnet and Longline Figure 2). After 3 years of higher gillnet effort, the 187,815 km gillnet hour expended in 2005/06 represents an annual decline of 16% across the fisheries and an 8% decline from the previous minimum in 2001/02.

The fisheries' total gillnet shark catches have largely reflected the levels of fishing effort being applied, demonstrating that the overall level of shark catch in the gillnet sector can be adequately managed via effort controls.

Longline fishing effort peaked in 1993/94 at just over 1,129,000 hook days, before declining rapidly to just 59,000 hook days in 2002/03. Despite the relatively high levels of longline effort during the mid-1990s, longline shark catches during this period were relatively low at less than 50 t per year.

By contrast, between 1979/80 and 1981/82 over 175 t of sharks were caught, with between 675,000 and 775,000 hook days.

Prior to 2003/04, demersal longline effort was targeted at the same shark and scalefish stocks as were targeted by gillnets. However, since 2003/04, the majority of longline effort has been targeted towards larger sharks off the west coast, resulting in mean total shark catches of 169 t taken by a mean annual effort of 268,166 hook days.

Not only do these figures demonstrate the potential for increasing exploitation of larger sharks through existing gear conversion arrangements, but also that the same direct relationship between catch and effort that exists for gillnets is not evident for longlines.

Stock Assessment

Assessment complete: **Yes (indicator species)**

Breeding stock levels:

Gummy shark:	**Adequate**
Dusky shark:	**Inadequate**
Sandbar shark:	**Inadequate**
Whiskery shark:	**Recovering**

Stock assessment is carried out for the 4 main shark species caught by the fishery. In previous years' reports, sandbar shark assessments have been summarised in the Northern Shark Fisheries Status Report. However, as the northern shark fisheries have now been excluded from most of this stock's range and the only significant remaining source of catch is the WCDGDLF, these assessments will henceforth be reported here.

The 'effective' catch rates (CPUE) referred to below, are the mean annual gillnet-only catch rates from the areas of the fishery that overlap the species' primary distributions and are considered to be the best available index of stock abundance (see McAuley, 2005[1] for details).

Gummy shark: Previous age-structured modeling indicated that the Western Australian gummy shark stock was 42.7% of its virgin biomass in 1997/98, slightly above its target 40% level (by 2010). However, as recent catch and CPUE trends have indicated little cause for concern, this principal target stock has not been comprehensively assessed since 1998 and a new model that incorporates recent catch and effort data needs to be developed.

In the meantime the stock is monitored via inferences from catch and CPUE data. The 13% annual increase in the 2005/06 'effective' gummy shark CPUE (2.5 kg/km gillnet hr) makes this the third highest for this species since records began in 1975. This continues the increasing trend in effective CPUE that began in the mid 1990s and a 5-year period of higher than 2.0 kg/km gillnet hr catch rates.

While the most likely explanation is increasing stock abundance, there is a slight possibility that increased targeting efficiency within the gummy shark fleet may be providing an overly optimistic interpretation of this trend. While effective catch rate estimates for gummy shark are drawn entirely from JASDGDLF Zone 2 data, the now reasonably substantial levels of catch and increasing catch rates reported from Zone 1 are also notable as these suggest a westwards expansion of this stock's distribution.

[1] McAuley, R. 2005. Status Report for the Southern and West Coast Demersal Gillnet and Demersal Longline Fisheries and Northern Shark Fisheries. Number 12. September 2005. Department of Fisheries, Western Australia. Unpublished report, 17 + x pp.

As the catch of gummy sharks is almost exclusively comprised of adults, the increasing trend in CPUE suggests that the breeding biomass is increasing.

Dusky shark: The status of the Western Australian dusky shark stock has been reassessed using a combination of revised demographic modeling techniques, updated biological and fishing mortality parameters developed during the recently completed Fisheries Research Development Corporation (FRDC)-funded project and analyses of Catch Per Unit Effort (referred to below as CPUE or catch rate) trends.

The new demographic analysis has indicated that although the demersal gillnet and demersal longline fisheries' catches of sharks born in 1994 and 1995 were likely to have been sustainable, the stock is less productive than previously thought. While the model indicates that the population has the capacity to offset demersal gillnet fishing mortality of primarily first-year (neonate) and second-year sharks, it also indicates that fishing mortality rates as low as 1 to 2% per year in older sharks (greater than 10 years of age) would cause stock recruitment to decline.

Although this analysis was based on age-specific mortality rates of sharks born in 1994 and 1995, these results nonetheless provide a valuable reference point for analysing recent catch rate trends.

Catch rates increased by 30% in Zone 1 of the JASDGDLF but decreased by 18% and 21% in Zone 2 and the WCDGDLF, respectively. Between 2004/05 and 2005/06, the effective catch rate of dusky sharks increased slightly from its historical minimum (by 7%) but remained far lower than its long-term average and less than one-third of its rate during the late 1970s (Demersal Gillnet and Longline Figure 5).

However, analysis of CPUE data for this species has become complicated, since the relative contribution of neonates to the fisheries' catch appears to have declined and catches of older juveniles have increased during recent years. Additionally, a minority of demersal gillnet vessels have increasingly reported using 'wetline' hook methods to apparently target larger sharks and the reported wetline catch of 'bronze whalers' in the area south of Shark Bay has doubled since the mid-1990s (to 22 t in 2005/06).

This practice has potentially led to the inclusion of larger hook-caught dusky sharks within the reported gillnet catch, thereby causing another significant bias in the CPUE data. Despite the effective CPUE estimates indicating that this stock is in decline, these factors are likely to have caused an overly optimistic CPUE trend during recent years.

These issues are expected to be resolved through the implementation of daily catch and effort log book records (see 'New management initiatives' below).

Because dusky sharks give birth to live young, there is likely to be a relatively direct relationship between recruitment and breeding stock biomass. Therefore, it can be inferred from the declining CPUE of juvenile dusky sharks in the gillnet sector that the breeding stock biomass is continuing to decline.

Sandbar shark: Stock assessment of the sandbar shark was undertaken using empirically-derived estimates of fishing mortality and demographic analysis techniques, similar to those used to assess the status of the dusky shark stock. As age-specific fishing mortality rates were estimated for the period 2001/02 to 2003/04, future assessments of this stock will increasingly rely on analysis of CPUE trends.

Demographic analysis results indicated that in the absence of fishing mortality, the sandbar stock had the capacity to grow at only 2.5% per year (exactly the same as the dusky shark), making it among the least productive shark populations for which demographic analyses have been completed.

The demographic model indicated that the combined levels of fishing mortality from the northern shark fisheries, the temperate demersal gillnet and longline fisheries and bycatch in non-target fisheries (approximately 250 – 440 t per year) were unsustainable between 2001 and 2004. As combined catches from the target fisheries were similar during the previous 4 years (230 – 290 t per year), over fishing is believed to have been occurring since at least 1997/98.

The rate of stock depletion was highest in 2003/04 when, in addition to the 204 t landed by the demersal gillnet and longline fisheries, the reported catch (of mainly adult sandbar sharks) in the northern shark fisheries was 209 t. Given this, the combined target fisheries catch of 918 t in 2004/05 (762 t of which was reported by the northern shark fisheries) is believed to have been highly unsustainable.

Effective sandbar shark CPUE estimates have declined markedly since 2002/03, which was approximately 5 years after the initial development of the northern shark fisheries. As catches by the demersal gillnet sector are mainly composed of 3 to 10 year-old sharks, this declining trend is coincident with a decline in recruitment beginning in the late 1990s.

It is thus inferred that the apparent declines in stock recruitment have been caused by a depletion of the breeding stock off the north-west coast. This inference is supported by declines in fishery-independent survey catch rate data from the north coast (see 'Breeding stock levels' below).

Fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach, where mature sandbar sharks are prevalent, show a 58% decline in the species' abundance between 2002 and 2005. Furthermore, the full extent of the depletion of mature-aged sharks has not yet manifested, as previous levels of juvenile fishing mortality in the temperate demersal gillnet and longline fisheries are likely to cause declining recruitment to the breeding stock over the next decade.

As the breeding biomass is already likely to be at the minimal acceptable limit reference point of around 40% of its virgin biomass and continuing to decline, this stock requires careful monitoring and may require additional species-specific recovery measures.

Whiskery shark: Whiskery shark catch rates increased by 94% and 29% in Zones 1 and 2 of the JASDGDLF, respectively but declined by 30% in the WCDGDLF. The effective catch rate

increased by 46% to 0.72 kg per km gillnet hr, its highest level in 15 years (Demersal Gillnet and Longline Figure 5).

The age-structured population model for whiskery shark, which was last updated in 2004 (based on 2002/03 data), was re-run this year with the additional 3 years of CPUE data. This latest assessment indicated that the whiskery shark stock has finally begun to recover after its significant depletion during the 1980s and slowly declining trend prior to the 2004 assessment.

Median estimates of total biomass were calculated to have increased by 3.4% per year for the last 2 years. The best estimate of total biomass in 2005/06 was 38.3% of its unfished level, with 95% confidence that the stock was between 35.9% and 40.4% of virgin biomass. Risk assessments, based on these model results, predicted that there was a 47.9% probability of achieving the whiskery shark biomass target of 40% by 2010 under the 2005/06 level of effective effort (244,789 km gillnet hr).

However, to ensure the continued stock recovery of this stock, catches should be constrained at around their 2001/02 levels (9% less than in 2005/06) and further measures are necessary to improve recruitment.

The age-structured population model estimated that mature female biomass had increased by between 1.3 and 1.8% per year since 2001/02, except in 2004/05 when it estimated a 3% decline in the female breeding stock.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery has been examined in detail for the period 1994 to 1999 (McAuley and Simpfendorfer 2003). There is some discarded bycatch of unsaleable species of sharks, rays and scalefish.

During the Ecologically Sustainable Development risk assessment of these fisheries in 2002, all impacts on stocks of bycatch species were determined to be low risk. As fishing effort is currently lower in all management zones than it was during the mid-to-late 1990s, bycatch levels have probably also proportionally reduced.

Protected species interaction: **Negligible – low**

Observed rates of capture of protected species were very low throughout the fishery during the mid-to-late 1990s (McAuley and Simpfendorfer 2003). Marine mammals were caught at a rate of just over 1 per 10,000 km gillnet hours, seabirds at 1 capture per 25,000 km gillnet hours and turtles at 1 capture per 100,000 km gillnet hours. It should be noted that demersal gillnet and longline fishing are not permitted north of Steep Point (26°30′ S), or within 3 nautical miles of the Abrolhos Islands baselines, where populations of turtles and dugongs are present.

The numbers of white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) caught were small (< *ca.* 20/yr and < *ca.* 80/yr respectively) prior to their protection in 1997. As the fisheries have subsequently been operating at lower levels of effort and because a high proportion of protected shark bycatch is released alive, the risk of this fishery significantly impacting the viability of populations of protected species was assessed as very low.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The level of effort is such that the gear is deployed infrequently over approximately 40% of the fisheries' area and under normal circumstances the physical impact of the gear on the bottom is minimal.

Social Effects

Direct: Estimated employment during 2005/06 was 60 skippers and crew in the JASDGDLF and 25 in the WCDGDLF. Unlike other regions, sharks are generally not targeted by recreational fishers in Western Australia, thus their direct social importance to this group is negligible.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of prized recreationally-caught fish. However, others consider them to be important components of marine ecosystems that deserve to be conserved.

Economic Effects

Estimated annual value (to fishers) for year 2005/06: $6.4 million

JASDGDLF:	$3.8 million (shark and scalefish) $600,000 (shark fins)*
WCDGDLF:	$1.6 million (shark and scalefish) $400,000 (shark fins)*

* As fishers do not specify the value of fins on their catch returns, fin values were calculated at 2 to 3% of sharks' whole weight (depending on species) and value was conservatively estimated using a price of $25 – 35/kg (also depending on species). Categories of shark which do not have saleable fins were excluded from fin valuation.

Fishery Governance

Target catch (or effort) range: Key species 725 – 1,095 tonnes

Individual target catch ranges for the key species in 2005/06 were as follows:

Gummy shark	350 – 450 t
Dusky shark	200 – 300 t
Sandbar shark	< 120 t
Whiskery shark	175 – 225 t

Catches of gummy shark in 2005/06 were marginally above the upper limit of their target range for the third consecutive year but acceptable as these catch levels were apparently due to increasing abundance.

The catch of dusky shark was within the target range for 2005/06, however possible changes to the size composition of this catch are of concern. Nonetheless, as the decline in the dusky shark breeding stock (see above) is attributed to external sources of mortality (see 'External Factors' below) and updated demographic analysis has confirmed that a gillnet catch of 200 – 300 t is sustainable, the target catch range for next season therefore does not need to be revised.

Sandbar shark catches were 50% above the revised acceptable limit for 2005/06 (<120 t, set in response to the lower sustainable levels estimated by the demographic model). Furthermore, the potential benefits of the smaller-than-anticipated catch of adult sandbar sharks in the northern shark fishery (see Northern Shark Fisheries Status Report elsewhere in this volume) were likely to have been offset in 2005/06 by the proportionately large catch of sandbars by longlines in the WCDGDLF.

Whiskery shark catches were within but at the lower end of the target catch range during 2005/06. Catches are expected to decline further following the implementation of new management strategies in 2006/07 (see below). When the resulting reductions in whiskery shark catches can be quantified, the target catch range will be adjusted accordingly.

Current fishing (or effort) level:

Unacceptable (JASDGDLF Zone 1)
Acceptable (JASDGDLF Zone 2)
Unacceptable (WCDGDLF)

The WA Demersal Net and Hook Fishery Management Advisory Committe (WADNHFMAC) agreed to set fishing effort performance targets for each management zone at their 2001/02 levels. These levels are considered likely to deliver sustainable harvests of the fisheries' key target species and also acceptably low levels of bycatch and protected species interactions. However, due to the flexibility of current (monthly) units of fishing effort and activation of unused (latent) units, which have caused excessive levels of effort over the last 4 years, more explicit (daily) effort control arrangements will be introduced in 2006/07 (see 'New management initiatives' below).

New management initiatives (2006/07)

Most of the new management arrangements for the JASDGDLF and WCDGDLF and the state-wide management of commercial shark catches that were foreshadowed in the last 2 status reports were introduced prior to the beginning of the 2006/07 fishing season. The remaining measures are expected to be in place by early 2008.

The key elements of this package (and their state of implementation by December 2006, given in parentheses) are:

- conversion of existing monthly gear units to daily gear units (pending);
- explicit caps on potential fishing effort within each zone equal to their 2001/02 levels (implemented);
- a 2-month closure in the temperate shark fisheries (waters between Steep Point and Albany) inshore of the 200 m isobath to aid the recovery of whiskery shark stocks (implemented);
- implementation of the vessel monitoring system in the temperate shark fisheries (partially implemented);
- implementation of daily catch and effort log book reporting (implemented);
- a prohibition on the possession of sharks and rays by commercial fishers outside the state's 4 shark fisheries (implemented);
- a prohibition on the use of wire traces in all commercial fisheries under state jurisdiction (except the northern shark fisheries) (pending);
- a state-wide commercial maximum (inter dorsal fin) size limit for dusky sharks of 70 cm (implemented); and
- a significant increase in penalties for illegally possessing sharks or rays (implemented).

To support and assess the success of these management changes, there will need to be increased monitoring of these fisheries, with a focus on catch size composition and tagging to update harvest rates, particularly for dusky shark and sandbar sharks.

A complimentary maximum size limit for recreationally-caught whaler shark species is also being considered for the southern and west coast bioregions, but this will not be implemented until the second half of 2007 or in 2008.

External Factors

There are a number of factors outside of the control of the fishery that are negatively impacting the performance of key temperate shark stocks. These include incidental catches of dusky shark, sandbar and gummy sharks in offshore Australian Government-managed fisheries and in overlapping WA-managed fisheries.

For the sandbar population particularly, the overlap with the northern shark fisheries which target the breeding stock further complicates the situation. The ongoing mortality of older juvenile and adult dusky sharks from entanglement in plastic packing straps is also compromising future recruitment to this stock.

Targeted gummy shark fishing by Australian Government-managed vessels to the east of Zone 2 may also have an effect on JASDGDLF catches of that species. However, as that fishery is tightly managed via quota controls and subject to regular stock assessments, it is unlikely that it is currently causing any detrimental effect to the WA fisheries.

All of these outside influences, however, need to be taken into account in the stock assessment process for these species and accommodated in the management strategy.

DEMERSAL GILLNET AND LONGLINE TABLE 1

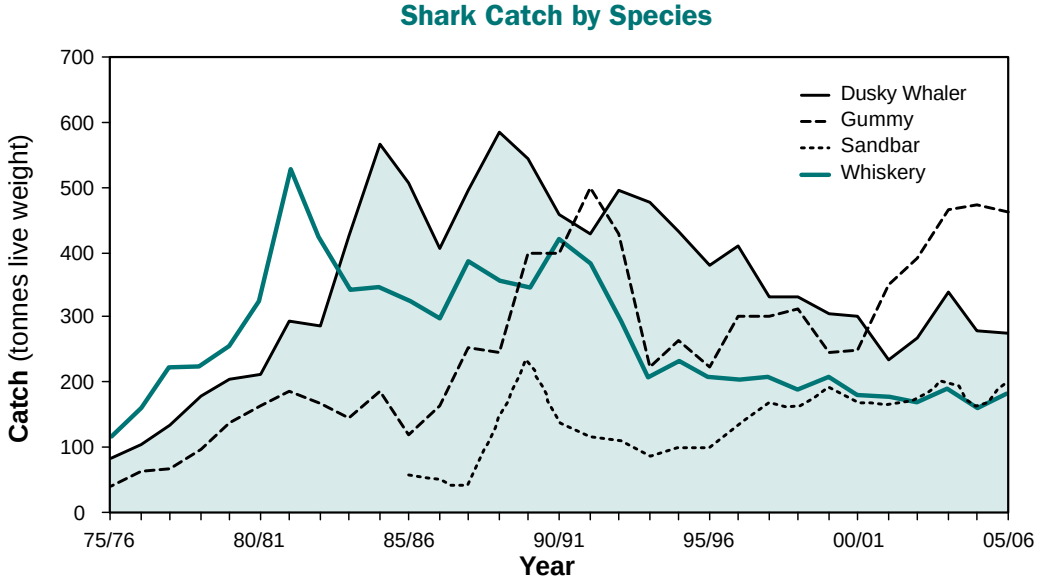
Shark catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) 2005/06.

Species		Catch (tonnes)				
		JASDGDLF			WCDGDLF	Fishery Total
		Zone 1	Zone 2	Total		
Gummy	*Mustelus antarcticus*	98	353	451	12	463
Dusky	*Carcharhinus obscurus*	121	44	165	109	274
Sandbar	*Carcharhinus plumbeus*	10	3	13	185	197
Whiskery	*Furgaleus macki*	85	74	159	28	187
Hammerhead	Sphyrnidae	14	18	31	26	57
Wobbegong	Orectolobidae	16	5	21	21	42
Longnose grey	*Carcharhinus brevipinna*	4	>1	4	20	23
Tiger	*Galeocerdo cuvier*				12	12
Shovelnose rays	(Rhinobatidae and Rhynchobatidae)				10	10
Other sharks and rays		47	18	65	26	91

DEMERSAL GILLNET AND LONGLINE TABLE 2

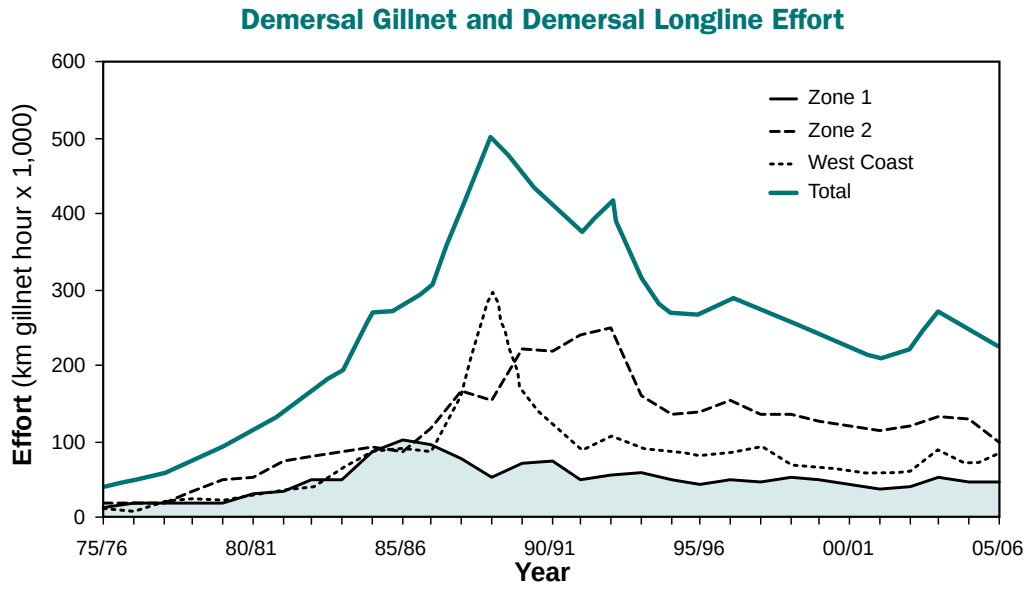
Scalefish catch species composition for the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) 2005/06.

Species		Catch (tonnes)				
		JASDGDLF			WCDGDLF	Fishery Total
		Zone 1	Zone 2	Total		
Queen snapper	*Nemadactylus valenciennesi*	20	19	40	4	44
Blue groper	*Achoerodus gouldii*	21	16	37	3	39
Pink snapper	*Pagrus auratus*	9	6	15	13	28
Dhufish	*Glaucosoma hebraicum*	12	1	13	15	27
Samson fish	*Seriola hippos*	2	2	4	16	20
Mulloway	*Argyrosomus japonicus*	0	5	6	7	13
Sweetlip emperor	*Lethrinus miniatus*	0	0	0	12	12
Redfish	*Centroberyx* spp.	6	2	8	0	8
Parrotfish	Scaridae	0	0	0	5	5
Other scalefish		14	12	26	14	40

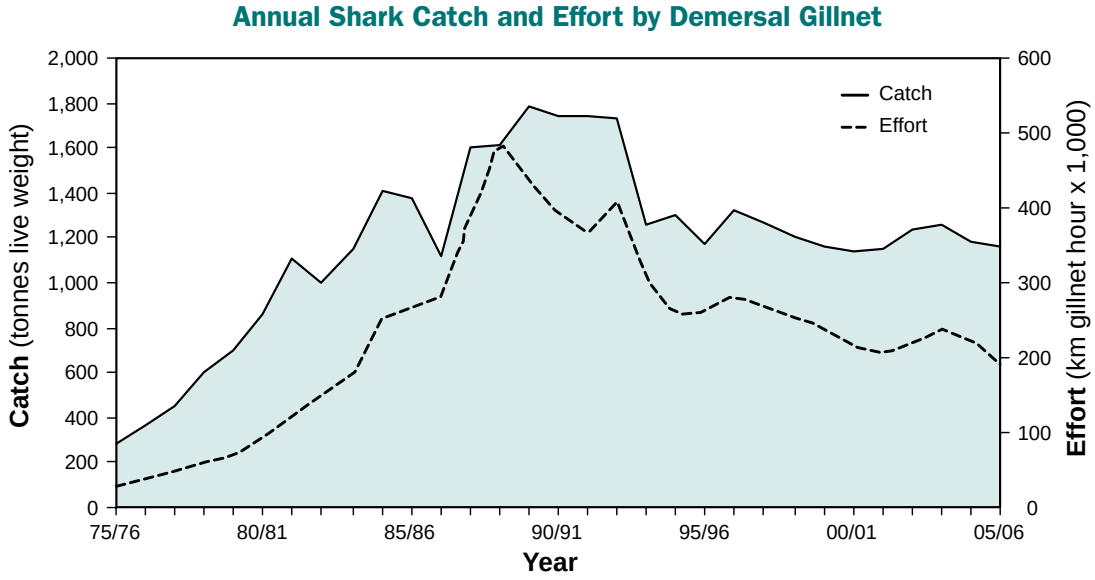


DEMERSAL GILLNET AND LONGLINE FIGURE 1

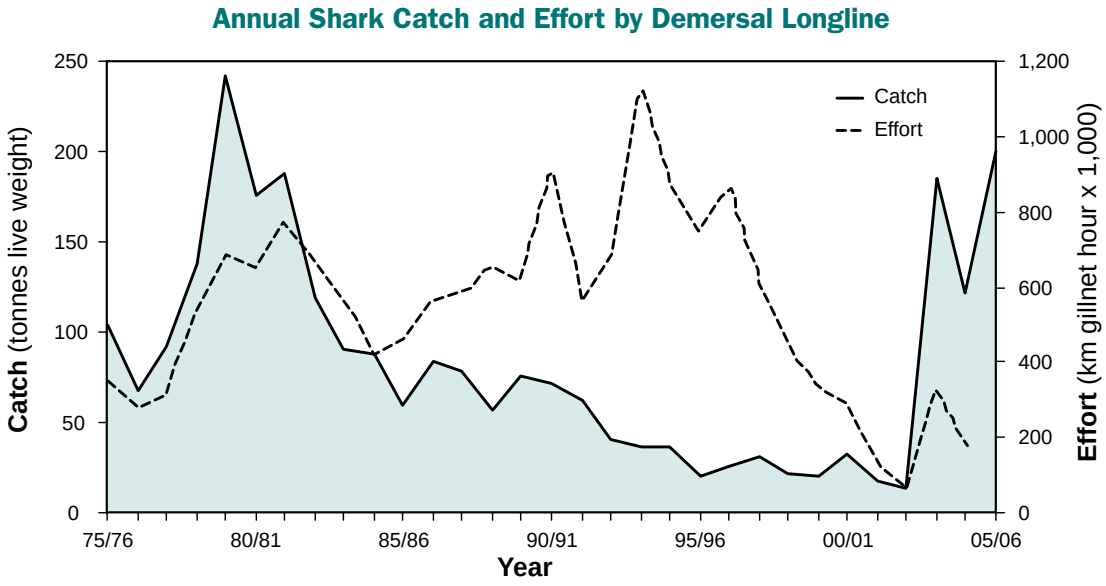
Annual catches of target shark species in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



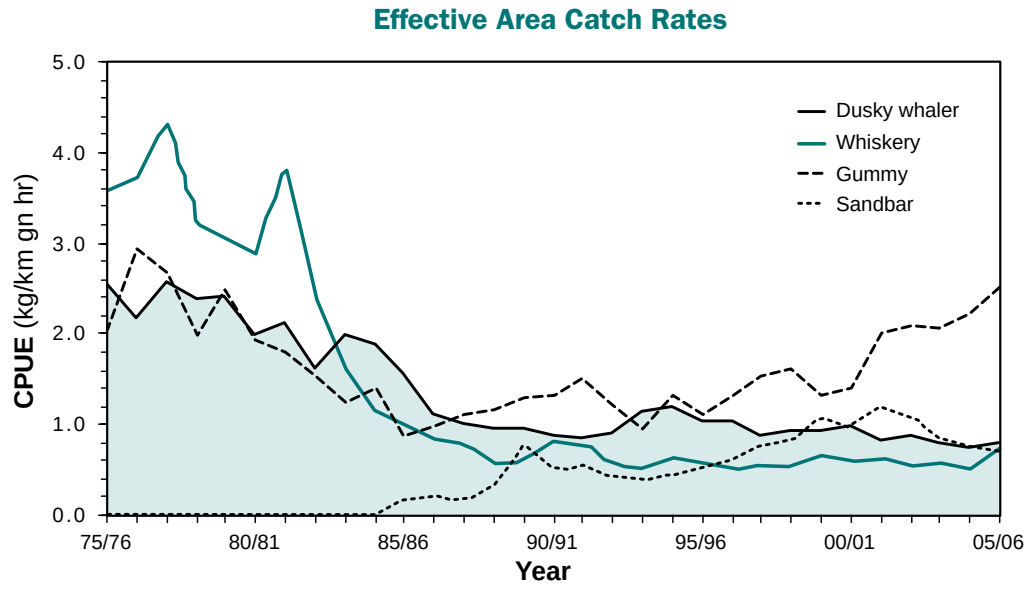
DEMERSAL GILLNET AND LONGLINE FIGURE 2
Effort in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



DEMERSAL GILLNET AND LONGLINE FIGURE 3
Catch and effort by demersal gillnet in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



DEMERSAL GILLNET AND LONGLINE FIGURE 4
Catch and effort by demersal longline in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



DEMERSAL GILLNET AND LONGLINE FIGURE 5
Effective catch rates for 4 target species of the demersal gillnet and longline fisheries for the period 1975/76 to 2005/06.

AQUACULTURE

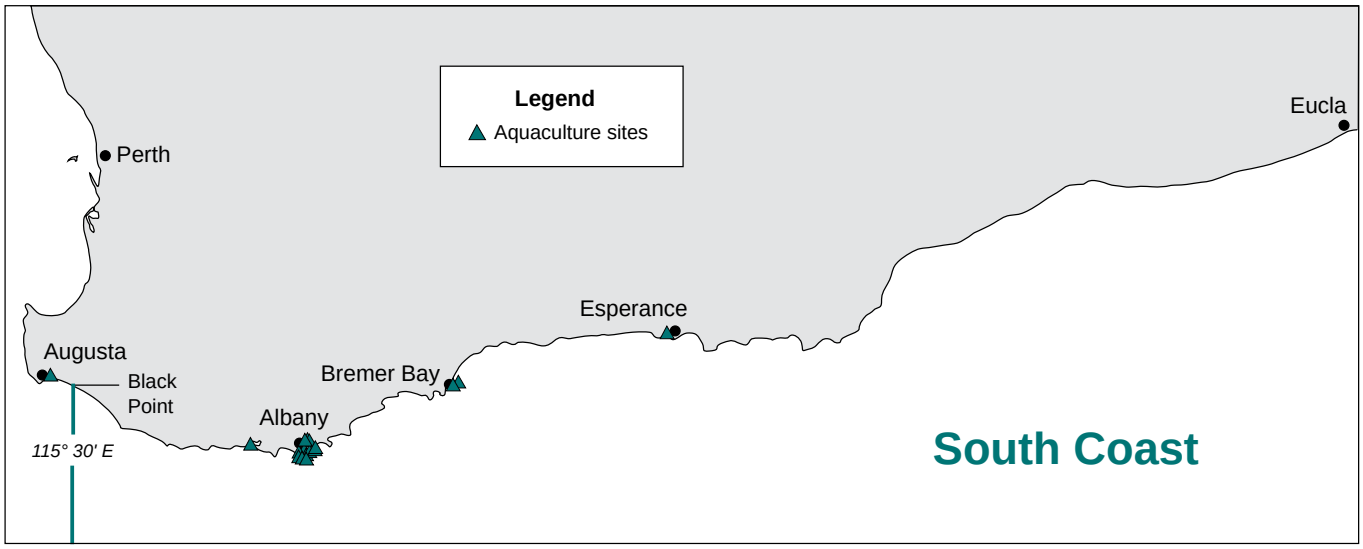
Regional Research and Development Overview

Abalone is a key aquaculture species. The development of this industry sector remains one of the priorities for the Aquaculture Development Council.

On-farm experimental work funded by the Fisheries Research and Development Corporation (FRDC) has been finalised, and abalone stock derived from the experimental work were moved to the Department of Fisheries' new WA Fisheries and Marine Research Laboratories facility at Hillarys in October 2005.

Joint abalone aquaculture research by the Department and Murdoch University has shown that specific red algae can be utilised in commercial abalone nurseries, particularly if they are used as juvenile growth forms and in combination with the common sea lettuce (*Ulva* spp.). Juvenile abalone as small as 4 to 5 millimetres can utilise fragments of the algae, and growth rates are very promising.

Department of Fisheries' researchers have also demonstrated that these algal species can easily be grown with existing infrastructure from a commercial abalone farm and growth rates of 10% per day can be maintained. The results of this research have allowed farmers to delay weaning juvenile abalone onto formulated feeds for several months, thus improving growth and survival rates, particularly during the warmer months when feeding formulated diets is problematic and high mortalities are encountered on farms.



SOUTH COAST AQUACULTURE FIGURE 1
Map showing the major licensed aquaculture sites of the South Coast bioregion.

REGIONAL COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers based at Albany and Esperance. These officers undertake a variety of compliance activities including land and at-sea inspection of vessels, catches, fishing gear, marine safety equipment and verification of licenses.

The Southern Region Community Education Officer oversees education and volunteer initiatives. Natural Heritage Trust (NHT) funding through South Coast Natural Resource Management Inc. has enabled the Department of Fisheries to establish a Volunteer and Education Activity Coordinator (VEAC) position in 2005.

Activities during 2005/06

Due to the variety of commercial and recreational fisheries, expanse of coastline and variable and seasonal weather conditions, Fisheries and Marine Officers (FMOs) employ a risk management-driven approach to prioritise and plan compliance activities.

Overall, FMOs delivered a total of 3,533 'on-patrol' compliance hours during 2005/06 (South Coast Compliance Table 1) representing a significant increase over previous years (South Coast Compliance Figure 1).

Officers made contact with a total of 299 commercial fishers, with the majority of the compliance effort directed towards to the Abalone Managed Fishery. Generally, only minor breaches were detected, mainly in terms of quota management and incorrect completion of catch and disposal records. Illegal (unlicensed) commercial abalone operations continue to be a major concern in

the South Coast bioregion, threatening the sustainability of the commercial and recreational abalone fishery.

The remainder of the commercial fishery compliance effort was directed to the wide range of minor commercial fisheries operating in the South Coast bioregion. Particular attention was paid to the South Coast Estuarine Fishery to undertake spot checks of net lengths and catch inspections, inspections of deep sea crab and rock lobster catches, and quota checks and monitoring in the Purse Seine Fishery.

During the year, 3 infringement warnings and 9 infringement notices were issued and a further 8 cases resulted in prosecution action being instigated against commercial fishers. In addition to 'black market' abalone operations, illegal sale of other fish by unlicensed individuals or groups continues to be an issue of concern in the region.

Recreational compliance activities concentrated mainly on checking shore and boat-based anglers, net fishers and shellfish collectors. FMOs made contact with a total of 2,497 recreational fishers in the bioregion. During 2005/06, 52 infringement warnings and 24 infringement notices were issued and 8 prosecutions were instigated against recreational fishers.

Compliance patrols in recreational fisheries principally involve checks to ensure that fishers are adhering to size and bag limits and complying with restrictions that apply in the recreational net fishery. The areas of highest risk of non-compliance with the management arrangements were considered to be abalone, cockles, marine finfish and estuarine netting.

There continues to be a growing awareness of the open season and availability of abalone on the south coast.

During 2005/06, FMOs delivered 200 hours to the marine safety compliance program within the South Coast bioregion. Officers conducted marine safety checks on recreational and commercial vessels. Regional marine safety checks are unfunded and conducted in conjunction with fisheries compliance checks.

New South Coast regional recreational fishing management arrangements were implemented on the 1st January 2006. Recreational fishing guides were distributed across the region. Extensive changes occurred with a new bag and category limit regime, minimum size limit increases to red snapper and tarwhine, the banning of recreational set netting in ocean waters and new management of recreational netting in estuarine waters.

A comprehensive community education strategy was implemented across the South Coast bioregion in 2005/06. Compliance effort towards these changes took a far more educative approach, whilst existing regulations were enforced such as finfish possession limits, size limits and recreational abalone regulations.

The education program in this bioregion is supported by Volunteer Fisheries Liaison Officers (VFLOs) who conduct education programs throughout the region.

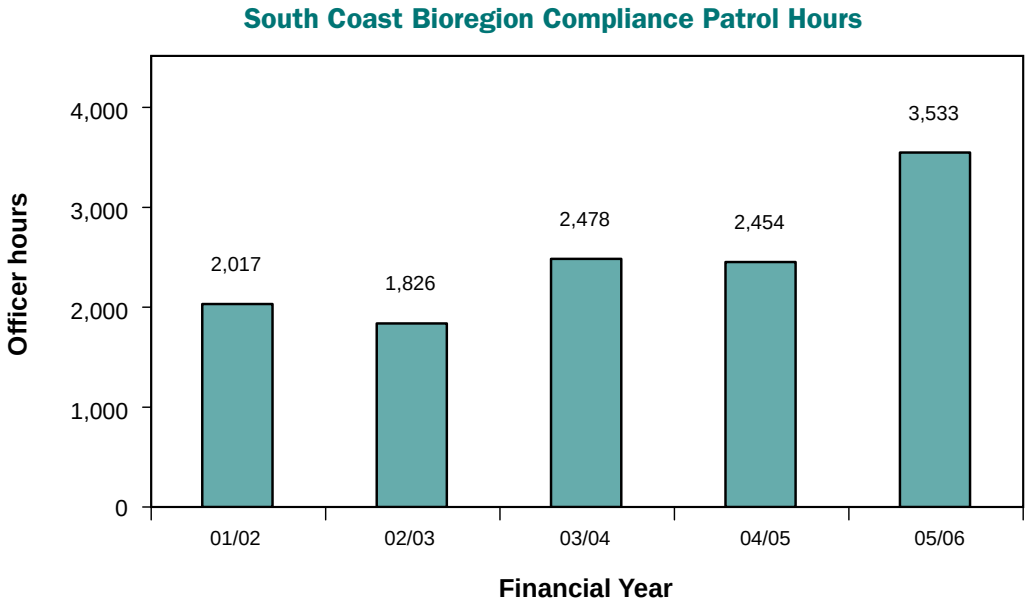
In 2005/06 the VFLO program involved 14 volunteers in the Albany and Denmark areas and 10 in Esperance. Community education activities conducted in the bioregion included attendance and presentations by FMOs and VFLOs at primary and secondary schools, regional shows and festivals, community group meetings and fishing competitions.

Initiatives In 2006/07

Fisheries and Marine Officers will continue to place priority on compliance checks in the Abalone Managed Fishery by conducting quota checks and verification of catch and disposal records. At-sea inspections of shark, rock lobster and deep sea crab vessels will continue in order to maintain compliance with gear restrictions. Throughout 2005/06, intelligence collection and compliance activities were conducted to combat illegal commercial operations harvesting abalone and other species.

The VFLO program in the South Coast bioregion, with additional support from its Volunteer and Education Activity Coordinator, experienced a higher activity level and contact rate in 2005/06. Esperance district volunteers, in partnership with Esperance Surfcasters Club, were awarded a Federal Recreational Fishing Community Grant. As a result, the grant will enable volunteers to undertake a program of intensive community fishing clinics to develop skills and knowledge and promote the 'fish for the future' ethic.

Coordinated education programs will be developed in parallel to the Naturaliste Marine Discovery Centre in Hillarys. A Seaweek Educators Expo is planned in Albany and will be the first of its kind held outside of Perth.



SOUTH COAST COMPLIANCE FIGURE 1

The figure gives 'On Patrol' Officer Hours showing the level of compliance patrol activity delivered to the South Coast bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

SOUTH COAST COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2005/06 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	3,533 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	299
District Office contacts	936
Infringement warnings	3
Infringement notices	9
Prosecutions	8
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	2,497
District Office contacts	1,525
Infringement warnings	52
Infringement notices	24
Prosecutions	8
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	343
District Office contacts	881
Fishwatch reports**	65

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine protected areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the Southern Inland bioregion that were referred to Albany or Esperance district staff.

Northern Inland Bioregion

Lake Argyle

Northern Inland Bioregion

ABOUT THE BIOREGION

The Northern Inland bioregion, encompassing the northern half of Western Australia, is predominantly a desert area, with few permanent water bodies.

As a result of occasional summer cyclones, the various river systems flow at flood levels for short periods before drying-out to residual waterholes. The only exceptions to this are man-made dams, which trap rainfall for water supply purposes and irrigation.

The only significant fishable water body in the region is Lake Argyle, created by damming the Ord River. The continuous release of water from the dam has resulted in the Ord River maintaining its freshwater fish populations year-round, as does the lake where some freshwater native fish populations have expanded. Populations of reptiles, such as the protected freshwater crocodile, are supported by the expanded food chain of native fish, and are thought to have expanded significantly from their original billabong-based populations.

The creation of Lake Argyle has produced a unique inland aquatic environment which is now home to various fishing and tourism-related activities. The lake supports the State's only commercial freshwater fishery – for the silver cobbler or catfish – together with a processing facility supplying predominantly Western Australian and interstate markets.

The lake and its associated river system also support recreational fishing for the freshwater component of the barramundi stock and cherabin (freshwater prawns).

Aquaculture development operations in the region have included the production of barramundi from a cage operation in Lake Argyle, and a small but growing pond production of redclaw crayfish in the Ord River irrigation system around Kununurra. Production of aquarium fish using bore water in the southern Gascoyne region is also being explored.

ENVIRONMENTAL MANAGEMENT

Regional Overview (Northern Inland)

The Department of Fisheries actively supports a number of studies into the native freshwater fish fauna and their habitats in northern river systems in conjunction with Murdoch University, the Department of Water and the Department of Environment and Conservation, and through involvement with local natural resource management councils. New aquaculture ventures are also subject to strict environmental evaluation under the Departmentís licensing and on-going arrangements, in conjunction with industry and TAFE.

A feral fish incursion response program is also in place to react to feral fish and/or non- endemic disease outbreaks where they occur.

The Ord River.

FISHERIES

Lake Argyle Silver Cobbler Fishery Status Report

S.J. Newman and C. Skepper
Management input from A. Bain

Fishery Description

The only commercial freshwater fishery in Western Australia is in Lake Argyle in the north-eastern Kimberley. This gillnet fishery specifically targets the silver cobbler or shovel-nosed catfish (*Arius midgleyi*).

Governing legislation/fishing authority

Commercial

Fisheries Notice no. 665 (Section 43 order)
Condition 55 on a Fishing Boat Licence

Recreational

Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)
East Kimberley Regional Recreational Fishing Advisory Committee (Kununurra)

Boundaries

The Lake Argyle Silver Cobbler Fishery (LASCF) is contained in the impounded waters of the Ord River at Lake Argyle.

Management arrangements

This fishery is managed by input controls in the form of a set of licensing conditions. It is a limited entry fishery.

For each licensee there is a gillnet length restriction of 1,500 metres and all nets must be suitably marked with licence identification. While there is no mesh size restriction, the fishers have adopted a code of practice that states that nets should have a mesh size not less than 6¼ inches (150 mm) and a drop length of 30 meshes.

All fishers are prohibited from taking any fish whatsoever by means of nets during the period from 1 November to 31 December in any year. Fishers in the LASCF are not permitted to take barramundi (*Lates calcarifer*).

Since 2000, operators have voluntarily reduced effort in the fishery and hence the levels of catch.

In response to concerns from charter operators, the general public and conservation groups, LASCF endorsement holders developed an industry code of practice to minimise the incidental capture of freshwater crocodiles. Implemented in 2001, the code specifies the accepted means of operation in the fishery and outlines contingency procedures for fishing gear that has been lost or abandoned.

Future management measures for this fishery include a review of the latent effort present within the fishery and a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species.

Research summary

Data for assessing the status of the silver cobbler stock in Lake Argyle are derived from the catch and effort returns provided by industry. These data are compiled annually and used as the basis for this assessment. Biological data on the species' specialised reproductive behaviour and low fecundity are used to interpret these assessments.

Retained Species

Commercial landings (season 2006): 78 tonnes

The target species in the fishery is the silver cobbler or shovel-nosed catfish. The fishery first developed in 1979, with increasing catches reported until 1988 (138 t). Catch levels then fluctuated between 90 t and 145 t until 1997 (Lake Argyle Silver Cobbler Figure 1), after which they increased to a peak of 231 t in 2000.

Owing to voluntary reductions in effort, catches declined in both 2001 and 2002. From 2003 to 2005, the level of catch has ranged from 131 to 165 t. In 2006, the catch dropped to 78 t and is below the target catch range for this fishery (Lake Argyle Silver Cobbler Figure 1).

Recreational catch: Not assessed

Limited data are currently available. The reported charter boat catch for Lake Argyle from 2002 to 2006 was less than 1 t of silver cobbler per annum.

Fishing effort/access level

Nominal effort in this gillnet fishery is calculated as the total number of fishing days by all boats multiplied by the average daily total net length fished per boat divided by 100 to give '100 m net days'.

During 2006, 3 vessels were active in the fishery, and generated an effort of 5,279 units (100 m net days). This level of effort is much lower than the 6,472 units reported in 2005 (Lake Argyle Silver Cobbler Figure 1).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The catch rates achieved in the fishery from 2000 to 2002 were similar to those achieved in 1993 and 1994. The much higher catch rate achieved in the fishery in 2003 is similar to that reported in the fishery in 1990 (Lake Argyle Silver Cobbler

Figure 1). The factors contributing to the increase in CPUE in 2003 are not known.

The catch rate in 2004 declined to similar levels to those reported in the period from 2000 to 2002. The catch rate evident in the fishery in 2006 is the lowest recorded since 1979 and is similar to that recorded in 1998 and 1999 (Lake Argyle Silver Cobbler Figure 1). The fishery will be closely monitored over the next few years.

The catch and effort data provided by industry are used to develop stock assessment models for the fishery. The modelling approach used in the following assessment of the fishery requires a number of assumptions related to catchability and age and growth, and the available data are not sufficiently detailed to determine whether or not these assumptions are reasonable.

This creates a high degree of uncertainty around the results generated from the models. The only way to reduce this uncertainty is to allocate more resources to the gathering of the necessary data from the fishery, and to gain an understanding of some key characteristics of both the fishery and the biology of the species.

The fishery was last formally assessed in 2001 when a process error model and an observational error model replaced the biomass dynamics model previously used. The results of this assessment work indicated that the stock was either fully fished or overfished. Both models indicated that the catch levels of 180 – 230 t reported by the fishery during the period 1998 – 2000 were unlikely to be sustainable.

The reduced effort applied by the fishery after 1999 has brought catches back into the acceptable range. These lower catches generated a slight upward trend in CPUE from 1999 to 2003, suggesting that stock abundance may be increasing (Lake Argyle Silver Cobbler Figure 1).

The simultaneous increase in catch and catch rate in 2003 may have reflected either the short-term use of a smaller mesh size within the fishery or an increase in recruitment. The reduced catch rate in 2006 now indicates that the catch rates have been declining since the relatively large catch of 2003.

The assessment completed in 2001 indicated that the fishery was probably over-exploited and the breeding stock may not have been sufficient to maintain existing recruitment to the fishery if fishing had continued at the catch levels seen during the years 1998 – 2000. The significant reductions in catch that occurred in 2001 and 2002 may have assisted in the recovery of the breeding stock.

The variable CPUE may be related to variations in recruitment strength that are unrelated to fishing. The declining catch rate since 2003 requires further investigation.

Non-Retained Species

Bycatch species impact: **Low**

Minimal fish bycatch occurs in this fishery as a result of the large mesh size used relative to the species present in the lake.

Protected species interaction: **Low**

There is an incidental capture of freshwater or Johnston's crocodiles (*Crocodylus johnstoni*) and some tortoises by the silver cobbler fishery in Lake Argyle. Although Lake Argyle is an artificially-created aquatic environment, it is now designated as a wetland of international importance under the Ramsar Convention.

While the crocodile population has probably increased in response to the creation of the dam in an otherwise arid environment, there are no assessments of the current size of the population, nor of the proportion of the population being captured incidentally by the fishery. In the absence of this information, but on the basis of the fishers' anecdotal information of low levels of capture, the incidental capture of crocodiles is considered to be of minimal ecological significance. In addition, fishers in Lake Argyle are also attempting to reduce the incidental capture of non-target species.

In 2005, LASCF endorsement holders' trialled the use of fish traps as a method of mitigating bycatch. Early indications suggest that this gear-type is ineffective for harvesting silver cobbler.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The surface gillnets used in the fishery have minimal impact on the habitat.

Social Effects

During 2006, 3 vessels fished in the LASCF with an average crew level of 2 people per vessel, indicating that 6 people were directly employed in the fishery. Additional employment occurs in the fish processing and distribution networks used by the LASCF.

Economic Effects

Estimated annual value (to fishers) for year 2006: **$207,000**

The LASCF landed a total of 78 t of fish in 2006 for a catch value of over $207,000. This estimate is based on the landed weight of silver cobbler recorded in the Department of Fisheries' CAES system and the 2005 average price per kilogram of whole weight of silver cobbler as supplied by fish processors.

Fishery Governance

Target catch range: **95 – 155 tonnes**

The target catch range under the current management regime is in the range of 95 – 155 t of silver cobbler. This range has been derived by applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002. The confidence intervals are obtained by estimating the variation of the observations compared with the variation of the predictions using the 13 years of catch data.

The catches from 1998 to 2000 exceeded this range (Lake Argyle Silver Cobbler Figure 1) and were driven by the utilisation of latent effort. The 2001 and 2002 catches were within the target catch range as a result of voluntary decreases in effort in this fishery. The catch in the fishery in 2004 and 2005 has been within the target catch range. The 2006 catch is below the target range, due to a reduced level of effort in the fishery.

Current fishing (or effort) level: Acceptable

The 2006 level of catch and effort was much lower than in previous years. This low catch is likely to assist the breeding stock in recovering. As such, the current level of catch and effort is considered acceptable. However, the declining catch rates in the fishery that are evident from 2003 to the present requires close monitoring.

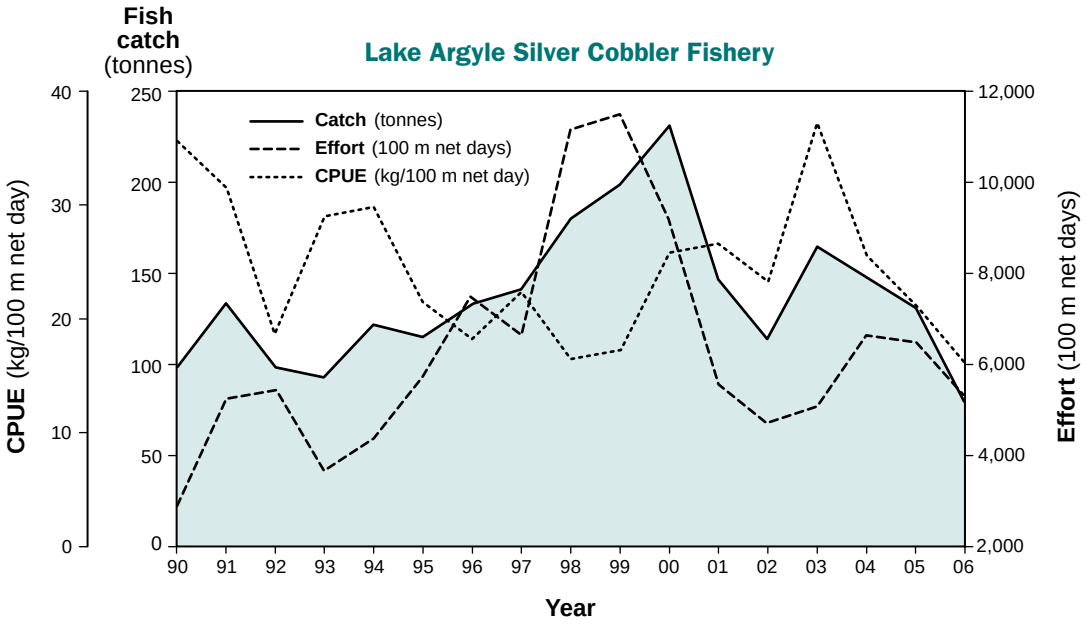
New management initiatives (2006/07)

The 2007 annual management meeting for the fishery is expected to focus on bycatch issues, particularly in relation to interactions with protected species. It is expected that this meeting will lead to new management initiatives for the fishery, including formalisation of current industry codes of practice and possibly further trialling of alternative gear-types.

External Factors

The variations in catch and catch rate seen from year-to-year are possibly related in part to the unknown catchability dynamics, recruitment levels and demographic characteristics of the silver cobbler – each of which may be affected by variations in environmental conditions within the Lake Argyle system.

Fishers head and gut the silver cobbler for transport to Perth markets in order to reduce freight costs, thus it is difficult to cost-effectively sample the size and age composition of the catch. The remote location of this fishery also means that it is a costly exercise to use observers to gain a better understanding of the catchability of this species.



LAKE ARGYLE SILVER COBBLER FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for the Lake Argyle Silver Cobbler Fishery over the period from 1990 to 2006.

AQUACULTURE

Regional Research and Development Overview

During 2006/07, Department of Fisheries' research and regional services staff in the Northern Inland bioregion continued to assist a variety of mainly Indigenous proponents with interest in inland aquaculture species including barramundi (*Lates calcarifer*), cherabin (*Macrobrachium rosenbergii*) and live-bait fish.

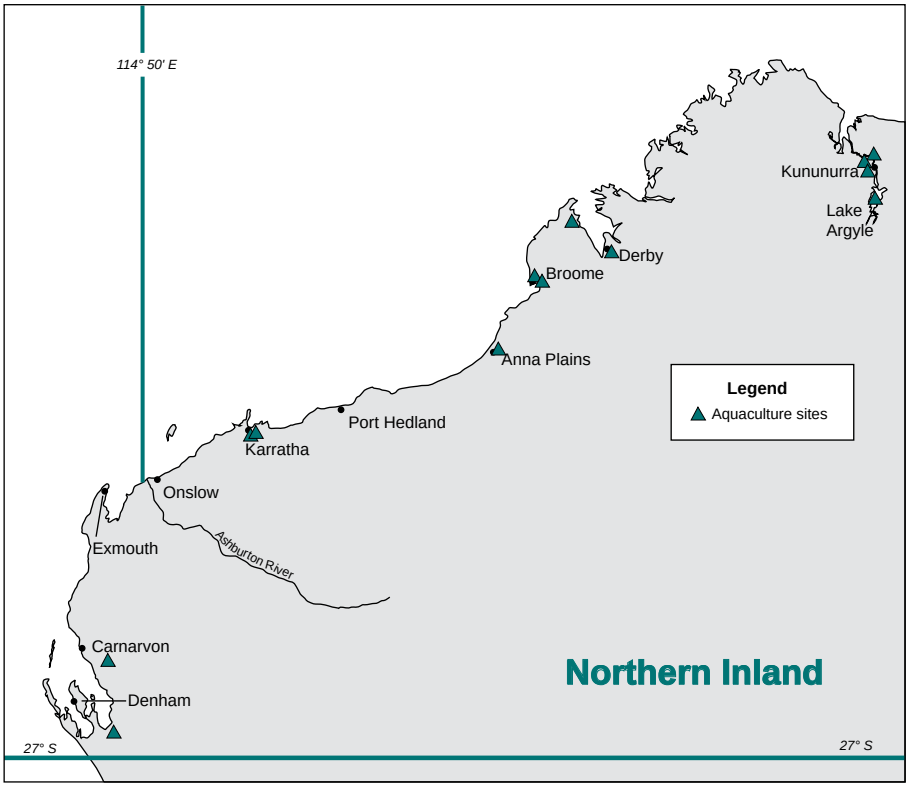
The Department was involved in assessing a range of potential sites in areas occupied by local indigenous communities interested in aquaculture projects. Staff have progressed the issuance of an aquaculture lease area in Lake Argyle for the Mirriuwung Gajjerong Aboriginal Corporation, in accordance with requirements for the Ord Stage II final agreement.

Progress has also been made on developing an indigenous model farm for the aquaculture of barramundi and redclaw crayfish near Kununurra, with commissioning of the site expected in 2007/08. A proposed prawn farm in the Wyndham area remains under consideration.

Research and regional services staff from the Department of Fisheries have also been assisting the Department of Planning and Infrastructure in identifying a new land-based aquaculture area for Lake Argyle to support the mid- to long-term expansion of aquaculture in the lake.

2 large externally-funded research projects have helped underpin the sustainability of barramundi aquaculture development in the Kimberley. These projects have been funded from the Fisheries Research and Development Corporation (FRDC), Sustainable Regions Program and the Australian Centre for International Agricultural Research.

Major issues resolved include the development of disease management strategies to limit spread of diseases in Lake Argyle; the development of techniques to reduce and remove 'muddy' flavour taint in fish farmed in Lake Argyle; the development of a national testing centre for flavour taint issues; and the refinement of a production and feed management model. This model is being further refined in work at the WA Fisheries and Marine Research Laboratories, at Hillarys in Perth.



NORTHERN INLAND BIOREGION FIGURE 1
Map showing the major licensed aquaculture sites of the Northern Inland bioregion.

Barramundi Farming Status Report

C. Lawrence and S. How

Industry Description

Production methods

Barramundi (*Lates calcarifer*) can be farmed in cages in lakes or coastal areas, in inland saline ponds, or in intensive recirculating culture systems using fresh water, inland saline water or seawater. In Western Australia the majority of barramundi production is from fresh water, particularly using cages or intensive recirculating systems.

Production areas

Barramundi is currently produced in cages in Lake Argyle or intensively in recirculating systems in the southern half of the state.

Management arrangements

An aquaculture licence from the Department of Fisheries is required to undertake barramundi farming. A water quality monitoring program that is to the satisfaction of the Department of Environment and Conservation must also be developed and maintained.

Aquaculture Production

Production current year (2005/06): 18 tonnes

Number of producers for year 2005/06: 13

In comparison to 2004/05, this represents a decrease of 3 productive farms.

Production projection next year (2006/07): 20 tonnes

Barramundi production in 2005/06 decreased by 93% compared to the previous year, with a corresponding decrease in value of 87% due to a return to more realistic prices per kilogram. This decrease in production can be attributed to 4 farms ceasing production since 2003/04. (Barramundi Farming Figure 1).

Future production levels may be affected by:

- appropriate management during periodic fluctuations in water quality in Lake Argyle;
- intense competition (particularly from Northern Territory and Queensland farms) that can depress market prices; and
- development of new farms.

Ecosystem Effects

With correct management, barramundi farming is considered to present a moderate risk to the environment. Even within protected coastal areas and lakes, cages can be operated with low environmental impact if they are appropriately located in deeper water with adequate current flow to remove nutrients.

Native fish present around the cages can also be expected to consume a significant amount of waste material (uneaten feed and faeces), thus reducing the overall impact on the environment. Monitoring of the major farm in Lake Argyle in 2002/03, as part of the requirements of the Department of Environment and Conservation, indicated minimal environmental impact.

Land-based farms producing more than 1 t of fish are required to minimise their environmental impact and are subject to discharge licensing, which includes monitoring of water quality.

Social Effects

While this industry has the potential to become a valuable source of regional employment and local tourism opportunities at Lake Argyle, production has decreased considerably over the past year.

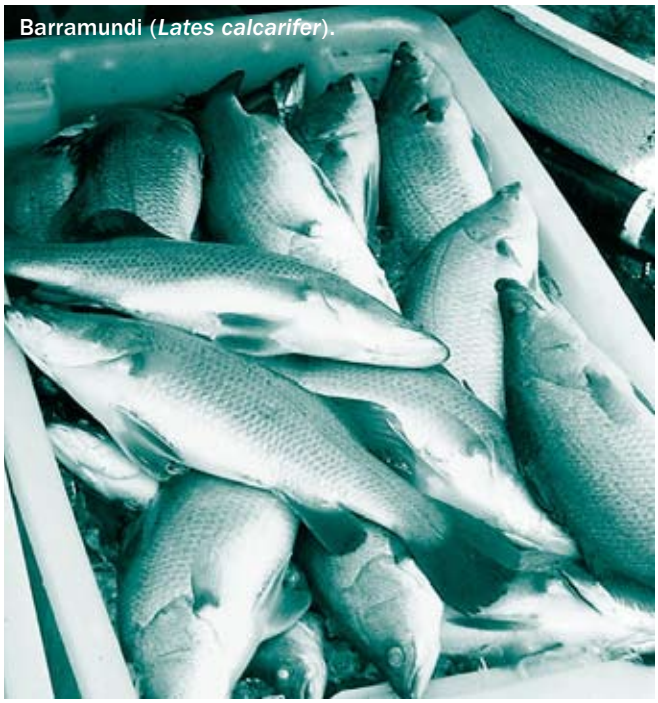
Economic Effects

Estimated annual value (to producers) for year 2005/06: $0.2 million

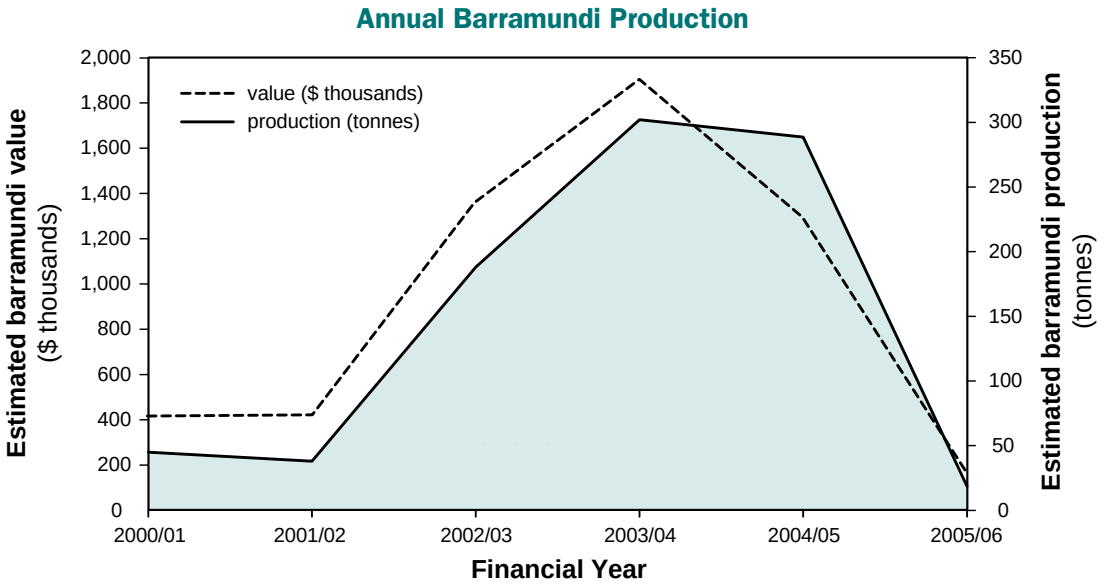
The value of barramundi production decreased by 87% in 2005/06.

External Factors

To compete with imported product, and farms in the Northern Territory and Queensland, WA producers will need to implement marketing strategies that emphasise the benefits of local produce.



Barramundi (*Lates calcarifer*).



BARRAMUNDI FARMING FIGURE 1
Estimated barramundi production and value from 2000/01 to 2005/06.

COMPLIANCE & COMMUNITY EDUCATION

The Northern Inland bioregion includes the freshwater rivers, lakes, billabongs and wetlands primarily located in the Kimberley. Commercial fishing is permitted in Lake Argyle (man-made lake) and in the tidal area of the mouth of the lower Ord River.

Compliance and education for the freshwater systems in the North Inland bioregion focuses on:

- habitat protection;
- translocation inspections of non-endemic freshwater species;
- protected species interaction;
- monitoring of introduced fish species;
- aquaculture lease and licence compliance;
- localised depletion of barramundi as a target recreational species;
- cherabin catches; and
- impact of the commercial fishery in Lake Argyle.

Patrols continue to focus on the Fitzroy and Ord Rivers, due to the large number of campers and fishers accessing the inland Kimberley rivers during the peak tourism period of May to October and the area-specific barramundi size and possession limit legislation. Both the Fitzroy River and the Ord River are identified as major breeding areas for barramundi.

Officers pay particular attention to catch of any protected sawfish species, disused recreational fishing gear and localised impacts of fishers.

Activities during 2005/06

During 2005/06, Fisheries and Marine Officers (FMOs) recorded 416 hours of active compliance patrol time in the Northern Inland bioregion – a decrease compared to the previous year but aligned with historic levels of patrol activity (Northern Inland Compliance Figure 1).

Across the Northern Inland bioregion, personal contact was made with 1,708 contacts across the commercial, recreational and other sectors (Northern Inland Compliance Table 1). FMOs focused on freshwater fishing compliance in areas of known high visitation or local complaints regarding non-compliant netting.

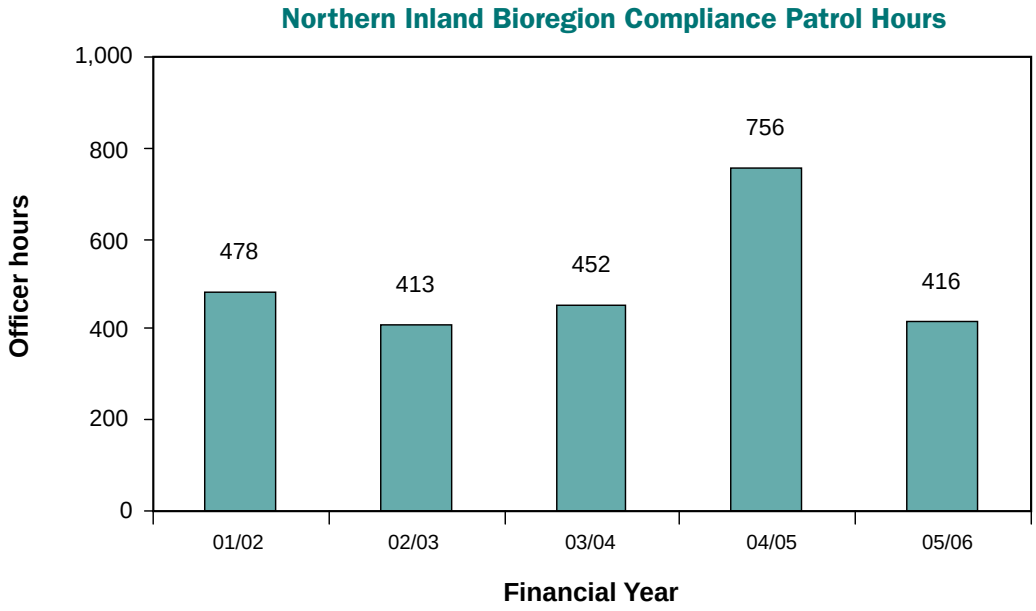
Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers and aquaculture sites to ensure that compliance with management, protected species interaction and environmental objectives were being met.

Initiatives in 2006/07

Compliance service delivery will continue to target any areas of complaint and high levels of recreational fishing pressure. These locations are reviewed during annual risk-assessment processes.

Compliance activities relating to the only freshwater commercial fishery, which targets the Lake Argyle silver cobbler, will continue. The small number of operators is scrutinised to ensure that high levels of compliance and community confidence are maintained.

Improved levels of engagement with children in regional towns and remote Aboriginal communities are planned, through fishing clinics and school presentations promoting ‘fish for the future’ messages.



NORTHERN INLAND COMPLIANCE FIGURE 1

This figure gives 'On Patrol' officer hours showing the level of compliance patrol activity delivered to the Northern Inland bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2005/06 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	416 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY*	
Field contacts by Fisheries & Marine Officers	11
District Office contacts	16
Infringement warnings	0
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	468
District Office contacts	39
Infringement warnings	1
Infringement notices	2
Prosecutions	1
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1,229
District Office contacts	0
Fishwatch reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** Fishwatch calls relating to the Northern Inland bioregion are not recorded, as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Northern Inland bioregion will be included in both the North Coast and Gascoyne Coast bioregion totals.

Southern Inland Bioregion

The Department of Fisheries Pemberton Freshwater Research Centre.

ABOUT THE BIOREGION

This region contains the state's only natural permanent freshwater rivers, which are fed by rainfall through winter and spring. These permanent rivers are restricted to the high-rainfall south-west corner of the state and flow through the significant native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of native vegetation in more inland areas.

Across the remainder of the southern inland bioregion, rivers flow primarily during the 3 months of winter rainfall, with very occasional summer flows from inland rain-bearing depressions resulting from decaying cyclones. Permanent fresh water bodies are essentially all man-made irrigation, water supply or stock-feeding dams. Some natural salt lakes also occur but generally dry out over summer each year.

The few natural freshwater rivers and man-made lakes support a small native fish fauna and create an environment, particularly in forest areas, which is highly valued by the community for a variety of recreational pursuits.

While there are no commercial fisheries in the southern inland bioregion, it provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers, as are black bream artificially stocked into some inland impoundments.

Aquaculture development in the southern inland bioregion is dominated by the farm-dam production of yabbies, which can reach about 200 t annually depending on rainfall and market demand. Semi-intensive culture of marron in purpose-built pond systems provides around 50 t per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stock maintained at the Department's Pemberton Freshwater Research Centre. Recent developments have focused on the short-term winter growout of trout in inland saline waters. Silver perch are also grown in purpose-built ponds in the warmer northerly areas to supply local markets, while intensive closed-circuit systems are being used to produce barramundi for the metropolitan restaurant trade.

ENVIRONMENTAL MANAGEMENT

Regional Overview (Southern Inland)

The conservation of the 13 species of freshwater native fish in freshwater ecosystems in the south-west of WA is a growing issue for the Department of Fisheries. Many of these species are endemic to WA and under pressure through increasing salinity, infrastructure (bridges and dams) and adjacent land-use development.

The Department has initiated a freshwater fish working group with representatives from the Department of Water and the Department of Environment and Conservation, to facilitate information exchange and identify research projects and associated funding sources to mitigate environmental impacts and so better protect native fish species.

The Department also has an approval process in place for assessing proposals to translocate non-endemic fish species into and within Western Australia, so as to minimise the environmental risks associated with this activity.

An incursion response program continues to be implemented to react to feral fish and/or non- endemic disease outbreaks where they occur. The Department has been active in the past year to mitigate the spread of feral cichlid fish from waters in tributaries flowing into the Swan River. This activity is on-going, and highlights the need for greater public awareness about avoiding the release of feral fish into natural waterways.

FISHERIES

Regional Research Overview

Western Australia's most popular freshwater fishing area is the Southern Inland bioregion, where 2 licensed recreational fisheries target marron (freshwater crayfish) and native and introduced freshwater fish species. In 2006/07, around 19,300 licences were issued for these 2 activities; however, this includes a large number (13,100) of 'umbrella' licences (covering all licensed recreational fisheries), which generally correlates with a lower participation rate.

Research for managing and enhancing the fisheries for marron (*Cherax tenuimanus** Smith) and the non-native trout (both rainbow trout, *Oncorhynchus mykiss* and brown trout, *Salmo trutta*) has been largely undertaken by the Department of Fisheries. In addition, collaborative university projects have provided data on the non-native redfin perch (*Perca fluviatilis*) and native freshwater cobbler (*Tandanus bostocki*) and their relationship to the small native freshwater species of the Southern Inland bioregion.

'Smooth' marron are targeted by recreational fishers but the few remaining key areas for the survival of the critically endangered 'hairy' or Margaret River marron are closed to fishing. Additional research is now underway to assist the recovery of the 'hairy' marron, which was previously (before 2002) part of the recreational marron fishery.

*Nomenclature of marron is currently under review by the International Code of Zoological Nomenclature (ICZN) case number 3267.

Licensed Recreational Marron Fishery Status Report

By M. de Graaf and T. Baharthah
Management input by C. Syers

Fishery Description

Marron are endemic to Western Australia and are the third largest crayfish in the world. Recreational fishing occurs in freshwater dams and rivers throughout the southern part of the State, extending from as far north as Geraldton to Esperance in the east. Fishers may only use legal scoop nets, drop nets or snares to take marron.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Freshwater Fisheries Stakeholder Sub-Committee of the Recreational Fishing Advisory Committee (RFAC)

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in both freshwater dams and rivers, although access to drinking water supply dams servicing the Perth metropolitan area and south-west regional centres are closed to the public by the Water Corporation.

Management arrangements

This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits.

A Ministerial Review of the fishery in late 2002, aimed at ensuring the long-term sustainability of the stocks, resulted in changes in the management arrangements for the 2003 season, most notably the reduction of the fishing season from 55 days to 16 days. The reduced length of the fishing season (16 days) was maintained in the 2006 season.

All marron fishers require a recreational fishing licence (either a specific marron licence or an 'umbrella' licence covering all licensed recreational fisheries). Licensed fishers were permitted to fish for marron from 20 January to 5 February 2006.

3 types of legal gear exist; scoop nets, drop nets and snares. Only a single scoop net or snare, or 6 drop nets may be used at any one time. Some waters, including all major public dams, have been declared 'snare-only'.

Waroona Dam was reopened to the recreational marron fishery in 2006 following the dam's closure in 2002. During this period, a highly successful breeding and restocking program was undertaken in order to rebuild the marron stock level in the dam.

In most waters, there is a minimum size of 76 mm carapace length and a bag limit of 10 marron per day. However, Harvey Dam and Waroona Dam are managed as 'Trophy Waters' with a minimum legal size of 90 mm carapace length and a daily bag limit and possession limit of 5 marron.

Research summary

Detailed research on the marron stocks in south-west rivers has been undertaken since the 1970s. Current research involves the annual scientific monitoring of stock levels before the summer fishing season, surveys of catches taken by recreational licence holders and volunteer log book holders, biological characteristics (growth, size-at-maturity, fecundity, etc) of key marron populations in different catchments and joint sampling with individual catchment groups and universities.

These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary. The following status report is based on these research findings.

A major FRDC research project commenced in July 2003 which aims to quantify the various factors that are influencing the marron fishery, and re-design long-term monitoring so as to provide better management advice to sustain this important fishery for the future.

Current research is mainly focussed on:

- determining the reproductive characteristics (size-at-maturity and fecundity) of marron throughout their range;
- development of a fisheries-independent abundance index in key river and dam populations;
- development of a tagging program to provide information on long-term growth and mortality throughout the marron range; and
- development of a recruitment monitoring program to predict future catches.

Retained Species

Commercial component: **Nil**

Recreational catch estimate (season 2006): **47,200 marron**

The total catch for the 2006 season was estimated at approximately 47,200 ± 7,780 standard error (SE) marron or 10.6 ± 1.8 t of marron (average weight per marron of 225 g, based on log book data). This is a decrease compared to the previous season (2005: 60,600 ± 5,460 marron or 13.6 ± 1.2 t). The decrease in catch is not due to a decrease in Catch Per Unit Effort (CPUE) but to a reduction in effort.

Fishing effort/access level

Total effort for the 2006 season was estimated from phone surveys at around 10,700 days.

Fishing effort significantly decreased compared to the previous season (e.g. 2005: 15,200 days). This decrease is due to a decrease in the number of participating licensed fishers (from 5,400 in 2005 to 3,300 in 2006) as the number of fishing days per fisher increased from 2.8 in 2005 to 3.2 in the 2006 season.

The season length for both the 2005 and 2006 season was just 16 days.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Current assessment involves research surveys of stock levels at several indicator sites before the summer fishing season, phone surveys of catches taken by recreational licence holders and volunteer log book holders, and joint sampling with catchment groups and universities.

These data enable trends in stock levels to be monitored and recommendations to be made for adjustments to fishery management when necessary.

The CPUE recorded by fishers, based on phone surveys, was higher (around 10%) in 2006 at approximately 4.4 marron per fisher per day compared to the previous season (2005: 4.0 marron per fisher per day). The CPUE has been relatively stable over the last 6 years, fluctuating between 4 to 5 marron per fisher per day.

In 2006 a new stock assessment program using traps was conducted, providing fishery-independent data on (relative) abundance of marron in 3 dams (Waroona Dam, Wellington Dam, Harvey Dam) and 5 rivers (Shannon, Warren, Blackwood, Preston and Murray River). This program will be extended next year to include Drakesbrook Dam, Moore River and Collie River. Fishery-dependent catch and effort data (e.g. CPUE as determined by log book or phone survey) can be poor indicators of true stock abundance.

The fishery operates over a number of river catchments and dams which contain a large number of essentially separate stocks. From the small number of stocks surveyed, the current breeding stock levels appear adequate (based on typical size-at-maturity).

Size-at-maturity (i.e. the size at which 50% of the females are mature) seems to be below the minimum legal size of 76 mm Rostrum Carapace Length (RCL) for the majority of marron stocks in the south-west (e.g. Warren River ±56 mm RCL, Murray River ±54 mm RCL, Collie River ±42 mm RCL, Preston River ±60 mm RCL, Waroona Dam ±63 mm RCL, Drakesbrook Dam ±31mm RCL, Wellington Dam ±54 mm RCL).

Present size restrictions seem to adequately protect the majority of the female breeding stocks. Further information on size-at-maturity from other catchments throughout the marron range needs to be obtained in the near future.

The exception with regards to size-at-maturity is the stock in Harvey Dam, where a larger female size-at-maturity of about 85 mm occurs, and a larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stock. Recent studies revealed that female size-at-maturity in the Hutt River, 600 km north of Perth, is also significantly larger (about 95 mm RCL) than the minimum legal size of 76 mm RCL. In 2007, the Hutt River will also be managed as a 'Trophy Water', with an increased minimum legal size of 90 mm RCL and a reduced bag limit of 5.

An increase in the minimum legal size might also be required in the near future for marron in the Moore River. Preliminary data show that size-at-maturity is large (± 79 mm RCL) and the current minimum legal size might not protect the female breeding stock sufficiently.

Non-Retained Species

Bycatch species impact: **Negligible**

The marron fishery does capture small quantities of non-target species, principally gilgies (*Cherax quinquecarinatus, C. crassimanus*) and koonacs (*C. plejebus, C. glaber*). Although little is known about their biology, the impact of the marron fishery on these species is thought to be low, as gilgies and koonacs are smaller than marron and are not targeted by marroners.

Protected species interaction: **Negligible**

This fishery does not interact with protected species. However, a second species of marron has been identified (Margaret River or 'hairy' marron) which is threatened mainly by the extension in range of the more common smooth marron, which is the basis of the recreational marron fishery.

In late 2002, recreational marron fishing upstream of Ten Mile Brook Junction (including all its tributaries) on the Margaret River was prohibited to remove the impacts of fishing on the remaining Margaret River marron stocks. However, illegal fishing is still reported in this reach of the Margaret River.

A recovery plan, developed jointly between the Department of Fisheries, the Department of Environment and Conservation, and other stakeholders on the recovery team, is underway for this species.

Ecosystem Effects

Food chain effects: **Low**

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size and that marron of all sizes have similar food and habitat requirements. Marron taken from man-made dams do not have a significant impact on natural freshwater ecosystems.

Habitat effects: **Negligible**

The impact of this fishery on the aquatic habitat is negligible. The major effects are litter in surrounding areas and the trampling of areas of riparian vegetation by marroners and subsequent bank erosion.

Social Effects

A large number of recreational marron licences are sold annually. For the 2006 season, a total of 15,918 licences were sold, including umbrella licences (13,113). This represents a considerable decrease from the 20,075 licences sold in 2005.

The marron fishery in the 2006 season involved approximately 3,300 licence holders undertaking about 10,700 fishing days, and provided a major recreational activity in regional areas of the south-west of the State.

Economic Effects

The value of the 2006 season recreational marron catch was in the approximate range of $255,000 (based on an average sale price of marron from aquaculture farms of approximately $24/kg, and a range of tonnage based on minimum legal size and the estimated average size of marron captured as calculated from log book returns).

Revenue from licence sales was estimated at approximately $206,000, which is used to support recreational fishery management, research and compliance. In addition, the estimated 10,700 days of marroning in regional locations provided a significant economic boost to regional towns in the south-west.

Fishery Governance

Target catch (or effort) range: 96,000 – 136,000 marron

In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available research data and the knowledge of the marron fishery, the fishery be managed to a maximum target catch of between 96,000 – 136,000 marron.

It should be noted that under current management arrangements (a short 16-day season since 2003) the average estimated recreational catch has been around 55,000 marron. The most likely explanation for the current low annual catch is not limited marron stocks but the sharp reduction in effort since 2003 (Recreational Marron Figure 1).

In 2007 the marron season will be increased from 16 to 23 days. Assuming relative stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Developments in marron abundance (using fishery-independent surveys) and marron catches (using a phone survey and log books) will be closely monitored after the 2007 season to determine the impact of the changes in season length and decrease in legal minimum size. Existing management arrangements will be reviewed and if necessary adjusted prior to the 2008 season.

Current fishing (or effort) level: Acceptable

Fishing effort has been low under current management arrangements. Since 2003, when the reduced 16-day season was introduced, effort (fishing days) dropped considerably – from around 40,000 fishing days (2000 - 2002) to around 11,000 fishing days (2003 – 2006).

New management initiatives (2006/07)

A Recreational Freshwater Fisheries Stakeholder Sub-committee (RFFSS) of the Recreational Fishing Advisory Committee was established in 2004 to develop a 5-year strategy for the management of the State's south-west recreational freshwater fisheries and provide advice on ongoing monitoring and adaptive management of the marron and trout fisheries.

The RFFSS reviewed the current management arrangements for the recreational marron fishery during 2005/06. In 2006, a discussion paper was released which contained future management options for the fishery. The following adjustments to the existing management options of the recreational marron fishery will occur from the 2007 season.

1) Minimum legal size increased from 76 mm to 80 mm.
2) Retention of the 10 marron (or 5 marron in 'trophy waters') per day bag limit, but the introduction of a possession limit of 20 legal-size marron per licensed fisher.
3) Increased season from 16 to 23 days (12 January to 4 February 2007).
4) Hutt River will be managed as a 'trophy water', with a minimum size limit of 90 mm RCL and a bag and possession limit of 5 marron per licensed fisher.
5) Removal of the 'snare-only' requirement within the Warren National Park.
6) Fishers will be permitted to carry marron drop nets and scoop nets by boat to the area that they intend to fish in order to access the relatively inaccessible sections of the Donnelly River (down stream of 'Boat Landing' only).
7) Shannon River to be closed to all fishing.

External Factors

The 3 main external factors which affect the marron fishery are winter rainfall, access to dams, and introduced species.

Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. It may also affect the ease with which fishers can access the water bodies used in the marron fishery, reducing pre-season illegal fishing.

A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001, owing to the diversion of its water to the Perth metropolitan water supply, and there is a strong possibility of limitations to fishing in Logue Brook Dam and Wellington Dam in the near future.

Waroona Dam was closed for several seasons (2002 – 2005) for refurbishment, reopening to marron fishing in 2006. Drakesbrook Dam, the next in line for maintenance work, is expected to be unavailable for recreational marron fishing in 2009 until possibly 2012.

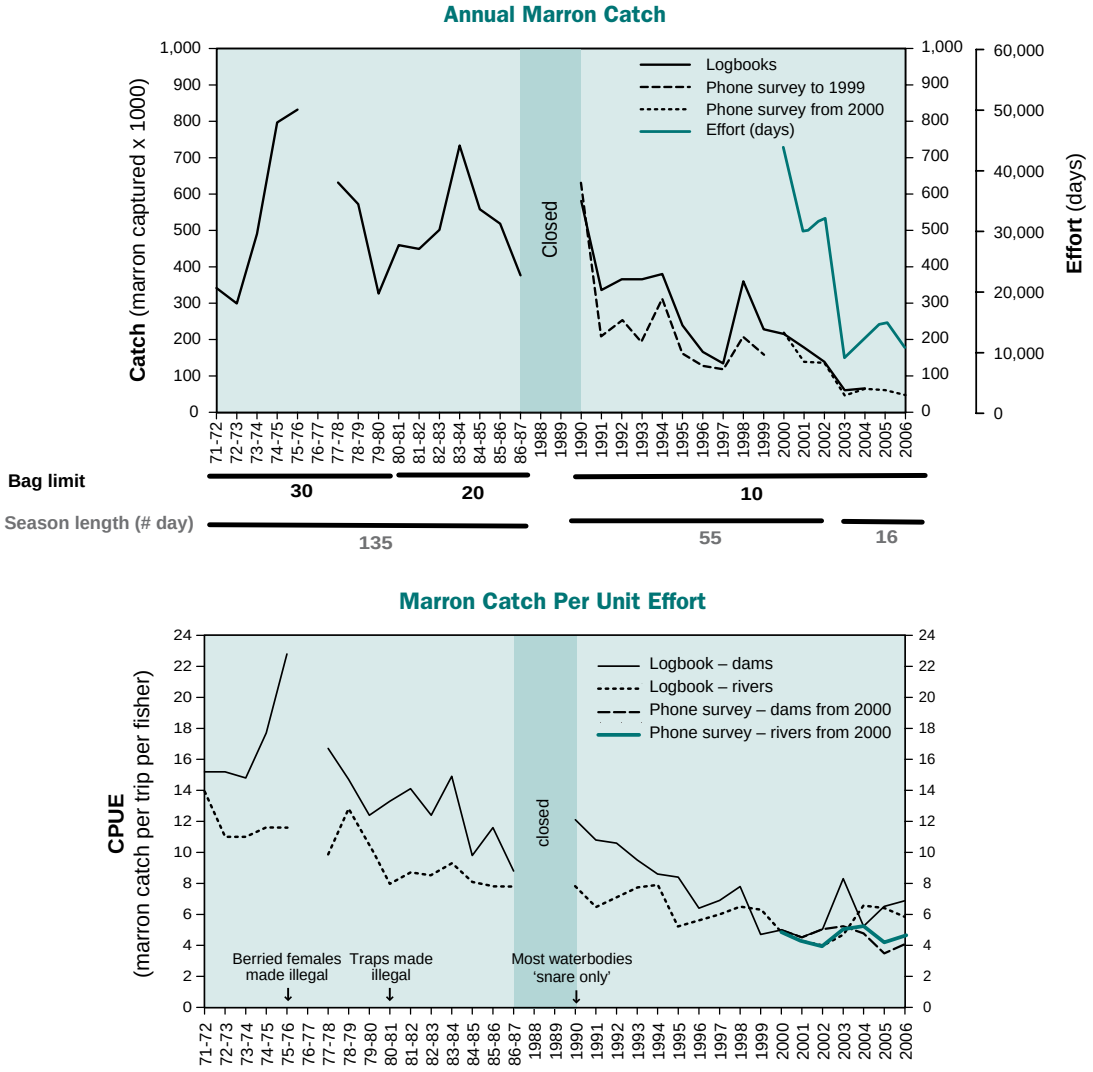
The Department of Fisheries is working closely with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species. Trials in Waroona Dam and Drakesbrook Dam showed that artificial habitat (a rock wall) provide an important refuge for juvenile marron and berried females.

The Department of Fisheries secured funding from the Water Corporation to de-stock marron from Drakesbrook Dam before the complete drainage. The marron will be kept at the Department's hatchery facilities in Pemberton and re-stocked during the winter of 2009. Furthermore, in cooperation with RecFishwest and Water Corporation, funding was secured from the Recreational Fishing Community Grants Programme to create large-scale artificial habitats in Drakesbrook Dam to enhance the recreational marron fishery.

The major introduced species that impact on the marron fishery are redfin perch (*Perca fluviatilis*), trout (*Oncorhynchus mykiss* and *Salmo trutta*) and yabbies (*Cherax albidus*). Redfin perch, which predate heavily on small marron, have been illegally stocked into most rivers and irrigation dams in the south-west. Redfin perch may be of greatest concern in irrigation dams, which generally have all structure (e.g. tree stumps) removed prior to filling and provide little shelter or protection for marron. Redfin perch control has been attempted at Waroona Dam as part of the refurbishment process.

Trout also predate on marron but to a much lesser extent than redfin perch due to the wider diet of trout, particularly rainbow trout, which prey predominantly on freshwater insects.

Yabbies, a direct competitor and a potential threat to marron, have been recorded from a number of areas within the marron recreational fishery, but at low abundances.



RECREATIONAL MARRON FIGURE 1
The estimated total catch (a) and catch per unit effort (b) of the recreational marron fishery between 1971 and 2006.

Licensed South-West Recreational Freshwater Angling Managed Fishery Status Report

M. de Graaf and T. Baharthah
Management input by C. Syers

Fishery Description

The south-west recreational freshwater fishery is focused primarily on angling for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) which are the subject of an annual controlled stocking program by the Department of Fisheries. In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*) and an exotic species redfin perch (*Perca fluviatilis*).

Redfin perch were released in the south-west many years ago and now occur as self-breeding populations in most water bodies. Licensed anglers may only use a single rod, reel and line or single handline when targeting these species.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation
Recreational Fishing Licence

Consultation process

Recreational Freshwater Fisheries Stakeholder Sub-Committee of the Recreational Fishing Advisory Committee (RFAC)

Boundaries

The south-west freshwater angling licence authorizes anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29° latitude (Greenough) and above the tidal influence, including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licensing, seasonal closures, fish gear restrictions, minimum sizes and bag limits. People under 16 years of age are not required to hold a licence to go freshwater angling.

To protect newly released trout, a closed season applies from 1 May to 30 August in most rivers and dams in the south-west of the State. During the closed season, fishing is still allowed on the Murray, Blackwood, Donnelly and Warren Rivers and sections of the Serpentine River. However, fishing for trout on the streams, brooks and tributaries flowing into these rivers is prohibited during the closed season. In addition, fishing for all species is totally prohibited in Waroona Dam, Logue Brook Dam and their tributaries during the closed season.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), together with a minimum legal size limit of 300 mm.

A daily bag limit of 40 applies to freshwater cobbler (*Tandanus bostocki*). No minimum legal size limit applies to this species. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*) and anglers are encouraged not to return any redfin to the water, as this feral species negatively affects the marron fishery and predates actively on trout fry.

To improve the quality of the trout fishery, Waroona Dam and Logue Brook Dam are 'artificial lure only' (no bait areas). Reduced bag limits (2 trout per day) have also been established in these selected waters. This has had the effect of improving the quality of the trout fishery over the spring period.

The trout stocking program, administered by the Department of Fisheries in consultation with the RFAC Recreational Freshwater Fisheries Stakeholder Sub-Committee (RFFSS), focuses on public waters where trout have been stocked or been present since the 1930s. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

Research summary

The Research Division of the Department of Fisheries produces and distributes trout fry, yearlings and excess broodstock to support the recreational trout fishery. In 2006 approximately 483,000 rainbow and 32,000 brown trout fry, 25,800 rainbow trout yearlings and 2,800 rainbow and 480 brown trout broodstock were stocked in selected public waters.

A limited survey of licence holders was performed for the 1998/99 season to obtain information on catch and effort within the fishery. Subsequently, an annual telephone survey commenced in 2001 and now provides regular information about this important recreational fishery. In cooperation with recreational anglers, redfin perch, freshwater cobbler, rainbow trout and brown trout have been collected for diet analysis.

Research information from these projects and the annual report from the manager of the PFRC have been used to compile the following status report.

Retained Species

Commercial catch: **Nil**

Recreational catch estimate (season 2005/06):
23.7 tonnes

An estimated 23.7 ± 4.2 t of fish were landed in this fishery by recreational anglers in the 2005/06 season, including 17.5 t of retained fish (49,300 fish) and 6.2 t of captured and released fish (31,500 fish). The estimated catch was composed of 18,600 rainbow trout (4.7 t), 1,300 brown trout (0.4 t), 48,100 redfin perch (15.9 t), 4,000 native freshwater cobbler (1.4 t) and 8,700 black bream (1.3 t).

The overall reported catch is lower (~36%) than the previous season, which was 37.9 t. Landings of redfin perch (44%; 38,000 fish), black bream (59%; 12,000 fish) and brown trout (51%; 1,400 fish) decreased significantly. Landings of rainbow trout (46%; 5,900 fish) and freshwater cobbler (64%; 1,600 fish) increased compared to the previous season.

Fishing effort/access level

Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 23,400 days – a decrease from the previous season (28,000 days).

Stock Assessment

Assessment complete: **Preliminary**

Breeding stock levels: **Not applicable**

A catch rate of 3.5 fish of all species per day was estimated for the 2005/06 season. This included 2.1 retained fish and 1.4 released fish per angler per day. This is lower (around 20%) than for the 2004/05 season, but well within the range of catch rates reported in the previous 6 years.

The phone survey data (Freshwater Angling Figure 1) indicate that the stock levels of both rainbow and brown trout, as indicated by catch rates and catches, have remained stable over the past 6 years.

Both species of trout display little or no breeding in local waters and the fishery is supported through the stocking of fry, yearling and ex-broodstock trout by the Department of Fisheries. Redfin perch breed in all waters, and dominate all freshwaters. The management arrangements (e.g. minimum legal size, bag limit) for the native freshwater cobbler are currently under review, based on historical and recent scientific data.

Non-Retained Species

Bycatch species impact: **Negligible**

Protected species interaction: **Moderate**

Currently, 2 species of south-west native fish are protected under the Commonwealth's *Environmental Conservation and Biodiversity Protection Act 1999* list of threatened fauna: western trout minnow (*Galaxias truttaceus hesperius*) listed as critically endangered since 18 August 2006, and Balston's pygmy perch (*Nannatherina balstoni*) listed as vulnerable since 24 November 2006.

In areas where the interaction of trout and native fish have been raised, trout stocking has ceased (Margaret River 1998, Bancell Brook (Harvey River) 2004, Blackwood River downstream of Jalbarragup crossing 2006). The likely effects of rainbow trout, brown trout and redfin perch on the endemic fishes of the south-west are discussed under 'Food chain effects' below.

Ecosystem Effects

Food chain effects: **Moderate**

A major environmental risk in this fishery relates to the spread of the introduced redfin perch. Redfin perch consume (non-) native fishes, aquatic insects and freshwater crayfish species (mainly marron). Further, redfin perch breed throughout the fishery and are the most dominant fish in this region.

While the release of redfin perch is not illegal, the Department of Fisheries' education program strongly encourages anglers to retain any redfin perch caught, regardless of size. Phone survey data indicates that the release rates of redfin by licensed anglers have been low (around 10%) and similar over the last 6 years, suggesting angler support for this initiative.

However, ongoing educational campaigns are required to increase the awareness among recreational fishers that redfin perch have a negative impact on native fish and crayfish (especially marron) stocks and should not be released in any river or dam.

Rainbow and brown trout are also introduced species, but have different diet and habitat requirements than redfin. Brown trout feeds on (non) native fish, freshwater crayfish and, to a lesser extent, terrestrial insects. On the other hand, rainbow trout consume predominantly aquatic and terrestrial insects.

Brown trout probably negatively affect native fish and crayfish populations directly through predation, while rainbow trout are more likely to affect native fish populations indirectly through competition for limited food resources.

Further, the reproduction of trout in the wild in Western Australia is minimal, due to a lack of suitable spawning sites. The stocking locations and the numbers of trout can therefore be controlled by regulating the quantities of hatchery-produced fish stocked.

Currently, trout are stocked in only 25 locations and not throughout the entire range of fresh waters in the south-west. Thus, although trout are also predatory fishes, the lack of natural reproduction means they are more controllable than redfin perch and are thus more acceptable as an introduced recreational species.

Habitat effects: **Negligible**

The impact of this fishery on the aquatic habitat is negligible.

Social Effects

A large number of freshwater angling licenses are sold annually. For the 2005/06 season, a total of 16,507 licences were sold, including umbrella licenses (13,113). This is similar to the number of licenses sold in 2004/05 (17,000).

Economic Effects

The fishery operates in the south-west and is a significant tourist attraction for the region, generating valuable income for regional centres. There are also a number of pay-for-fishing operators who target the tourist market. The license sales contributed approximately $220,000 of revenue, which is used to support breeding, stocking, research, management and monitoring activities.

Fishery Governance

Target catch (or effort) range: **Not applicable**

Current fishing (or effort) level: **Acceptable**

New management initiatives: **(2006/07)**

The Recreational Freshwater Fisheries Stakeholder Sub-committee (RFFSS) of the Recreational Fishing Advisory Committee was established in 2004. The RFFSS assumes the role of the former trout stocking committee in the development

of trout stocking strategies for the fishery and provides advice on ongoing monitoring and adaptive management of the trout and marron fisheries.

The RFFSS is currently reviewing the management arrangements for freshwater fisheries in the State's south-west. Part of the review will be the management arrangements (size limits, bag limits etc.) of the native cobbler, based on the available historical and recent scientific data.

External Factors

The extent and success of the freshwater angling fishery in the south-west is dependent mainly upon the availability of high-quality freshwater bodies for stocking. The degraded nature (e.g. increased salinity) of many freshwater streams and rivers, coupled with the effect of climate change (e.g. reduced flow and water levels), has a strong negative effect on the future of recreational freshwater fishing.

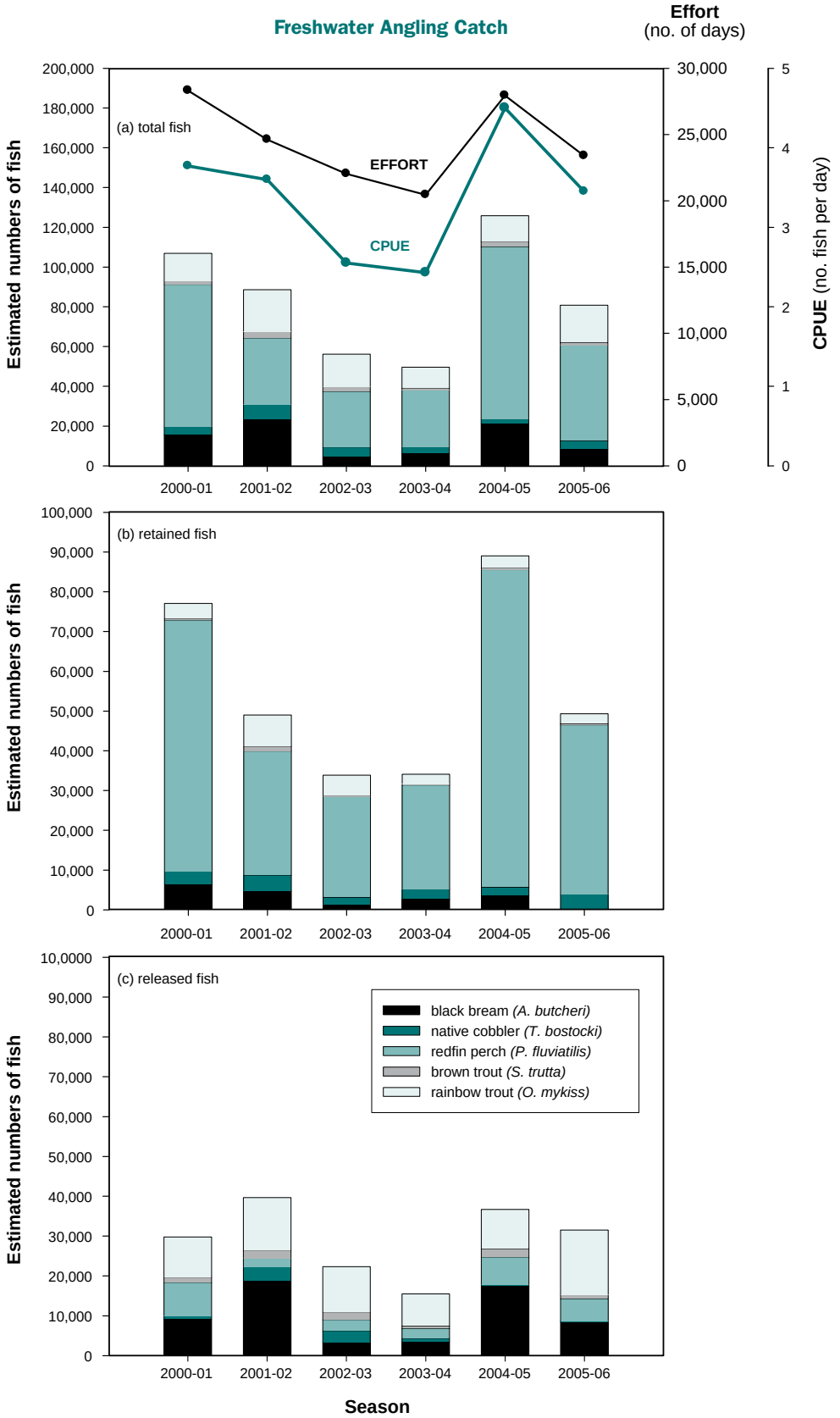
The availability of water for stocking is dependent on rainfall and access to irrigation dams. Thus, low rainfall and reduced access to permanent water bodies are having a negative influence on the freshwater angling fishery.

A major issue in this fishery is ongoing access to irrigation dams, as the management objectives of these waters change from irrigation and recreation to irrigation and/or public drinking water supply. The Water Corporation closed access to Stirling Dam in 2001, owing to the diversion of this water to the Perth metropolitan water supply. Further, construction of the new Harvey Dam resulted in limited access to this water by recreational anglers and a disruption of the freshwater fish stocks within the associated basin.

Waroona Dam underwent refurbishment and stocking recommenced in 2004 to provide fishing opportunities for the 2004/05 season. The Department of Fisheries is working closely with the Water Corporation to reduce the impacts to recreational fishing by enhancing stocks in refurbished dams.

The intermittent flow and general condition of most rivers make many areas in the south-west unsuitable for trout. Livestock access, cleared banks and de-snagging of streams all reduce the quality of the stream for trout and other aquatic species. Rehabilitation projects in the USA have produced better stream quality and better angling, and similar initiatives may be considered in Western Australia, particularly in irrigation dams.

Rainbow trout (*Oncorhyncus mykiss*).



FRESHWATER ANGLING FIGURE 1
Estimates of the total numbers of fishes retained (a), released (b) and the development of total catch, effort and CPUE (c) by species in the south-west freshwater angling fishery since the 2000/01 season.

AQUACULTURE

Regional Research and Development Overview

The 3 key areas of aquaculture research in the Southern Inland bioregion are Fisheries Research and Development Corporation (FRDC)-funded marron husbandry and selective breeding research; captive breeding programs for conserving endangered native fish and crayfish; and evaluation of the use of grains in aquaculture feeds.

The Department of Fisheries' captive breeding program to conserve native fish and crayfish biodiversity in the Southern Inland bioregion has successfully bred the critically-endangered Margaret River marron in research ponds at the Pemberton Freshwater Research Centre. The progeny from this project, funded by the Natural Heritage Trust through the South West Catchments Council, will be reared to sexual maturity, spawned, and their progeny used to restock the Margaret River.

In addition, the Department established captive populations of other endangered and vulnerable native fish and crayfish at the Pemberton Freshwater Research Centre and Shenton Park Aquaculture Laboratory. Aquaculture techniques that have previously been used to produce commercial species are now being applied by the aquaculture research group to prevent extinction of key freshwater species in Western Australia.

A major collaborative project in association with the Department of Agriculture and Food, the University of Western Australia, CSIRO, the University of Tasmania and feeds production and grain processing companies, with funding support from the Grains Research and Development Corporation, has continued the quality assessment of local agricultural products, such as lupins and canola, in aquaculture feeds.

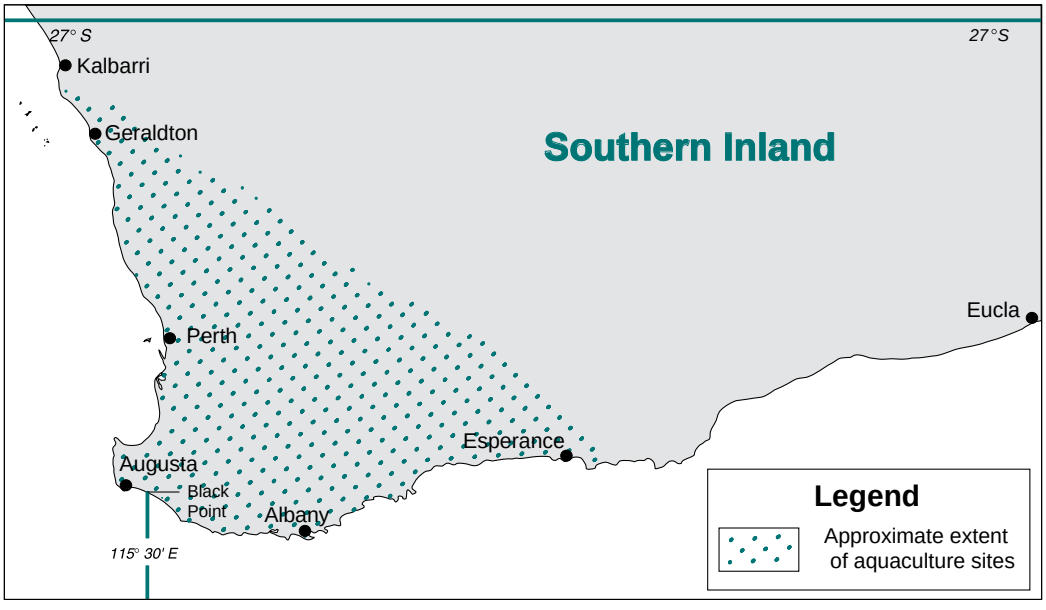
Much of the product evaluation work is being conducted at the Pemberton Freshwater Research Centre, in a purpose-built, temperature-controlled finfish nutrition research system. Rainbow trout continues to be used as the main test species to fast-track the quality assessment process, which is part of a major national R&D program led by the Department of Fisheries.

Complementary research, funded by the FRDC, is being conducted with inter-state partners using Atlantic salmon (*Salmo salar*) and black tiger prawns (*Penaeus monodon*), as there are larger aquaculture industries for these species in Australia. As well as undertaking feeding trials, considerable effort has gone into assessing the influence of feed grains on the aquaculture feed extrusion manufacturing process, as well as their physical processing properties such as milling, storage and transport characteristics.

Drawing from this work, a major grain value-adding industry has developed in Western Australia that is already exporting millions of dollars worth of product inter-state and internationally. Considerable promotional work to the domestic and international markets has also been undertaken to encourage industry adoption of these feed grains.

Industry adoption, both domestically and internationally, has been good, but further progress will be dependent on future successful grain production seasons, following the major droughts in recent years.

The Aquaculture Development Council has commenced a project aimed at identifying suitable sites for inland aquaculture in Western Australia. The outcomes of this project will provide significant insight into the potential for such an industry, as well as guidance for potential aquaculturists with an interest in this type of aquaculture. This project is scheduled for completion in 2007.



SOUTHERN INLAND AQUACULTURE FIGURE 1
Map showing the approximate extent of aquaculture sites in the Southern Inland bioregion.

Marron Farming Status Report

C. Lawrence and S. How

Industry Description

Production methods

The majority of marron (*Cherax tenuimanus*) farming occurs in purpose-built earthen ponds. These ponds average 1,000 m^2 in surface area and each pond is equipped with aeration, water supply and a drain to facilitate harvesting.

Research by the Department of Fisheries has established the criteria essential for optimising production from commercial marron farms. These correctly-designed, well-constructed and professionally-managed farms are responsible for the majority of marron production, with almost 60% of WA marron production coming from the most productive 10% of marron farmers.

Some gully dams are also used for farming marron, however these can only sustain much lower feed rates, stocking densities and yields.

Production areas

Licensed purpose-built farms for marron extend from Esperance to Hutt River north of Geraldton. The majority of farms are, however, concentrated in the higher-rainfall south-west coastal areas. Potential exists to expand production by the utilisation of irrigation dam water in transit to agricultural farms on the south-west coastal plain.

Management arrangements

Licence approvals are required to farm marron. 2 types of marron licence are available.

- An Aquaculture Licence (Marron) allows the holder to sell marron of any size to any person. Applicants must demonstrate that they own or occupy private property with a minimum of 2,500 m^2 of impounded water available for marron aquaculture purposes.
- An Aquaculture Licence (Marron Limited) allows the licence holder to sell marron of 76 mm carapace length or greater to the holder of a Fish Processor's Licence or an Aquaculture Licence (Marron).

Aquaculture Production

Production current year (2005/06): 54 tonnes

Number of producers for year 2005/06: 178

In comparison to 2004/05, this represents a decrease of 11 productive farms. However there are still more licensed marron farms than farms for any other form of aquaculture in WA.

Production projection next year (2006/07): 60 tonnes

Marron production decreased by 3.5% in 2005/06. This is due to 11 farms ceasing production last year. Supply of marron is still insufficient to meet market demand, resulting in an increase in the value/kg of marron (Marron Farming Figure 1).

A significant number of purpose-built marron farms have been developed, and other existing farms have constructed more ponds. This should progressively contribute to expansion in production in WA, as will ongoing improvements in husbandry and selective breeding to improve growth rates.

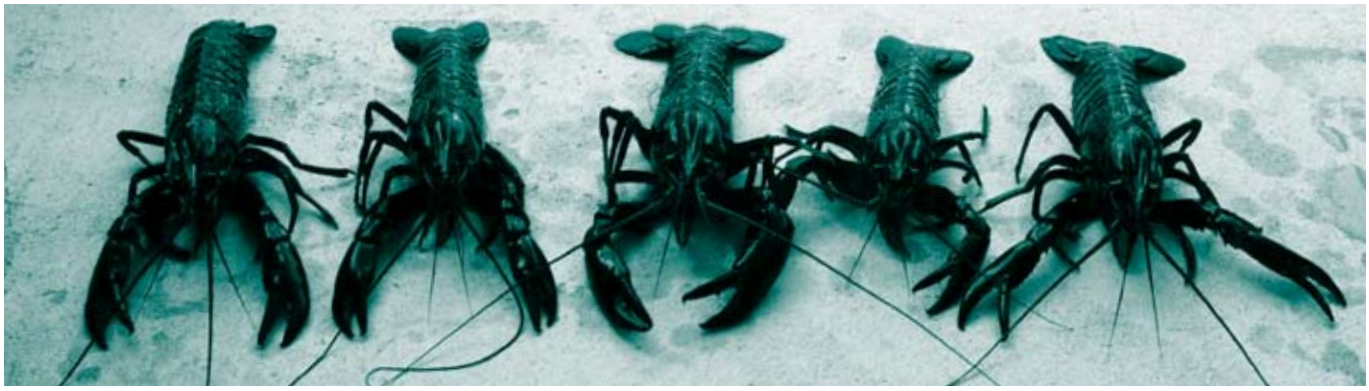
However, while some farmers have recognised the need for better stock management and feeding practices, production may not improve at some farms unless efficient aeration techniques are used to support increased pond biomass. Commercialisation of faster-growing marron from Department of Fisheries selective breeding research will address the industry problem of poor broodstock selection which has led to a steady decline in growth rates.

Ecosystem Effects

Marron farms present a low risk to the environment because there is relatively little water discharged from these facilities. The nutrient 'input' from feeds, per unit pond area, is also relatively low because of the use of efficient feeding strategies and feeds of relatively low nutrient content, particularly nitrogen and phosphorus.

The Department of Fisheries recommends treating discharge water using settlement and reed ponds to improve the quality of this water for discharge or re-use on the farm. A demonstration facility, including settlement and reed ponds, has operated well at the Pemberton Freshwater Research Centre and this technology is now being adopted by industry.

As marron farms currently experience few disease problems, they pose little immediate threat to the health of wild stocks.



Two types of marron farming licence are available.

Social Effects

There are more marron farms than any other type of licensed aquaculture venture in Western Australia. The industry has the potential to provide significant regional employment, as production increases.

Increasingly, marron farms are being constructed to allow diversification of farm usage away from other, sometimes unprofitable or less profitable, agricultural uses.

Economic Effects

Estimated annual value (to producers) for year 2005/06: $1.4 million

(Note that this estimate excludes ornamental marron.)

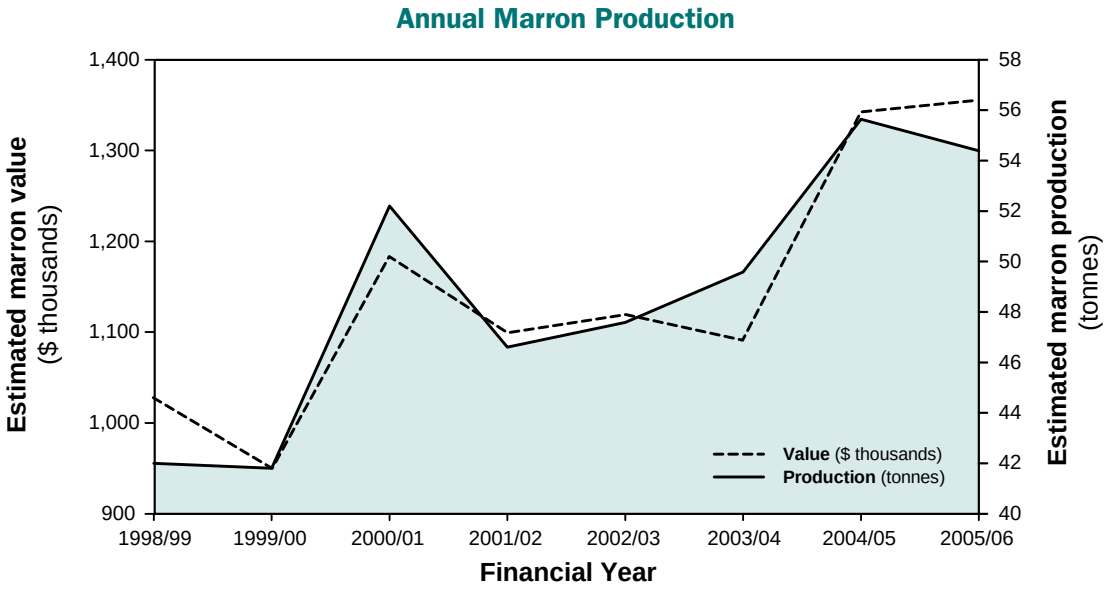
The value of marron production remained stable between 2004/05 and 2005/06. Even though there has been considerable competition with other luxury crustacean products, ex-farm market price for marron has risen to an average farm gate value of almost $25/kg in 2005/06 (Marron Farming Figure 1).

External Factors

The development of a new farm to full production usually requires around 3 years and, for most farms, production is influenced by rainfall. The reliance upon often inconsistent rainfall to fill dams on commercial farms has contributed to renewed interest in both the utilisation of irrigation dam water on the south-west coastal plain for marron farming and the use of water re-use systems.

An external factor of concern to the marron industry is the potential for agricultural chemicals, applied by aerial spraying or use of ground-based 'misters', to impact on adjacent marron farms or natural waterways. The rapid expansion of tree farms and vineyards in the southern inland bioregion has heightened these concerns.

A literature search by research staff has indicated limited relevant information on the toxicity of the chemicals used, particularly alpha-cypermethrin, to freshwater crayfish. Joint codes of conduct are needed with such industries to help minimise the risks.



MARRON FARMING FIGURE 1
Estimated marron production and value from 1998/99 to 2005/06.

Yabby Farming Status Report

C. Lawrence and S. How

Industry Description

Production method

Yabbies (*Cherax albidus*) are farmed in stock watering dams. In these dams yabbies require minimal management other than supplementary feeding and harvesting by baited traps. Although yields per dam are relatively low, the combined production from a large number of farmers results in a significant form of farm diversification.

Production areas

Yabbies are an introduced species and so, for translocation reasons, the licensed commercial yabby farming industry is restricted to the drier inland agricultural areas of the south-west. Commercial yabby farming is only permitted to the north and east of the 'yabby boundary', which approximately follows the direct line from Perth to Albany.

Management arrangements

Licence approvals are required for yabby processors and commercial harvesters. Agricultural farms may sell yabbies without a licence to licensed farmers/processors.

Aquaculture Production

Production current year (2005/06): 66 tonnes

Number of producers for year 2005/06: 17

(This number refers to licensed farmers or processors. Note most farmers do not require licences.)

Production projection next year (2006/07): 75 tonnes

While yabby production has not recovered from the major decline in 2001/02 that coincided with low rainfall and high commodity prices, it has stabilised at a level of around 60 – 80 t/year (Yabby Farming Figure 1).

Ecosystem Effects

Yabby farming presents a low risk to the environment because negligible amounts of water are discharged from farm dams, whose primary purpose is the provision of water for stock. Nutrient inputs into dams are also very low because of the low feed rates used.

Because the yabby farming industry is located away from the marron zone, it poses little threat to marron fisheries, which are more at risk from landholders within the marron zone stocking yabbies in dams on a non-commercial basis.

Research has also shown that the current commercial yabby stocks are not destructive burrowers, but rather build shallow burrows. However, yabbies can suffer from the microsporidian *Thelohania* and this may pose a risk to native freshwater crayfish stocks if they escape from farm dams.

Social Effects

On-farm management of yabby stocks is generally undertaken by women and teenagers who, through yabby harvesting, generate a small but valuable income for a large number of agricultural households. Yabby processors also provide useful regional employment.

Economic Effects

Estimated annual value (to producers) for year 2005/06: $1.0 million

The value of yabby production decreased by 12% in 2005/06. However, even in the presence of competition from other crustaceans used for 'luxury' food, the market price for yabbies has increased to an average farm gate value of $15/kg, most likely due to a combination of reduced supply and the farming of larger, and therefore more valuable, yabbies.

Despite labour shortages, farmers have managed to harvest yabbies through the winter, resulting in a more even distribution of production throughout 2005/06.

External Factors

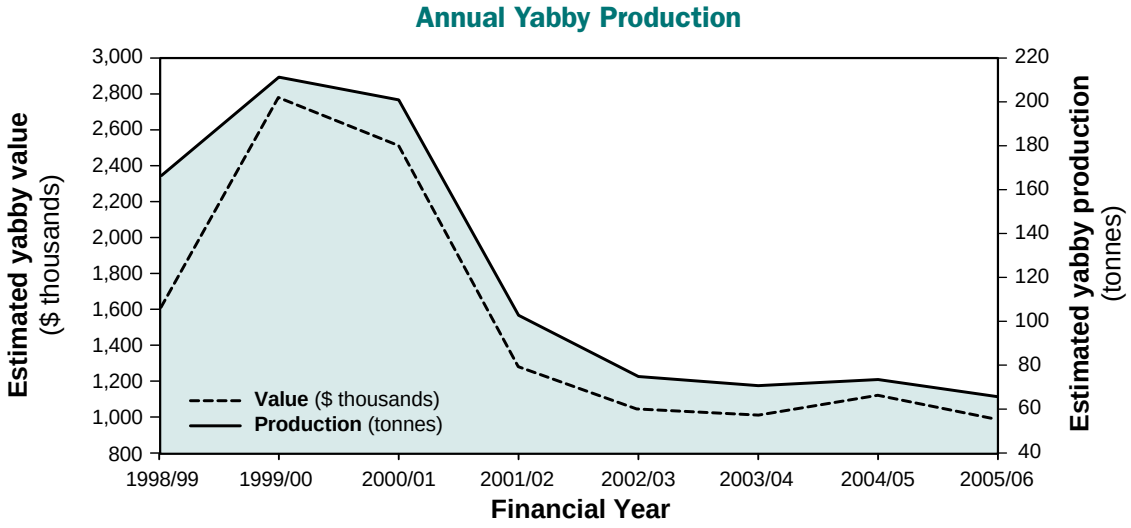
Production deceased slightly in 2005/06. This is most likely due to the inability to trap yabbies due to labour shortages in the wheatbelt region as a result of increased employment opportunities in the lucrative mining and building sectors of the WA economy.

Commodity prices for alternative products from wheatbelt farms have a significant influence upon yabby production. Drought is also a key issue, as most farmers rely on surface run-off to fill stock watering dams.

Owing to the lower farm gate value for yabbies ($15/kg compared to $24/kg for marron), few purpose-built yabby ponds are used. As dam volumes decline, more intensive management can sustain yields, but eventually the yabbies are forced to use the dam floor in shallow water, where organic matter accumulates and creates an unfavourable environment for their survival, particularly on warm days.

Whether yabby production continues to increase or decrease depends largely upon commodity prices received by farmers for other produce (i.e. crops and livestock), the high value of the Australian dollar, and the availability of labour in rural communities. When commodity prices, the Australian dollar and/or cost of labour is high, there is less economic incentive for farmers to trap yabbies to supplement farm income.

The yabbies therefore remain in the dams until commodity prices, the value of the dollar or labour costs drop or crops are poor. When this situation occurs, yabby production increases, as more farmers start harvesting and selling yabbies from their dams.



YABBY FARMING FIGURE 1
Estimated yabby production and value from 1998/99 to 2005/06

Trout Farming Status Report

C. Lawrence and S. How

Industry Description

Production methods

2 species of trout are produced in Western Australia – rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*).

Rainbow trout are farmed in purpose-built ponds and tanks for the food market. In addition, both rainbow trout and brown trout are stocked in large gully dams and ponds for 'pay fishing' by recreational fishers and tourists.

More recently, some farmers located in salt-affected regions have trialled trout production in ponds supplied with saline groundwater or installed floating cages on saline waterbodies.

Production areas

Intensive culture of trout is confined to the lower south-west by summer water temperatures and limited by the need for a large throughput volume of water. Potential exists to expand production by the utilisation of irrigation dam water in transit to agricultural farms on the south-west coastal plain. In addition, inland farmers with saline water are evaluating the performance of rainbow trout, stocked as yearlings and grown out in dams, ponds or cages during cooler months.

Management arrangements

An aquaculture licence is required by trout producers, though not by small inland saline farmers. Translocation approval can also be a requirement.

Aquaculture Production

Production current year (2005/06): **17 tonnes**

Number of producers for year 2005/06: **13**

Production projection next year (2006/07): **25 tonnes**

In 2005/06, while trout production decreased 22%, the value of the industry increased by 15% (Trout Farming Figure 1). This increase in value can be largely attributed to a 45% increase in the value/kg obtained by farmers as a function of supply struggling to meet demand.

Ecosystem Effects

Trout farming is considered to present a low-to-medium risk to the environment. Farms producing more than 1 t of fish annually require discharge licensing, including monitoring of water quality.

The Department of Fisheries recommends use of swirl separators to improve the quality of this discharge prior to release or re-use. A demonstration facility, including a swirl separator, settlement pond and reed pond for stripping nutrients, has operated well at the Department's Pemberton Freshwater Research Centre (PFRC).

Inland saline trials usually involve little discharge. However, farms developed in the future to utilise high flow rates of pumped underground saline water for rearing trout in ponds or raceways can use swirl separators to improve water quality prior to reuse or discharge.

Trout farms pose a low risk to public waterways, as inadvertent release of large numbers of fish from land-based farms is unlikely and there are few localities in Western Australia where escapees could reproduce.

Social Effects

Recreational pay fishing for trout is a significant contributor to the tourism industry in the south-west region. Inland saline trout production may have potential for improving returns from salt-affected land, but production is still highly dependent on rainfall.

Economic Effects

Estimated annual value (to producers) for year 2005/06: $172,000

(Note this estimate includes the value of yearlings provided to inland saline farmers but not production by these farmers, as the smaller farms are not licensed and hence do not provide aquaculture returns.)

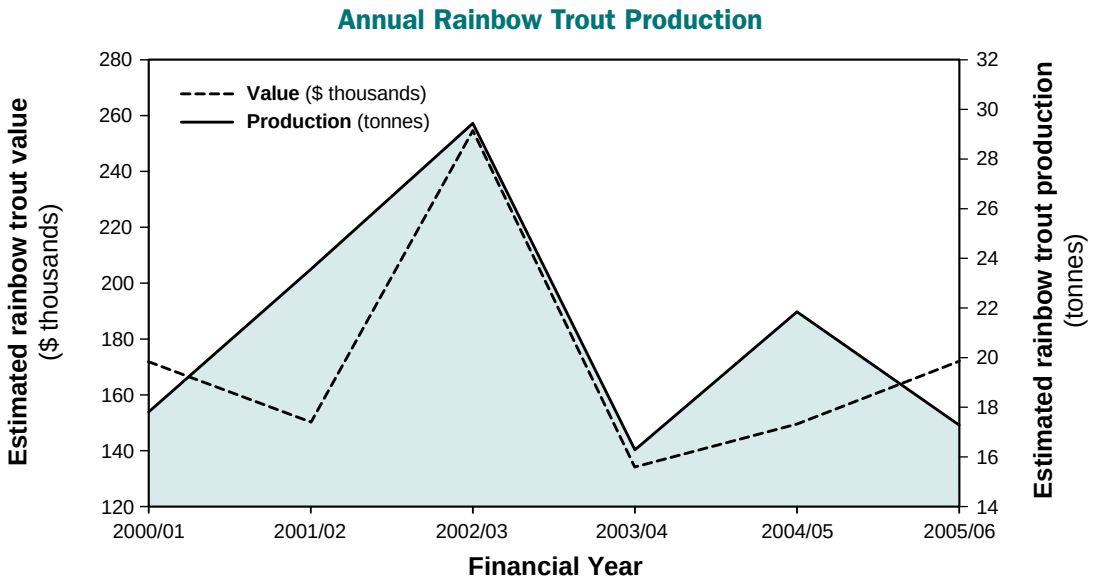
The value of rainbow trout production increased by 15% in 2005/06.

Internationally, prices for farmed trout and salmon (salmonids) are being depressed by massive increases in production, particularly in Norway and Chile. Domestic trout prices, particularly for frozen product, are restricted by competition from large-scale producers, especially by those in Victoria. Nonetheless, distance from other producers provides some degree of protection for the Western Australian industry from national and global suppliers.

The PFRC trout hatchery provides support for the commercial trout farming industry as a by-product of producing trout fry for recreational stocking programs. Fry and yearlings are also supplied to private buyers who stock private dams within tourist complexes.

Trout sold via tourist fishing ventures do not usually appear within the commercial production records, although they add significant commercial benefits to that sector and the regional economy. There is a trend for major trout producers to move towards tourist fishing ventures, effectively 'adding value' to the trout grown in these systems.

While there is no reliable method of estimating the value of this sector, its tourism value within the south-west may exceed that of the trout grown for the general fish market trade.



TROUT FARMING FIGURE 1
Estimated rainbow trout production and value from 2000/01 to 2005/06.

Silver Perch Farming Status Report

C. Lawrence and S. How

Industry Description

Production method

Silver perch (*Bidyanus bidyanus*) are farmed in purpose-built earthen ponds. These ponds are equipped with aeration, water supply and a drain to facilitate harvesting.

Production areas

Silver perch is an introduced species from the Murray-Darling region and so, for translocation reasons, the licensed commercial silver perch farming industry is restricted to individually-approved sites.

Management arrangements

A licence is required to farm silver perch and approval is based on assessment of individual sites, particularly in relation to the risk of escape into natural waterways.

Aquaculture Production

Production current year (2005/06): **21 tonnes**

Number of producers for year 2005/06: **10**

Production projection next year (2006/07): **30 tonnes**

While the industry was limited by availability of imported juveniles in earlier years, local juvenile production has now increased to meet demand. This is largely due to the adoption by industry, with the assistance of the Department of Fisheries, of spawning techniques developed by researchers in New South Wales.

Silver perch production increased by 3% this year. However the value of this sector increased by 15%. This increase in value/kg can be largely attributed to a function of supply struggling to meet demand after 3 farms ceased production in 2004/05, with a corresponding 48% decrease in production that year.

Ecosystem Effects

Silver perch farming presents a low risk to the environment, as much less water is discharged from these farm dams than from an intensive trout farm. Farms producing more than 1 t of fish annually require discharge licensing, including monitoring of water quality.

The Department of Fisheries recommends use of swirl separators to improve the quality of this discharge prior to release or re-use. A demonstration facility, including a swirl separator, settlement pond and reed pond for stripping nutrients, has operated well at the PFRC.

Silver perch may pose a risk to native fauna stocks if they escape from farm dams and, for this reason, individual site inspections can be required prior to licensing a farm.

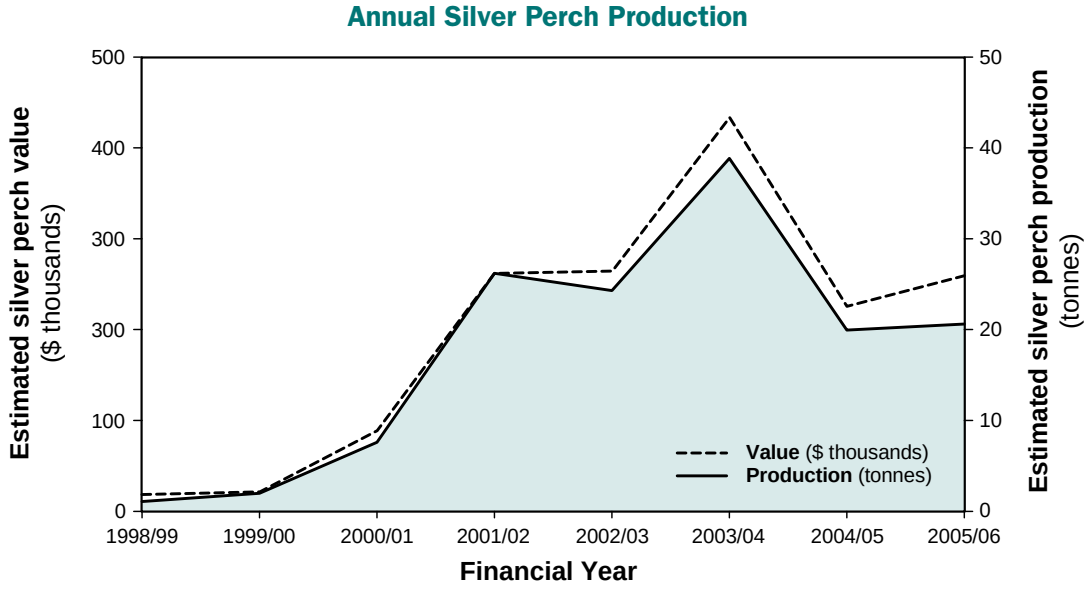
Social Effects

Silver perch farming allows diversification of farm usage away from other, sometimes unprofitable, agricultural uses.

Economic Effects

Estimated annual value (to producers) for year 2005/06: **$260,000**

The value of silver perch production increased by 15% in 2005/06.



SILVER PERCH FARMING FIGURE 1
Estimated silver perch production and value from 1998/99 to 2005/06

Ornamental Fish Farming Status Report

C. Lawrence and S. How

Industry Description

Production methods

Dedicated small ponds and aquaria are used to breed ornamental finfish and crustaceans and rear juveniles for live sales.

Production areas

Production occurs throughout Western Australia, but is mainly focused in the Perth metropolitan areas adjacent to the main markets. Both native and non-native species are produced.

Management arrangements

Specific licence approvals are needed for commercial production.

Aquaculture Production

Production current year (2005/06): **107,000 fish**

Number of producers for year 2005/06: **20**

Production projection next year (2006/07): **100,000 – 300,000 fish**

Annual commercial production recorded for this sector indicates considerable volatility in production and prices for major aquarium fish groups (Ornamental Fish Farming Figure 1). Such fluctuations can result from the production and marketing strategies of individual farms.

This year goldfish production decreased by 16%, with a corresponding 11% decrease in the value of this sector. Ornamental koi carp production decreased by 57%, however the value of koi production increased by 9%, indicating that farmers were producing fewer but more valuable fish.

Production of ornamental non-native fish increased by 117%, but value decreased by 5%.

Production of ornamental native fish and crustaceans increased by 13%, largely due to continued growth in the production of ornamental blue marron. Blue marron are now the main native ornamental species produced.

Larger farms inter-state may compete intensively with local producers, or if inter-state production is depressed for key species, an inter-state marketing opportunity is created for local producers. Since 2001/02, ornamental marron have been included in this production sector, and these are now a significant component of the total value of production for the sector.

Ecosystem Effects

Ornamental fish farming is considered to present a low risk to the environment because there is relatively little water discharged from ornamental fish farms. Operators are required to ensure that stock does not escape into natural waterways.

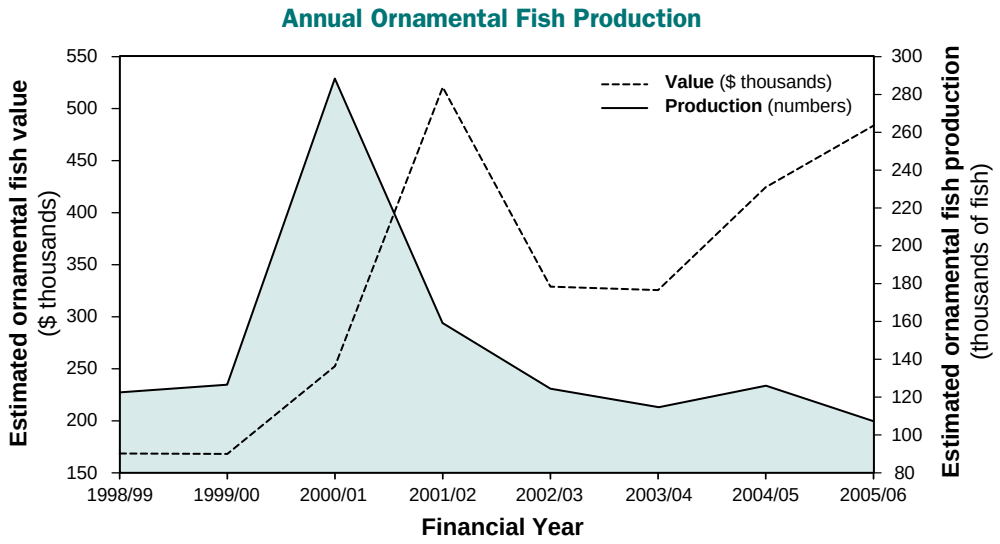
Social Effects

This industry provides part-time employment for numerous small-scale producers and has potential as a form of farm diversification for future entrants to the industry.

Economic Effects

Estimated annual value (to producers) for year 2005/06: **$484,000**

The value of ornamental fish production increased by 14% in 2005/06.



ORNAMENTAL FISH FARMING FIGURE 1

Estimated ornamental fish production and value from 1998/99 to 2005/06. (The ornamental fish category includes ornamental native and non-native fish, koi carp and goldfish. Ornamental crustaceans are included in the production years 2001/02 to 2005/06.)

COMPLIANCE AND COMMUNITY EDUCATION

Fisheries and Marine Officers (FMOs) based in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Rockingham, Mandurah, Bunbury, Busselton, Albany and Esperance conduct recreational fishing compliance and education activities in the Southern Inland bioregion.

The Volunteer Fisheries Liaison Officer (VFLO) program is a vital education mechanism in the Southern Inland bioregion. Although the VFLO program is based in major coastal centres, it is used particularly prior to – and during – the opening of the marron season to conduct peer-to-peer education.

The highest risk of non-compliance in the Southern Inland bioregion is within the recreational marron fishery. As the marron season lasts for just 16 days, the risk of illegal fishing during the closed season (February-December) is extremely high.

Increasingly, dams and catchment areas once open to marroning are being closed by Water Corporation, which presents further challenges to ensure compliance in these areas. During the open marron season, illegal activities (such as the use of scoop and drop nets in 'snare only' waters, take of undersize marron, and adherence to possession limits in trophy waters such as Harvey Weir) are a focus of compliance activities. FMOs continue to carry out joint initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites.

The other main fishery in the Southern Inland bioregion is the recreational trout fishery. Compliance and education in this fishery focuses on the illegal use of baits in 'artificial lure-only' waters, exceeding bag limits, fishing without a current freshwater or umbrella recreational fishing licence, and the taking of trout during the closed season.

Compliance patrols for the other recreational fisheries in these inland areas, as well as inspections of fish wholesale and retail premises, also form part of the compliance activities conducted by FMOs in the southern bioregion.

Activities during 2005/06

During 2005/06, FMOs delivered 1,982 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – a significant increase on the previous year (Southern Inland Compliance Figure 1).

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 2,477 field contacts with recreational fishers. During the year, 30 infringement warnings and 20 infringement notices were issued and 35 prosecutions were instigated.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The recreational mobile patrol in this region again greatly assisted with service delivery to the marron fishery. Officers continued to conduct joint patrols with police to address the issue of the theft of marron from dams on private properties and from licensed aquaculture dams.

The 2006 marron season was a very busy period for compliance staff, particularly with above-average rainfall throughout the catchments in the Southern Inland bioregion. The compliance activities for the 2006 marron season were developed from a risk assessment process, which identified non-compliant 'hot-spots'.

Consultation was conducted on a new 5-year management strategy for the marron fishery.

Aquaculture compliance activities are also major focus in the Southern Inland bioregion for FMOs. Activities manly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and joint patrols with police to investigate theft from farm dams.

During 2005/6, FMOs made contact with 161 commercial fishing or aquaculture operations in the bioregion (Southern Inland Compliance Table 1 – inspections of retail outlets are classified as commercial fishing operations in this context).

The Department of Fisheries' southern region Community Education Officer is a member of the Margaret River Marron Recovery Team. In consultation with department research staff, other government agencies and the Cape-to-Cape Catchments Group, a community fish-out event was conducted in November 2005 and Margaret River Marron protection signs were produced. In December 2005, department staff met with representatives from Water Corporation and the Department of Environment and Conservation to discuss and coordinate compliance issues in this area.

Initiatives for 2006/07

A new 5-year marron fishery management strategy is being implemented for the 2007 season. Regulation changes are extensive including the introduction of a possession limit, new carapace minimum size limit, closure of Shannon River to marroning, drop nets allowed within Warren River National Park, gear able to be transported downstream of the boat landing on the Donnelly River, extension of the season to 23 days, and the introduction of the Hutt River as another 'trophy water'. The Department of Fisheries' southern region staff will be installing a range of new signage, distributing new 80mm/90mm gauges and communicating changes to marron fishing rules through local media.

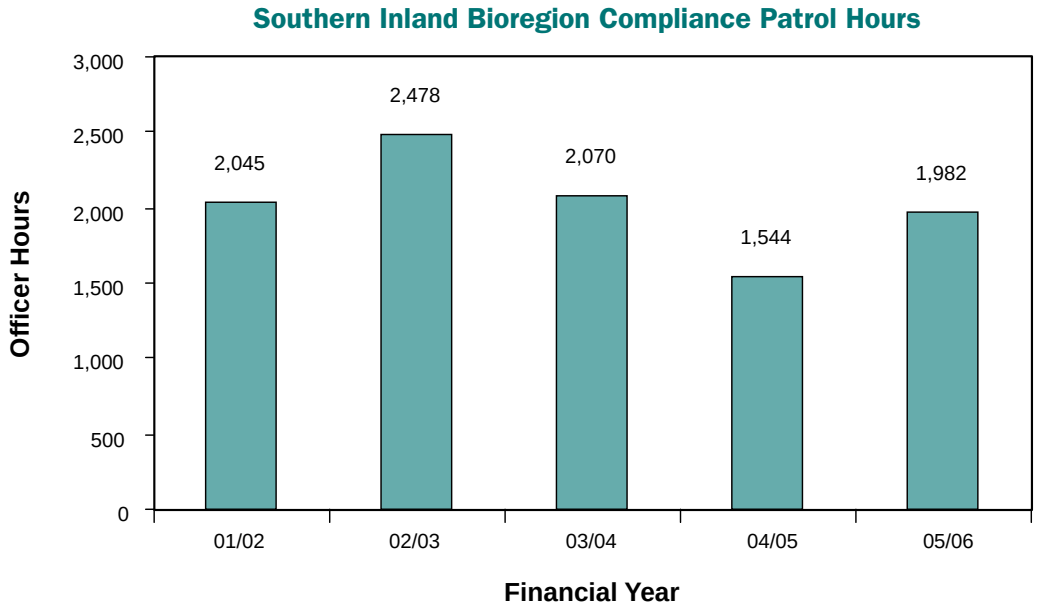
Poaching of wildstock marron during the closed season and theft of marron from dams on private property and aquaculture facilities remains a focus of compliance activities. District FMOs and the recreational mobile patrol will continue to work in partnership with local police to develop joint initiatives, facilitate the transfer of intelligence information and respond to compliance situations.

The VFLO program is to be instrumental in delivering information to marron fishers and campers during the opening of the marron season at the Collie River and through the Blackwood

River basin. During the season, the southern regional Community Education Officer will run an interpretive workshop for marron in Margaret River, involving around 30 community participants.

The conservation project for the critically-threatened Margaret River marron is being continued, with education and compliance outcomes in the southern inland region. New signage is being maintained and a landholder monitoring program is continuing under the supervision of the Department of Fisheries' Research Division's freshwater scientist.

The southern regional Community Education Officer will be conducting several school education activities promoting awareness of endemic freshwater fish and crustaceans of the south-west and highlighting potential threats, including feral fish species. Some of these activities are being carried out in partnership with Ribbons of Blue/Waterwatch and natural resource management groups to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species. A trial community fish-out of goldfish from Barrabup Pool in Nannup will be carried in February 2007.



SOUTHERN INLAND COMPLIANCE FIGURE 1

In this figure, "On Patrol" Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland bioregion over the previous 5 years. The 2005/06 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.

SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2005/06 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,982 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	161
District Office contacts	0
Infringement warnings	0
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	2,477
District Office contacts	2,612
Infringement warnings	30
Infringement notices	20
Prosecutions	35
District Office contacts	0
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	227
Fishwatch reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine protected areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** Fishwatch calls relating to the Southern Inland bioregion are not recorded, as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Southern Inland bioregion will be included in both the South Coast and West Coast bioregion totals.

State-wide

The Marine Aquarium Fish Managed Fishery targets more than 250 species of fish under its management plan.

FISHERIES

Marine Aquarium Fish Managed Fishery Status Report

S.J. Newman and M. Cliff
Management input from S. Brand-Gardner

Fishery Description

The Marine Aquarium Fish Managed Fishery (MAF) targets more than 250 species of fish under its management plan. By way of endorsement, fishers also take coral, algae, live rock, live sand and invertebrates. It is primarily a dive-based fishery that uses hand-held nets to capture the desired target species from boats up to 8 m in length.

While the MAF operates throughout all Western Australian waters, catches are relatively low in volume, due to the special handling requirements of live fish. Fishing operations are heavily weather-dependent, owing to the small vessels used and the potentially hazardous conditions (e.g. waves and swell) encountered. In addition, human constraints (i.e. the physiological effects of decompression) limit the amount of effort exerted in the fishery, the depth of water and the extent offshore to where collections can occur.

Governing legislation/fishing authority

Commercial

Marine Aquarium Fish Management Plan 1995
Marine Aquarium Fish Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation (WTO)

Recreational

Fish Resources Management Act 1994
Fish Resources Management Regulations 1995 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry

Recreational

Recreational Fishing Advisory Committee (RFAC)

Boundaries

The MAF operates in Western Australia's state waters, spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km.

During the past 3 years the fishery has been active in waters from Esperance to Broome, with popular areas being around Dampier, Exmouth, Perth and Albany.

Management arrangements

This fishery is managed primarily through input controls, in the form of limited entry to the fishery, and permanent closed areas.

There are 13 licences in the fishery and in most years all licences are used. In 2006, 11 licences were operated in the fishery.

Licensees are not permitted to operate within any waters closed to fishing (e.g. Rowley Shoals, Reef Protected Areas, sanctuary zones). The fishery is permitted to operate in general-purpose zones of marine parks for the collection of fish and some invertebrates (usually excluding coral and live rock). Fishing is also prohibited on Cleaverville Reef (to exclude the take of coral and associated organisms).

Fish caught in this fishery may not be used for food purposes, and operators are not permitted to take species covered by other specific commercial management arrangements or management plans.

The MAF is permitted to take most species from the syngnathid family (seahorses and pipefish), which are listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, there is a total ban on the take of leafy seadragons (*Phycodurus eques*).

Research summary

Information provided by the fishery in the form of statutory monthly catch and effort returns is used as the basis to provide research advice for fisheries management. Statutory catch and effort reporting at the fine spatial scale of 10 minutes of latitude and longitude commenced in September 2004.

Retained Species

Commercial landings (season 2006): 28,203 fish

Collectors in this ornamental fishery can earn a high return from the capture of very small quantities of individuals. Therefore, the catches are small in comparison to the more common, food-fish fisheries.

Fishers report the level of catch (kg or numbers) by species or species group. A summary of the 2006 levels of catch is provided in Marine Aquarium Fish Table 1. The reported landings of aquarium fish for 2006 are similar to those reported in 2005.

Recreational catch: Not assessed

There is no documented recreational fishery. If members of the public wish to collect specimens for their own private aquariums they are permitted to do so, but are restricted to normal recreational bag limits and, for some species, size limits. There is a complete ban on the recreational take of coral, live rock and totally protected fish such as leafy seadragons.

Fishing effort/access level

Effort in the fishery has been relatively stable over the past 3 years at an average of 806 days fished, with nearly all licensees reporting some level of activity. Effort in the fishery is concentrated in discrete areas adjacent to the limited number of boat landing sites along the Western Australian coastline.

Given that the specimens are collected for a live market, licensees are restricted in terms of the quantities that they can safely handle and transport (for example, by boat to shore, by vehicle to

the holding facility and then on to the retailer) without impacting on the quality of the product.

The size of the holding facility and access to regular freight and infrastructure services (such as airports, particularly in the remote northern parts of WA) restricts the levels of effort that can be expended in the fishery at any given time.

Stock Assessment

Assessment complete: **Preliminary**

Breeding stock levels: **Adequate**

The operating extent of the fishery is low relative to the widespread distribution of the plethora of species targeted. No other fisheries exploit these species and therefore there is virtually no potential for impact on breeding stocks.

Non-Retained Species

Bycatch species impact: **Negligible**

Divers in the MAF use hand-held nets to capture the desired target species. As a result of these highly selective fishing methods, there is no bycatch in this fishery.

Protected species interaction: **Negligible**

The MAF is permitted to take syngnathids (excluding leafy seadragons) and has retained at least 14 species of syngnathids, although only 5 are generally targeted: the Western Australian seahorse (*Hippocampus elongatus*), the western spiny seahorse (*Hippocampus angustus*), common or weedy seadragon (*Phyllopteryx taeniolatus*), knobby seahorse (*Hippocampus tuberculatus*) and spotted pipefish (*Stigmatopora argus*).

These species are widely distributed in Western Australian waters and occur in both shallow and deep waters in both urban and remote locations. It is estimated that 80% of populations occur in areas that receive little to no impact from fishing.

While, in general, some species of syngnathids may be vulnerable to overfishing because they reproduce relatively slowly, have low rates of dispersal and are highly habitat-dependent, there is no evidence of decline for any syngnathid species retained by the MAF (Pogonowski *et al.* 2002).

Ecosystem Effects

Food chain effects: **Negligible**

Habitat effects: **Negligible**

Social Effects

Under clauses 9 and 10 of the Marine Aquarium Fish Management Plan 1995, a licensee (or their nominated operator) may fish with 2 nominated divers, thus permitting up to 3 persons to fish on each licence at any one time. A recent survey has indicated that at least 69 people are directly employed in the fishery.

Another aspect to the social effects of this fishery is the increased awareness of marine ecosystems through the provision of specimens for public and private aquariums.

Economic Effects

Estimated annual value (to fishers) for year 2006: **Not assessed**

Fishery Governance

Target catch (or effort) range: **Not assessed**

Current fishing (or effort) level: **Acceptable**

The current effort level in the fishery is constant from year-to-year and the operating extent of the fishery is low relative to the widespread distribution of the plethora of species targeted. Therefore, the current level of fishing activity is considered acceptable.

New management initiatives (2006/07)

The management arrangements for the MAF are currently under review. Among the changes under consideration is more equitable access for all licensees to collect coral and 'live rock'.

The Australian Government Department of Environment and Water Resources has recently approved the MAF as environmentally sustainable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* and therefore declared the fishery as an approved Wildlife Trade Operation (WTO) for 3 years.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2006.

Common Name	Quantity (numbers)	Weight (kg)
Fish	28,203	
Syngnathidae	1,116	
Hermit crabs	160,774	
Invertebrates	136,331	
Algae		722
Hard coral		4,552
Soft coral		2,289
Living rock, living sand, sponge, other		13,243

Specimen Shell Managed Fishery Status Report

A. Hart and M. Cliff
Management input from S. Brand-Gardner

Fishery Description

The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale.

Up to 550 different shellfish species are collected by hand by a small group of divers operating from small boats in shallow coastal waters. While the fishery covers the entire Western Australian coastline, there is some concentration of effort in areas adjacent to population centres such as metropolitan Perth, Bunbury, Albany and Port Hedland.

Governing legislation/fishing authority

Specimen Shell Management Plan 1995
Specimen Shell Managed Fishery Licence
Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* (Export Exemption)

Consultation process

Meetings between the Department of Fisheries and industry

Boundaries

The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath.

Management arrangements

This fishery is managed through input controls in the form of limited entry, gear restrictions and permanent closed areas. The primary controls in the fishery are natural – depth, time and tide.

There are 32 licences in the fishery, though some of these are completely inactive and many more are fished only rarely. A maximum of 2 divers is allowed in the water per license at any one time and specimens may only be collected by hand.

There are a number of closed areas where the SSF is not permitted to operate, for example within various marine parks and aquatic reserves and other closed waters such as Reef Observation Areas and Fish Habitat Protection Areas. Much of the west side of North West Cape and the Ningaloo Marine Park are prohibited areas for the fishery. The exclusion of Marmion Marine Park in the Perth metropolitan area is also important because of its populations of 2 cowrie species.

Some molluscs – such as abalone, mussels, scallops and pearl oysters – form the basis of other commercial fisheries and are subject to separate management plans. The SSF is not permitted to take any species for which separate management arrangements exist.

A comprehensive Ecologically Sustainable Development assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The only issue identified through this process related to the breeding stock levels of specimen shell species. Boxed text in this status report provides the annual assessment of performance for this issue.

Some minor-scale collection of dead shells is also undertaken above the high water mark by collectors operating under the authority of a commercial fishing licence, mainly for sale into the souvenir, pet supply and hobby craft markets. However, this does not form part of the Specimen Shell Managed Fishery.

Research summary

Current fishery-dependent data collection systems monitor the catch (species-specific), effort and catch rates for the fishery. Fishers within the SSF provide monthly returns under the statutory catch and effort system (CAES). These returns contain information on catch (species, numbers and spatial area), and days and hours fished by month and year.

In August 2004, fishers commenced reporting using 10 x 10 nautical mile (nm) grids rather than 60 x 60 nm grids, providing a finer spatial scale to the data collected. At the same time, they began collecting additional information on sightings of the 8 mollusc species identified as potentially 'vulnerable.' These data are used as the basis to provide research advice for fisheries management.

Retained Species

Commercial landings (season 2006): 19,074 shells

Landings

In 2006, the total number of specimen shells collected was 19,074, distributed over a wide range of species. In the past 5 years, more than 535 separate species of molluscs have been collected, with an average of more than 200 species per year – the majority in very low numbers.

There is some focus of effort on mollusc families most popular with shell collectors, such as cowries, cones, murexes and volutes. For example, *Cypraea venusta*, *C. marginata and C. friendii* make up approximately 15% of all shells collected in 2005 and 2006. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

(Note that reported total landings exclude *Trochus hanleyanus* taken for other purposes.)

Fishing effort/access level

Although there are 32 licences in the fishery, only 6 of these are regularly active. Effort has been stable over the past 5 years, at an average of around 1,200 days fished. In 2006, 1,027 days were fished.

Recreational catch: Not assessed

Shell collecting is a popular recreational pastime, and members of the public are permitted to collect shells for their private collections. The recreational catch, while unknown, is considered

to be declining, as evidenced by declining membership in shell collecting associations.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

During the 2006 season the catch rate was approximately 19 shells per day (excluding *Trochus hanleyanus*).

Ponder and Grayson (1988) examined the specimen shell industry on a nationwide basis, rating vulnerability to over-exploitation on the basis of species biology, accessibility to collection, and rarity. Species collected in Western Australia which were identified by Ponder and Grayson as potentially vulnerable comprised 6 cowries and 2 volutes (*Amoria* spp.).

'Shell sighting' is a new abundance category reported on for the second time this year. It is a measure of the population of vulnerable shells that is observed but not taken, and provides evidence for the breeding stock being conserved each year. Of the 8 vulnerable species, an overall average of approximately 61% in 2005 and 71% in 2006 of the shells sighted were not harvested.

The figures for sighted versus taken vulnerable shells from 2005 have been reworked, however as theses figures are not kept properly by all licencees it is anticipated that current averages are an overestimate.

The reporting of catch and effort on the finer spatial scale of 10 x 10 nm blocks from August 2004 is also providing more accurate information on the distribution of certain species.

All species collected in Western Australia, including the 8 prized species, occur over wide geographic ranges (hundreds or thousands of kilometres) and wide depth ranges (up to 200 m) where a substantial portion of the population cannot be collected.

Even in shallow waters, many localities cannot be fished because of the lack of access to the beach and the small boats used, and collecting is prohibited in many of the more easily reached areas which are now in marine parks and reserves. Additional protection is afforded by the fact that collectors will ignore any specimens with slight visual imperfections, but their reproductive potential in the population remains undiminished. In summary, it is considered that the fishery has very little likelihood of impacting on breeding stocks.

The performance measures for the fishery relate to the maintenance of breeding stocks as indicated by catch levels and catch rates. In 2006, the catch level of approximately 19,000 shells and catch rate of 19 shells/day were both within the ranges set, i.e. 10,000 – 25,000 shells and 10 – 40 shells/day.

Non-Retained Species

Bycatch species impact: **Negligible**

There is no bycatch in this fishery owing to the highly selective fishing methods.

Protected species interaction: **Negligible**

The fishery had no reported interactions with protected species during 2006. Reports of interactions with protected species are required to be recorded on monthly catch and effort returns.

Ecosystem Effects

Food chain effects: **Negligible**

Habitat effects: **Negligible**

Social Effects

Over the past few years, around 30 divers have operated occasionally in this fishery. However, with only 5 or 6 licences recording consistent activity, the number of people employed regularly in the fishery (licensees plus dive buddies) is likely to be around 12.

Economic Effects

Estimated annual value (to fishers) for year 2006: **Not assessed**

Fishery Governance

Target catch range: **10,000 – 25,000 shells**

A preliminary performance measure has been developed of a total annual catch range from 10,000 to 25,000 shells, which encompasses the range of catches taken from 2000 to 2003. This performance measure has been developed to ensure that any major change in the patterns of fishing is noticed and investigated. If it is triggered, this may not necessarily indicate any problem with the stocks, but rather fluctuations in the natural environment or market dynamics.

New management initiatives (2006/07)

The management plan for the SSF is currently under review. To address safety concerns of the licensees, a Ministerial Exemption was granted on 25 September 2006, which permits the use of up to 2 fishing boats of any size (provided that the boats are not used simultaneously) and the use of up to 2 assistant fishers who are not nominated on the Managed Fishery Licence (provided no more than 2 people are in the water at any one time).

In May 2005, the Australian Government's Department of Environment and Heritage found the fishery to be managed in an ecologically sustainable way and therefore included specimen shells on the list of exempt native specimens which serves to exempt the fishery from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of 5 years before reassessment.

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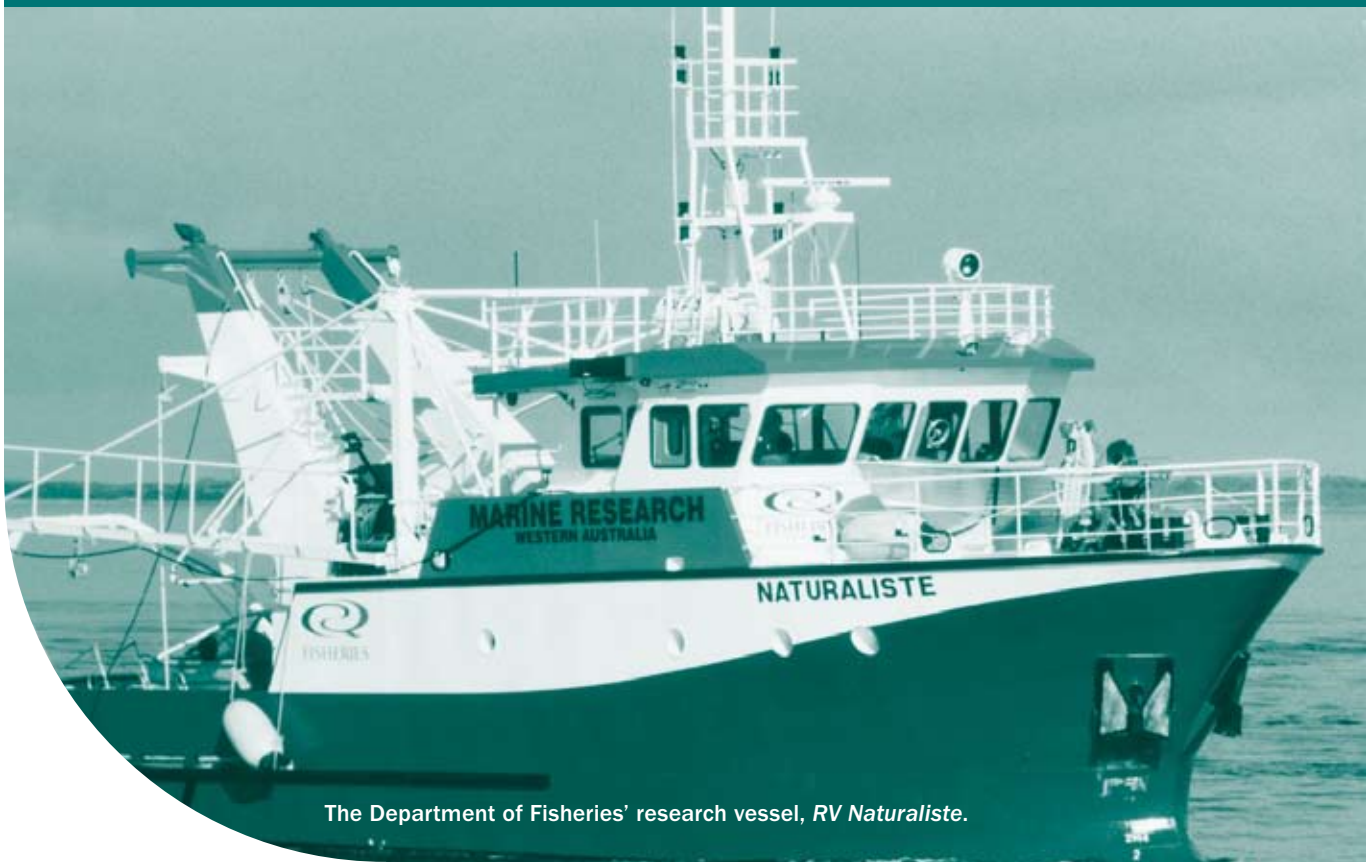

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APPENDIX 1

Stock status and catch ranges for major commercial fisheries

(Appendix 5 from Annual Report 2006/07[1])

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
West Coast Bioregion							
West coast rock lobster	Yes	Adequate	8,166 – 14,523	10,326	2005/06	Yes	The below-average catch is due to a poor puerulus settlement 3 to 4 years previously.
Roe's abalone	Yes	Adequate	112.7 (Q) (679 – 914 days)	98.4 (625 days)	2006	Yes	The stocks of Roe's abalone are considered to be higher than historical levels. However, increased fishing efficiency is considered the main cause for the reduced effort. The effort range will be reviewed.
Abrolhos Islands and mid west trawl	Yes	Adequate	95 – 1,830	205	2006	Yes	The annual recruitment (and therefore catch) of scallops is highly variable, depending upon environmental conditions. The low catch in 2006 was anticipated, due to low recruitment.
South west trawl	NA	NA	Not available	Prawns 8 Scallops <1	2006	NA	
Cockburn Sound crab	Yes	Inadequate	200 – 350	52	2005/06	No	This was the third consecutive year of low commercial catches in Cockburn Sound. A subsequent review of the stock status resulted in the whole fishery being closed for the 2006/07 season. A research program is currently underway to monitor if there has been a recovery.
Deep sea crab	Yes	Adequate	100 – 300 (crystal crabs)	188	2006	Yes	This is a developing fishery targeting a long-lived species.
Estuarine fisheries (west coast)	NA	NA	75 – 220 (Peel/Harvey only)	185	2006	Yes	Recent catches are stable but low relative to historic levels (pre-1990) due to substantial reductions in commercial effort in each estuary.
West coast beach bait	Yes	Adequate	60 – 275 (whitebait only)	231	2006	Yes	Yearly fluctuations in whitebait stocks are due to environmental conditions.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
West Coast Bioregion (Continued)							
West coast demersal scalefish	Yes	Inadequate	558 – 798	975	2005/06	No	The catch is above the target range for the fifth year. The recent stock assessment indicates that 2 key indicator species are being over-fished.
Gascoyne Coast Bioregion							
Shark Bay prawn	Yes	Adequate	1,501 – 2,330	1,559	2006	Yes	Tiger and endeavour prawns were within target catch limits and king prawns just below the target range, due to targeting of larger-sized prawns.
Exmouth Gulf prawn	Yes	Adequate	771 – 1,276	899	2006	Yes	All 3 major prawn species were within target catch limits.
Shark Bay scallop	Yes	Adequate	1,250 – 3,000	1,044	2006	Yes	The annual recruitment of scallops is highly variable. The catch in 2006 was below the target catch range, due to low recruitment levels and catch rate thresholds introduced this season which halted fishing for 2 months during the season, with a smaller meat size being caught once the fishing recommenced.
Shark Bay beach seine and mesh net	Yes	Adequate	235 – 335	229	2006	Yes	The total catch fell below the target range for the first time, due to low fishing effort. The tailor catch in recent years was affected by self-imposed imposed restrictions by the fishery rather than reduced abundance. Therefore, there are no concerns about these stocks.
Shark Bay snapper	Yes	Inadequate	338.3 (Q) (425-558 days*) * June – July	318.2 (416 days*)	2006	Yes	Despite the increased catch rate, based on an updated stock assessment a further review of management arrangements was undertaken and the TACC reduced to 277.3 t for the 2006/07 season to achieve the required rate of stock recovery.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
North Coast Bioregion							
Onslow prawn	Yes	Adequate	60 – 180	54	2006	Yes	Tiger and banana prawns were within target catch limits, whereas king and endeavour prawns were just below target ranges. Reduced effort was a factor with the lowest number of days fished since 2000.
Nickol Bay prawn	Yes	Adequate	90 – 300	394	2006	Yes	Following high summer rainfall, higher than normal banana prawn catches were predicted.
Broome prawn	Yes	Adequate	55 – 260	45	2006	Yes	King prawns were within the target catch range, but coral prawns were considerably below their target range. This species was not targeted due to poor prices for small prawns. The exploitation rate was still less than 40%.
Kimberley prawn	Yes	Adequate	240 – 500	335	2006	Yes	Banana prawn catches were within expected range for observed rainfall. Other species were also within target catch ranges.
Kimberley gillnet and barramundi	Yes	Adequate	25 – 40 (barramundi)	36	2006	Yes	Barramundi catch level was similar to 2005 and was within the target range.
Northern demersal scalefish	Yes	Adequate	Total 600 – 1,000 (goldband <327) (red emperor <167)	Total 801 (goldband 336) (red emperor 166)	2006	No	Catches of goldband snapper and red emperor were both lower than last season, but are still either above or close to the target range. A stock assessment review of goldband snapper and red emperor is currently in progress, with results expected in 2007.
Pilbara fish trawl	Yes	Adequate	2,000 – 2,800	2,222	2006	Yes	Catches of lower-value species decreased.
Pilbara demersal trap and line	Yes	Adequate	160 – 360 (trap) 50 – 115 (line)	473 (trap) 105 (line)	2006	No	Trap catches were again above the upper limit, due to increased catch of some species. Line catch, including goldband snapper, however reduced to acceptable levels, due to management changes for this sector.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
North Coast Bioregion (Continued)							
Mackerel	Yes	Adequate	246 – 410 (all except grey mackerel)	275	2006	Yes	The implementation of the formal management arrangements continues to affect the fishery. Catches declined significantly in the Pilbara, due to decreased effort and poor weather, but good catches were reported elsewhere.
Northern shark	Yes	Declining	< 20 (sandbar only)	<1	2005/06	Yes	The target sandbar catch has been lowered significantly to reflect the sustainability objectives of new management arrangements introduced in 2005.
Pearl oyster	Yes	Adequate	557,000 oysters (Q) (14,071 – 20,551 dive hours)	538,882 oysters (13,684 dive hours)	2006	Yes	Effort was below the historical range, indicating stocks are higher than historical levels. The TAC increased to 603,000 in 2007.
South Coast Bioregion							
South coast crustacean	Yes	Uncertain	50 – 80 (southern rock lobster)	40	2005/06	No	The downturn in the lobster fishery may be a result of recruitment over fishing in both SA and WA. Management of this fishery is under review.
Abalone (greenlip/ brownlip)	Yes	Adequate	211.5 (Q) (907 – 1,339 days)	206 (1,161 days)	2006	Yes	Fishery is considered to be within historical levels, however localized declines in some areas have prompted a review of performance indicators for the fishery.
Estuarine fisheries (south coast)	Yes	Adequate	200 – 500	170	2006	Yes	The total catch is below target level due to ongoing decline in total effort level, but the stock levels of key species are considered adequate.
WA salmon	Yes	Adequate	1,200 – 2,800	1986	2006	Yes	Recent catches are low relative to historic levels, due to very limited market demand.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
South Coast Bioregion (Continued)							
Australian herring	Yes	Uncertain	475 – 1,200 (south coast only)	301	2006	Yes	Stock levels appear to have declined over last 5 to 10 years as result of poor recruitment, possibly due to environmental factors. At same time, commercial catch (and effort) has declined to a historically low level, partly due to market forces, and so is currently acceptable.
Albany/King George Sound purse seine	Yes	Adequate	1,500 (Q)	1,342	2005/06	NA	Quotas are adjusted annually. Target effort levels are not available.
Bremer Bay purse seine	Yes	Adequate	1,500 (Q)	391	2005/06	NA	Quotas are adjusted annually. Target effort levels are not available. The low catches this season are due to a scarcity of market-size fish in the traditional fishing grounds.
Esperance purse seine	Yes	Adequate	1,500 (Q)	138	2005/06	NA	Quotas are adjusted annually. Target effort levels not available. The low catches this season are due to a scarcity of market-size fish in the traditional fishing grounds.
Southern and west coast demersal gillnet and longline	Yes	Gummy and whiskery increasing. Dusky and sandbar declining.	725 – 1,095	1,121	2005/06	No	The depletion of the breeding stocks of dusky and sandbar sharks has resulted in reductions in the juvenile catch rates of these species, and this situation will continue for many years. The use of monthly gear units has seen the recent activation of latent effort and catch levels have therefore increased. Consequently, management will shift from the use of daily gear units to more explicitly controlled fishing effort.
Northern Inland Bioregion							
Lake Argyle catfish	Yes	Adequate	95 – 155	78	2006	Yes	The reduction in catch is related to a drop in the level of effort for 2006.

1 The information in this table is also used in Appendix 5 of the Department of Fisheries' Annual Report 2006/07, where it underpins some of the Department's Performance Indicators. Appendix 5 in the Annual Report utilised an earlier draft of this table and may vary slightly from this version. The Performance Indicators calculated from the information have not changed.

2 Catch figures supplied for latest year/season available.

NA Not assessed. Q Quota management.

APPENDIX 2

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APPENDIX 3

Table of catches from fishers' statutory monthly returns for 2005/06

This table contains the landed[1] and estimated live weight[2] of species recorded in the compulsory catch and fishing effort returns provided by commercial fishers each month. These data include the catch taken as by-product as well as the targeted catch.

These catch data may differ slightly from some of the catch estimates presented for specific fisheries as the latter may include additional data from other sources, such as research log books and processors. The figures may also differ slightly from previously reported figures, as additional data may have been received by the Department of Fisheries. The table represents the latest year for which a complete set of data is available.

While scientific names have been included wherever possible, it should be noted that many fish recorded under a common name cannot be identified as belonging to a particular single species and therefore must be reported as being part of a commercial grouping of several species. For example, the common name 'jobfish' may be used for several species of the genus *Pristipomoides*.

Data for species with live weight catches of less than 500 kg have been combined into the general or 'other' category within each class.

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish			
Amberjack	*Seriola dumerili*	7,718	7,718
Barramundi (giant perch)	*Lates calcarifer*	18,906	25,824
Bass grouper	*Polyprion americanus*	9,281	9,281
Bigeye (not tuna)	Priacanthidae	30,705	30,705
Boarfish	Pentacerotidae	3,117	3,807
Bonito	*Sarda australis*	1,220	1,227
Bream, black	*Acanthopagrus butcheri*	44,525	44,525
Bream, monocle	*Scolopsis* spp.	22,036	22,036
Bream, Mozambique	*Wattsia mossambica*	726	726
Bream, Robinson's	*Gymnocranius grandoculis*	43,678	43,678
Bream, sea	*Gymnocranius* spp.	6,477	6,477
Bream, silver (tarwhine)	*Rhabdosargus sarba*	5,808	5,808
Bream, western yellowfin	*Acanthopagrus latus*	25,760	25,760
Catfish, sea (golden cobbler)	Ariidae	16,988	18,613
Chinaman fish (not cod)	*Symphorus nematophorus*	19,902	19,902
Cobbler	*Cnidoglanis macrocephalus*	34,872	49,417
Cobbler, silver	*Arius midgleyi*	53,811	88,064
Cod	Serranidae	63,453	63,852
Cod, bar (grey-banded, eight-bar)	*Epinephelus octofasciatus*	39,126	39,135
Cod, breaksea	*Epinephelides armatus*	8,728	8,890
Cod, chinaman	*Epinephelus rivulatus*	2,134	2,161
Cod, radiant/comet	*Epinephelus radiatus/morrhua*	1,159	1,171
Cod, Rankin	*Epinephelus multinotatus*	153,832	153,832
Cod, spotted	*Epinephelus microdon/areolatus/bilobatus*	94,397	94,406
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	203,058	211,901
Emperor, blue-lined (grass; black snapper)	*Lethrinus laticaudis*	3,489	3,493
Emperor, blue-spot	*Lethrinus hutchinsi*	549,523	549,523
Emperor, red	*Lutjanus sebae*	403,358	403,476
Emperor, red-spot (snapper)	*Lethrinus lentjan*	60,907	60,907
Emperor, spangled	*Lethrinus nebulosus*	104,430	104,476

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (continued)			
Emperor, sweetlip	*Lethrinus miniatus*	180,053	180,090
Emperor, yellow-tailed	*Lethrinus atkinsoni*	787	787
Flagfish (Spanish flag)	*Lutjanus vitta, L. quinquelineatus, L. carponotatus, L. lutjanus*	210,935	210,939
Flathead	Platycephalidae	10,973	10,973
Flounder	Bothidae	2,470	2,472
Garfish, sea	*Hyporhamphus melanochir*	34,935	34,992
Groper, baldchin	*Choerodon rubescens*	35,723	38,651
Groper, blue	*Achoerodus gouldii*	35,746	43,062
Groper (wrasses)	Labridae	5,717	5,717
Halibut	*Psettodes erumei*	2,020	2,020
Hapuku	*Polyprion oxygeneios*	40,847	40,856
Herring, Australian	*Arripis georgianus*	352,395	352,395
Herring, Perth	*Nematalosa vlaminghi*	8,021	8,021
Javelin fish	*Pomadasys* spp.	31,368	31,368
Jobfish (goldband snapper) - see Snapper, goldband			
Jobfish, rosy - see Snapper, rosy			
Jobfish (sharptooth snapper)			
Kingfish, black (cobia)	*Rachycentron canadum*	25,184	25,431
Kingfish, yellowtail	*Seriola lalandi*	2,597	2,687
Knifejaw	*Oplegnathus woodwardi*	2,275	2,328
Leather jacket	Monacanthidae	22,084	31,739
Mackerel, blue	*Scomber australasicus*	1,223	1,223
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	16,382	18,012
Mackerel, other	Scombridae	20,747	23,661
Mackerel, scaly	*Sardinella lemuru*	1,659,944	1,659,944
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	1,240	1,780
Mackerel, Spanish	*Scomberomorus commerson*	188,332	263,094
Mangrove jack	*Lutjanus argentimaculatus*	14,814	14,817
Maray	*Etrumeus teres*	16,740	16,740
Morwong	Cheilodactylidae	916	1,090
Mullet, other	Mugillidae	2,953	2,963
Mullet, red	Mullidae	70,523	70,523
Mullet, sea	*Mugil cephalus*	199,930	199,930
Mullet, yellow-eye	*Aldrichetta forsteri*	37,842	37,842
Mulloway	*Argyrosomus hololepidotus*	21,678	23,307
Mulloway, northern (black jew)	*Protonibea diacanthus*	1,665	1,868
Parrot fish	Scaridae	20,040	20,360
Perch, darktail sea (maroon sea) - see Snapper, maroon			
Perch, Moses - see Snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	56,634	56,634

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (Continued)			
Perch, red - *see* Snappers, other			
Perch, scarlet sea (saddletail sea) - *see* snapper, saddletail			
Perch, yellowtail	*Amniataba caudavittatus*	1,262	1,262
Perches, other - *see* Snappers, other			
Pike, sea	*Sphyraena novaehollandiae*	1,434	1,434
Pilchard	*Sardinops sagax ocellatus*	1,906,272	1,906,272
Pomfret, black	*Parastromateus niger*	3,552	3,552
Redfish	*Centroberyx* spp.	61,543	62,224
Redfish, Bight	*Centroberyx gerrardi*	68,082	68,257
Redfish, yelloweye	*Centroberyx australis*	746	773
Rockcod, blackspotted	*Epinephelus malabaricus*	3,780	3,780
Rockcod, goldspotted	*Epinephelus coioides*	3,108	3,108
Salmon, Western Australian	*Arripis truttaceus*	1,937,046	2,004,084
Samson fish (sea kingfish)	*Seriola hippos*	76,030	80,704
Sawfish	Pristidae	150	555
Scad, yellowtail	*Trachurus novaezelandiae*	16,307	16,307
Scorpionfishes	Scorpaenidae	7,156	7,156
Shark, blacktip	*Carcharhinus* spp.	54,586	95,034
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	190,759	301,332
Shark, bull (river whaler)	*Carcharinus leucas*	11,344	18,036
Shark, eastern school	*Galeorhinus galeus*	4,892	7,781
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	4,910	7,806
Shark, grey reef	*Carcharhinus amblyrhynchos*	490	779
Shark, gummy	*Mustelus antarcticus*	310,033	490,849
Shark, hammerhead	Sphyrnidae	56,923	91,884
Shark, lemon	*Negaprion acutidens*	4,333	6,884
Shark, mako (shortfin)	*Isurus oxyrinchus*	1,782	2,826
Shark, pigeye	*Carcharhinus amboinensis*	15,811	25,280
Shark, saw	*Pristiphorus* spp.	2,141	4,989
Shark, southern saw	*Pristiophorus nudipinnis*	356	831
Shark, spinner	*Carcharhinus brevipinna*	2,042	3,035
Shark, spot-tail	*Carcharhinus sorrah*	6,805	16,502
Shark, spurdog	Squalidae/Oxynotidae	502	654
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	115,869	183,914
Shark, tiger	*Galeocerdo cuvier*	15,264	24,270
Shark, whiskery	*Furgaleus macki*	127,448	191,013
Shark, wobbegong	Orectolobidae	51,665	78,667
Shark, other		63,574	94,280
Shovelnose (fiddler rays)	Rhinobatidae and Rhynchobatidae	4,467	14,828
Skates and rays, other		7,978	17,011
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	2,198	2,198

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (Continued)			
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	364,950	364,950
Snapper, fingermark (golden)	*Lutjanus johnii*	445	768
Snapper, frypan	*Argyrops spinifer*	46,946	46,946
Snapper, goldband	*Pristipomoides multidens*	666,043	666,139
Snapper, long nose	*Lethrinus olivaceus*	17,759	17,759
Snapper, maroon (formerly maroon sea perch	*Lutjanus lemniscatus*	24,235	24,235
Snapper, Moses (formerly Moses perch)	*Lutjanus russelli*	66,408	66,408
Snapper, nor-west	Lethrinidae	49,515	49,562
Snapper, pink	*Pagrus auratus*	665,756	676,977
Snapper, queen	*Nemadactylus valenciennesi*	48,651	55,388
Snapper, rosy (formerly rosy jobfish)	*Pristipomoides filamentosus*	23,559	23,559
Snapper, ruby	*Etelis* spp.	60,276	60,324
Snapper, saddletail (formerly scarlet sea perch)	*Lutjanus malabaricus*	193,111	193,118
Snapper, sharptooth	*Pristipomoides typus*	7,644	7,739
Snappers, other	Lutjanidae	1,760	2,141
Sprat, blue	*Spratelloides robustus*	10,947	10,947
Sweep	*Scorpis aequipinnis*	1,235	1,321
Sweetlip	Haemulidae	96,380	98,311
Tailor	*Pomatomus saltatrix*	23,416	23,416
Threadfin	Polynemidae	1,261	1,389
Threadfin bream (butterfish)	Nemipteridae	245,659	245,659
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	72,197	73,793
Trevalla, deepsea	*Hyperoglyphe antarctica*	13,721	13,721
Trevally, golden	*Gnathanodon speciosus*	8,449	8,449
Trevally, other (skippy)	Carangidae	193,107	193,567
Trevally, skipjack	*Pseudocaranx dentex*	3,757	3,778
Tripletail	*Lobotes surinamensis*	3,226	3,273
Trout, coral	*Plectropomus maculatus*	24,811	25,203
Trout, spotted (duskytail groper)	*Epinephelus bleekeri*	10,451	10,451
Trumpeters	Terapontidae	3,551	3,551
Tuna, mackerel	*Euthynnus affinis*	893	893
Tuna, other	Scombridae	2,103	2,341
Tuna, skipjack (striped)	*Katsuwonus pelamis*	2,800	2,800
Tuna, yellowfin	*Thunnus albacares*	1,442	1,623
Tuskfish, bluebone	*Choerodon* spp.	27,122	27,155
Whitebait	*Hyperlophus vittatus*	240,790	240,790
Whiting, golden-lined	*Sillago analis*	9,303	9,303
Whiting, King George	*Sillaginodes punctata*	9,601	9,601
Whiting, other	Sillaginidae	1,502	1,502
Whiting, western sand	*Sillago schomburgkii*	173,604	173,604
Other fish varieties		72,379	75,298
Total fish		**14,002,262**	**14,897,010**

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	834,567	834,567
Crab, champagne (spiny)	*Hypothalassia acerba*	10,951	10,951
Crab, crystal (snow)	*Chaceon bicolour*	187,904	187,904
Crab, giant (king)	*Pseudocarcinus gigas*	5,821	5,821
Crab, mud	*Scylla serrata*	3,371	3,371
Total crabs		**1,042,614**	**1,042,614**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	463,346	463,346
Prawn, brown tiger	*Penaeus esculentus*	934,376	934,376
Prawn, coral	*Metapenaeopsis* spp.	127,797	127,797
Prawn, endeavour	*Metapenaeus endeavouri*	220,660	220,660
Prawn, western king	*Penaeus latisulcatus*	1,591,046	1,591,046
Other prawns	Penaeidae	124	124
Total prawns		**3,337,349**	**3,337,349**
LOBSTERS			
Bugs	Scyllaridae	17,044	17,233
Rock lobster, southern	*Jasus edwardsii*	38,202	38,202
Rock lobster, western	*Panulirus cygnus*	10,395,985	10,395,985
Total lobsters		**10,451,231**	**10,451,420**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	15,161	37,930
Abalone, greenlip	*Haliotis laevigata*	60,578	161,553
Abalone, Roe's	*Haliotis roei*	91,347	105,621
Cuttlefish	Sepiidae	51,746	51,804
Octopus	*Octopus* spp. (mainly *O. tetricus*)	104,811	202,961
Scallop, saucer	*Amusium balloti*	556,210	2,779,250
Squid	*Sepioteuthis* spp., *Loligo* spp.	31,127	31,127
Total molluscs		**910,980**	**3,370,246**
OTHER CLASSES			
Beche-de-mer	Holothuridae	22,109	66,327
Total other classes		**22,109**	**66,327**
GRAND TOTAL		**29,766,545**	**33,164,966**

1. *Landed weight:* refers to the mass (or weight) of a product at the time of landing, regardless of the state in which it is landed. That is, the fish may be whole, gutted or filleted etc. This unit is of limited use for further analysis except where it is known that the product is very homogenous in nature. Where more detailed analysis of the data is required the landed weight is generally converted to a more meaningful measure, the most frequently used being termed live or whole weight or 'nominal catch'.
2. *Live weight:* refers to the landings converted to a live weight basis. This is often referred to as the 'live weight equivalent of the landings', shortened to the 'live weight'. Although live weight may be the preferred unit it is rarely obtained as a direct measure. This is because it would usually have to be made on board a fishing vessel where the practical difficulties associated with the working conditions render it impossible. Live weight has to be derived and this is usually done by applying a conversion factor to the landed weight.

More information may be obtained from the 'CWP Handbook of Fishery Statistical Standards' at the website http://www.fao.org/figis/servlet/static?dom=ontology&xml=sectionB.xml.

APPENDIX 4

Pemberton Freshwater Research Centre activities 2006/07

The Pemberton Freshwater Research Centre (PFRC) is the largest freshwater hatchery and research facility in Western Australia. Located on the Lefroy Brook in Pemberton, it consists of 2 neighbouring sites – the original PFRC hatchery and the Dr Noel Morrissy Research Ponds located on Thomson's Flat.

The original PFRC hatchery site contains 10 earthen ponds, 22 concrete ponds, trout hatching and larval rearing troughs, a 48-tank trout nutrition facility and a training centre. The nearby Dr Noel Morrissy Research Ponds feature 25 earthen ponds (ranging in size from 150m^2 breeding ponds to 1,000m^2 commercial grow-scale ponds), 28 tanks and a post-harvest handling facility. This site on Thomsons Flat also includes an area that is leased to the Pemberton Aquaculture Producers (PAP) for marron processing and marketing.

The PFRC staff are responsible for the maintenance and production of trout, native fish and crayfish at the facility. They are also responsible for stocking trout into public waters and packing trout and marron for sale to commercial farmers.

Efficient management and operation of a large production and research facility for fish and crayfish such as the PFRC requires a high level of expertise. As a result, PFRC staff provide a key regional extension service to aquaculture, recreational fishing and conservation client groups.

The PFRC provides facilities, expertise and stock to support research and industry development in 4 key areas of conservation, recreational fishing, aquaculture and freshwater fisheries. Key PFRC projects in 2006/07 are briefly discussed below.

Trout production for recreational fishing, aquaculture and research

Trout production at the PFRC provides fingerlings and yearlings for recreational fishing, aquaculture and research. 2 species of trout are produced at the PFRC – brown trout (*Salmo trutta*) for recreational fishing and rainbow trout (*Oncorhynchus mykiss*) for both aquaculture and recreational fishing.

In 2006/07 the PFRC produced 700,00 fry, representing an increase in production of 8% compared with 2005/06. These consisted of 668,000 rainbow trout fry and 32,000 brown trout fry – representing an increase in production of 5% and 100% respectively, in comparison to 2005/06.

The majority of production (73%) consisting of 483,000 rainbow trout fry and 32,000 brown trout fry were stocked into public waterways to support recreational fishing. A further 88,000 rainbow trout (13%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism.

Included in the 88,000 trout fry sold to the recreational groups were 41,000 rainbow triploid fry. The recent acquisition of new equipment to produce triploids using a high pressure chamber will increase the triploidy rate compared to the PFRC's present heat shock method.

The PFRC has established a reputation amongst commercial trout farmers for consistent hatchery production of quality fry and eyed ova. In 2006/07, commercial farmers purchased 57,000 fry from the PFRC, representing 8% of PRFC trout production.

The remaining 6% of trout produced were retained for future brood stock for the PFRC, yearling stocking, trout nutrition research and sales to Challenger TAFE in June 2007 to stock an Fisheries Research and Development Corporation-funded project to evaluate commercial trout production using SIFTS (Semi Intensive Floating Tank System) in inland saline water bodies.

In 2006/07, during the winter to spring months, some 26,000 rainbow yearlings, as well as 2,800 rainbow and 480 brown trout ex-brood stock, were released to public waters for recreational fishing.

Trout research for recreational fishing and aquaculture

In late 2006 the Department of Fisheries commenced a review of trout production at the PFRC to consider 2 key factors – brown trout egg viability and rainbow trout brood-stock selection strategies.

Firstly, brown trout egg viability is sub-optimal, but prior to disposing of this valuable line that is highly regarded by recreational fishers, Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. The factors being investigated include poor sperm motility, water quality or climate change.

Once the extent of the problem has been quantified and contributing factors identified, a decision can then be made to either implement measures to resolve the issue and continue brown trout production or discontinue production.

Preliminary investigations by Dr Craig Lawrence into brown trout sperm motility in 2006 resulted in modifications to hatchery protocols to include assessment of sperm quality prior to egg fertilisation. This strategy led to a 100% increase in the number of brown trout produced in 2006/07.

Secondly, the current breeding strategy for both rainbow and brown trout at the PFRC focuses upon random selection of brood-stock. However, trout production at the PFRC has 2 key client groups with different objectives – recreational fishers and aquaculturists. It is therefore likely that breeding objectives for these 2 groups may be different.

Accordingly, in late 2006 Research Division staff commenced discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that in the coming years, brood stock selection strategies at the PFRC can be implemented to produce trout with traits that specifically meet the needs of key client groups.

The genetic line of rainbow trout at the PFRC is unique. It has already been shown to have superior temperature tolerance

compared with most domesticated lines elsewhere. Discussions with trout farmers and fishers have already established that brood stock selection to further increase upper temperature tolerance and growth of the trout stock at PFRC would be desirable, particularly if combined with triploid production to produce sterile progeny.

With climate change resulting in major losses on trout farms overseas, this breeding strategy could have a major benefit for Western Australia through export sales of eyed ova that can tolerate the warmer water temperatures being recorded on commercial farms internationally.

Aquaculture feeds development

In 2006/07 the Aquaculture Nutrition Group completed their work in the development of feed grains for the aquaculture feed sector. A further 5 research trials were run at the PFRC during this period that have helped to contribute to making the application of grains in fish feeds locally, nationally and internationally more viable.

The grains industry has now completed commissioning of a fully operational $8 million plant in Perth that processes lupins for the aquaculture feed market in Australia and internationally. In 2006, about 30,000 t of WA-produced grain, worth an estimated $10.5 million, were used in aquaculture feeds worldwide.

Native fish and crayfish conservation and biodiversity research

In response to a declining prevalence of native fish in the south-west, the PFRC established a brood-stock population of pygmy perch (*Edelia vittata*) in 2006. The aim of this research project is to develop large-scale production techniques for this species to enable stocking of public and private water bodies.

It is thought that the decline in prevalence of native fish is related to the increased spread of introduced Gambusia (*Gambusia affinis*). Although Gambusia were originally introduced to control mosquito populations, it has been shown that the native pygmy perch consume more mosquito larvae. Therefore, while production and stocking of pygmy perch has direct conservation and biodiversity benefits, it is also likely to result in human health benefits through a reduction in mosquito numbers and Ross River virus.

The brood-stock population of pygmy perch established at the PFRC in 2006 were weaned onto a commercially-available formulated pellet. These brood-stock subsequently spawned in concrete tanks, their eggs hatched and larvae were reared. Modifications are being implemented to the hatchery protocols for this species in order to reduce egg predation, increase larval survival and increase production to levels suitable for large-scale restocking programs.

In addition, brood-stock populations of 2 other freshwater native fish species that have been listed as critically endangered – the trout minnow (*G. truttaceus*) and Balson's pygmy perch (*N. Balstoni*), are being established at the PFRC in an effort to close their lifecycles, develop large-scale production techniques and restock water bodies within their original distribution.

In 2005/06 a captive breeding program to conserve marron biodiversity was established at the PFRC. The key focus of this program was to establish a breeding population of the Margaret River marron, which has been listed as critically endangered.

The South West Catchments Council (SWCC) provided funding to develop a molecular genetic test (RAPIDs) for the PFRC to identify 'pure' marron from hybrids in collaboration with the University of Western Australia. This resulted in the establishment at the PFRC of the only 'pure' brood stock population of the rare Margaret River marron.

These brood stock produced over 1,200 juveniles in the first year of this project. These juveniles are being reared to sexual maturity at the PFRC, and their progeny will be available for restocking the Margaret River catchment.

In addition, captive breeding populations from 3 other river systems were established at the PFRC in 2005/06. These brood-stock represent the genetic biodiversity of the northern, central and eastern marron populations found in WA.

Each genetic line was spawned in 2006/07 and these juveniles are being reared to sexual maturity at the PFRC. Their progeny will be available for:

- marron farmers wishing to increase the genetic diversity of their stocks based upon the results of the recently completed Fisheries Research and Development Corporation-funded marron project;
- wild fisheries research involving the release and recapture of tagged juveniles in the recreational marron fishery; and
- restocking both catchments and farm dams in each of the 3 regions.

Marron aquaculture research and development

In 2006 the Fisheries Research and Development Corporation project 2000/215 "Improved performance of marron using genetic and pond management strategies" was completed. Working with industry on commercial marron farms, Department of Fisheries' Research Division staff validated and established current 'best practice' farming techniques.

This showed that correctly constructed and professionally managed marron farms can achieve production levels that are twice that of those which do not follow 'best practice'. The project also showed that poor brood-stock selection, where farmers sell their largest marron and breed from the remaining slower-growing animals, had reduced the growth rate of marron on commercial farms. To address this situation, the Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate.

In 2006, over 10,000 marron from the selective breeding program were sold to juvenile producers for mass production and sale of progeny to commercial farmers. In 2007, the PFRC has produced 25,000 juveniles for sale to industry. A repository population of the better performing genetic lines was retained at the PFRC for future selective breeding and sale of progeny to industry.

APPENDIX 5

Activities of the Fish Health Unit during 2006/07

The Fish Health Unit of the Department of Fisheries was formed in 1988 and is based at South Perth within the Animal Health Laboratories of the Department of Agriculture. The unit is staffed by 1 full-time and 2 part-time fish pathologists, one research scientist, one laboratory manager and one technical officer.

The unit is accredited to ISO 17025 and provides a diagnostic service to the fishing and aquaculture industry in Western Australia, investigates 'fish kills', contributes to policy advice developed by the Department, carries out research on diseases of aquatic organisms, and has a minor extension role. Greater emphasis has been placed on staff visiting aquaculture farms to encourage sustainable farming practices.

Key activities and achievements of the unit during 2006/07 were as follows:

- The laboratory continued in its role as one of 6 regional resource centres for aquatic animal health within the Network of Aquaculture Centres (NACA) in the Asia-Pacific.
- The fish health laboratory received a total of 216 diagnostic cases during 2006/07 – a slight increase on the previous year. The types of fish diagnostic cases were consistent with those in 2005/06, with about 70 cases mainly due to submissions from barramundi farmers and commercial ornamental fish breeders.
- The provision of export health certificates for yabbies and marron has continued its downward trend since 2002/03, when 51 certificates were issued, to only 1 in this reporting period. This decline is due to the continuing drought and to changes within the industry.
- The provision of pearling translocation certificates remained steady at around 30 cases.
- Cases of the endemic notifiable disease epizootic ulcerative syndrome continue to be reported from estuarine fish in the south-west river systems. This disease is considered established in wild populations and is monitored for international reporting purposes only. No other notifiable diseases were reported.
- A major mortality of pearl oyster (*Pinctada maxima*) in Exmouth Gulf in October to November 2006 resulted in a considerable extra workload for the Fish Health staff, and an additional technical officer was employed from January 2007 for a 12-month period using Development and Better Interest Funds. Over 7,000 histology slides have been examined and over 800 polymerase chain reaction tests (to detect DNA) have been carried out. To date, the cause of the mortalities has not been determined, but from the epidemiology of the disease it is believed to be an infectious process, probably a virus.
- In collaboration with staff from the Water and Rivers Commission, 15 reports of 'fish kills' throughout the State were investigated. This was up from the 10 investigated last year. Most 'fish kills' were due to poor water quality or toxic algal blooms.
- In collaboration with the Department of Agriculture and Murdoch University, work continued on a project funded by the Fisheries Research and Development Corporation and the Australian Government's Department of Agriculture, Forestry and Fisheries (DAFF) to develop Australian standard diagnostic techniques for the endemic notifiable disease EUS and the exotic disease crayfish plague (both caused by fungi of the genus *Aphanomyces*). Crayfish plague has not been recorded in Australia and development of a standard diagnostic technique is a precautionary step.
- The Fish Health Unit completed a tender to manage a national project investigating the health of certain groups of quarantined ornamental fish and a final report was submitted to Biosecurity Australia.
- The expertise of the Fish Health Unit is frequently sought by the national Aquatic Animal Health Committee, the National Animal Health Strategy Advisory Group and Biosecurity Australia. Western Australia held the chair of the National Aquatic Animal Health Technical Working Group until October 2006. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues.

APPENDIX 6

Annual performance for commercial fisheries subject to export approval under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999*

The following table provides a summary of the issues and performance measures for fisheries subject to the above Act and their annual performance. The period assessed in each case is the most recent season for which complete data are available. As a result of the duration required for data collection and analysis, the years being assessed in this volume are the 2005/06 season or the calendar year 2006.

In addition to this summary, more detailed information on the annual performance of each fishery is provided in the relevant status reports presented throughout this volume. Within the individual status reports, each performance measure assessed is shown in a highlighted box to assist the reader.

It should also be noted that where naturally-occurring fluctuations in fish stocks have required management adjustments or where improvements have been made to methods of analysis, these have in some cases (asterisked) required a revision of the performance measure this year.

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
Fishery: **Abalone** *Date of certification:* August 2004 *Approval type:* Export exemption *Expiry date*: September 2009	Greenlip/brownlip abalone, Areas 2/3 (spawning stock)	Effort range 907 – 1,339 diver days; minimum meat weight 140 gm greenlip, 160 gm brownlip.	Acceptable	
	Roe's abalone, Area 1 (spawning stock)	Effort range 14 – 43 diver days; total catch 9,900 kg.	Acceptable	Adverse weather conditions limited fishing.
	Roe's abalone, Area 2 (spawning stock)	Effort range 80 – 106 diver days; total catch 19,800 kg.	Acceptable	88% of quota taken in Area 5, due to adverse weather.
	Roe's abalone, Area 5 (spawning stock)	Effort range 100 – 140 diver days; total catch 20,000 kg.	Acceptable	
	Roe's abalone, Area 6 (spawning stock)	Effort range 80 – 127 diver days; total catch 12,000 kg.	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175 – 215 diver days; total catch 36,000 kg.	Acceptable	A reduction to 12,000 kg recommended for 2007 in Area 8.
	Roe's abalone Area 8 (spawning stock)	Effort range 140 – 200 diver days; total catch 15,000 kg.	Acceptable	
Fishery: **Abrolhos Islands and mid west trawl** *Date of certification:* 17 March 2005 *Approval type:* Wildlife Trade Order *Expiry date*: 17 March 2008	Scallops (spawning stock)	The residual stock index determines a predicted catch that should set the length of the season.	Acceptable	
Fishery: **Beche-de-mer** *Date of certification:* December 2004 *Approval type:* Wildlife Trade Order *Expiry date*: January 2008	Beche-de-mer species (spawning stock)	The preliminary acceptable catch range is 50 – 150 t; catch rate above 80 kg/ crew-day fished.	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
Fishery: **Broome prawn** *Date of certification:* August 2004 *Approval type:* Export exemption *Expiry date:* August 2009	Western king prawn (spawning stock)	Annual exploitation rate of king prawns to not exceed 60% in any 1 year.	Acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of 20 – 90 t (7-year catch range).	Acceptable	Catch slightly below range due to low effort.
Fishery: **Exmouth Gulf prawn** *Date of certification:* March 2003 *Approval Type:* Export exemption *Expiry date*: February 2008	Tiger prawn (spawning stock)	Catch rate above 8 – 10 kg/hr	Acceptable	Spawning catch rate indicator slightly below threshold therefore no further fishing took place after spawning.
	King prawn (spawning stock)	Total catch within acceptable range of 350 – 500 t.	Acceptable	
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 120 – 300 t.	Acceptable	
	Banana prawn (spawning stock)	Total catch within acceptable range of 10 – 60 t for years with significant rainfall and zero to 2 t for years with low rainfall.	Acceptable	No recorded catch correlates to low rainfall.
	Coral prawns (spawning stock)	Total catch within acceptable range of 20 – 100 t.	Acceptable	
	Discarded fish (abundance)	The major species of bycatch are found in significant numbers outside of the trawled areas.	Acceptable	
	Impact to mud/shell (habitat)	Less than 40% of mud/ shell habitat in Exmouth Gulf trawled.	Acceptable	
	Discarding fish (provisioning)	Reduction in amount of discards and ratio of discards to target catch from levels prior to introduction of Bycatch Reduction Devices.	Acceptable	
Fishery: **Kimberley prawn** *Date of Certification:* November 2004 *Approval Type:* Export exemption *Expiry date*: November 2009	Banana prawn (spawning stock)	Total catch within acceptable range of 200 – 450 t.	Acceptable	
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15 – 60 t.	Acceptable	
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7 –80 t.	Acceptable	Just below target range due to lower retention and low market value.
	Coral prawns (spawning stock)	Total catch within acceptable range of zero to 6 t (10-year catch range).	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
	Black tiger prawn (spawning stock)	Total catch within acceptable range of zero to 1 t.	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1 – 50 t.	Acceptable	
Fishery: **Mackerel** *Date of certification:* November 2004 *Approval type:* Export exemption *Expiry date*: November 2009	Spanish mackerel (spawning stock)	Total catch within acceptable range of 246 – 410 t; acceptable regional catch ranges: Kimberley 110 – 205 t; Pilbara 80 – 126 t; Gascoyne/West Coast 56 – 79 t.	Acceptable	Pilbara and Gascoyne/ West Coast catches below target range, due to considerable reduction in effort as a consequence of new management arrangements.
Fishery: **Northern demersal scalefish** *Date of certification:* November 2004 *Approval type:* Export exemption *Expiry date*: November 2009	Red emperor and goldband snapper (spawning stock)	Spawning biomass greater than 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase greater than 20% above the average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	Increasing trend in catches for these species has triggered the requirement for an updated stock assessment, which is currently in progress.
	Cods/groupers (spawning stock)	Total annual catch should not increase greater than 20% above the average catches of previous 4 years; no decrease in annual trap catch rates in 2 consecutive years.	Acceptable	As for red emperor and goldband snapper (above).
Fishery: **Onslow and Nickol Bay prawn** *Date of certification:* November 2004 *Approval Type:* Export exemption *Expiry date*: November 2009	Banana prawns (spawning stock)	Nickol Bay: total catch in high rainfall areas within acceptable range of 40 – 220 t; in low rainfall areas within acceptable range of 0 – 40 t.	Acceptable	Catch above range, due to favourable rainfall.
		Onslow: total catch within acceptable range of 2 – 90 t.	Acceptable	
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay is 2 – 40 t	Acceptable	
		and Onslow is 10 – 120 t	Acceptable	
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay is 20 –70 t and Onslow is 10 – 55 t.	Nickol Bay: below but acceptable	
			Onslow: below but acceptable	
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1 – 10 t and Onslow 5 – 20 t.	Below but acceptable	
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1 – 15 t (10-year catch range) and Onslow 4 – 20 t.	Below but acceptable	
	Black tiger prawn (spawning stock)	Total catch within acceptable range of zero to 2 t.	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
Fishery: **Pearl oyster** *Date of certification:* September 2003 *Approval type:* Export exemption *Expiry date*: October 2008	Silver-lipped (gold-lipped) pearl oyster (spawning stock)	Fished area should be less than 60% of species distribution; catch rates should not decrease by greater than 50% from historical averages of 29.5 oysters/hr (Zone 2) and 34.8 oysters/hr (Zone 3); greater than 30% of Zone 1 catch should be greater than 150 mm shell length.	Acceptable	Catch rates in Zones 2 and 3 were above performance levels. Size-frequency data in Zone 1 showed that rebuilding of stock had occurred, and that fisheries were targeting smaller size animals.
Fishery: **Pilbara trap** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: November 2007	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass. Annual trap catch should not increase greater than 20% above the average catch of previous 4 years. No decrease in annual trap catch rates in more than 2 consecutive years.	Acceptable	The age structured model will be updated in 2007.
Fishery: **Pilbara trawl** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: December 2007	Long-lived target species (spawning stock) – includes Rankin cod, red emperor, scarlet perch, goldband snapper, red snapper, spangled emperor	Spawning biomass of Rankin cod and red emperor should remain above minimum limit of 40% of virgin spawning biomass; annual trawl catch should not increase greater than 20% above the average catch of previous 4 years; and no decrease in annual trawl catch rates in more than consecutive years.	Acceptable	The age structured model will be updated in 2007.
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be greater than 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase more than 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in 2 consecutive years.	Acceptable	The age structured model will be updated in 2007.
	Bycatch of protected species – dolphins	Number of dolphins caught by the fishery should be less than 75/yr, assuming 100% catch mortality; all skippers to maintain records of the time, date, shot duration and location of each incidental capture.	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
	Bycatch of protected species – turtles	Number of turtles caught should be reduced by 50% of 2002 level following implementation of mitigation devices; number of turtles released alive should be greater than or equal to 72% of total captures per year; all skippers to maintain records of the time, date, shot duration and location of each incidental capture.	Acceptable	
	Bycatch of protected species – syngnathids	Number of pipefish caught and released alive should be less than 500/yr; number of seahorses caught and released alive should be less than 60/yr; all skippers to maintain records of the time, date, shot duration and location of each incidental capture.	Acceptable	
	Bycatch of protected species – sawfish	Number of sawfish caught should be less than 120/yr; number of sawfish released alive should be increased to 50% of captures by 2008; all skippers to maintain records of the time, date, shot duration and location of each incidental capture.	Acceptable	
	General ecosystem – large epibenthos	The total area of the Pilbara demersal fish fishery (encompassing both trawl and trap fisheries) that is closed to trawling is 80%; the total area of the Pilbara demersal fish fishery between depths of 30 m and 120 m should remain at or below the current level of 60%.	Acceptable	
Fishery: **Salmon** *Date of certification:* November 2004 *Approval type:* Export exemption *Expiry date*: November 2009	Western Australian salmon (spawning stock)	Expected catch range under the current management regime is 1,200 – 2,800 t.	Acceptable	
Fishery: **Shark Bay experimental crab fishery** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: November 2007	Blue swimmer crab (breeding stock)	Catch per unit effort (CPUE) to remain above 1 kg/trap lift.	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
Fishery: **Shark Bay prawn** *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: January 2008	Tiger prawn (spawning stock)	Level of spawning stock present during the spawning season above 2 kg/hr, preferred level between 3 and 4 kg/hr.	Acceptable	
	King prawn (spawning stock)	Total catch within historical acceptable range of 1,100 – 1,600 t, given no change in effort.	Below but acceptable	Due to reduced effort and targeting of larger-size prawns.
	Coral and endeavour prawns (spawning stock)	Total catch within historical acceptable ranges given no change in effort: coral 80 – 280 t, endeavour 1 – 30 t.	Acceptable	Endeavour prawns not targeted in this fishery.
	Loggerhead turtles (captures)	90% of turtles captured from non-Bycatch Reduction Device nets returned alive.	Acceptable	
	Discarded fish (abundance)	Majority of bycatch species are found in relatively significant numbers outside of trawled areas.	Acceptable	
	Impact to sand/shell (habitat)	Less than 40% of sand/shell habitat in Shark Bay trawled.	Acceptable	
	Impact to coral/sponge (habitat)	Less than 20% of the remaining coral/sponge habitat in Shark Bay to be contained within the legally trawled area.	Acceptable	
	Discarding fish (provisioning)	Reduction in amount of discards and ratio of discards to target catch from pre-catch reduction device levels.	Acceptable	
Fishery: **Shark Bay scallop** *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: January 2008	Scallop (spawning stock)	Monitoring of recruits/ residual stock to ensure the start date of the season is set so that there is adequate level of breeding stock present when spawning commences.	Acceptable	
	Loggerhead turtles (captures)	90% of turtles captured from non-Bycatch Reduction Device nets returned alive.	Acceptable	
Fishery: **Shark Bay snapper** *Date of certification:* June 2004 *Approval type:* Export exemption *Expiry date*: June 2009	Pink snapper (spawning stock)	Catch rate not to fall below 500 kg/standard June – July boat day.	Catch rates in 2006 have increased significantly, but a further quota reduction was instigated.	There is a need to review the current Ecologically Sustainable Development trigger level of 500 kg/ standard boat day.

Fishery details	Issue/species	Performance measure	Current performance in 2005/06 or 2006	Comment
Fishery: **South coast crustacean** *Date of certification:* September 2004 *Approval type:* Wildlife Trade Order *Expiry date*: September 2007	Southern rock lobster (spawning stock)	Catch to remain below 40 t for Esperance fishery.	Acceptable	Management of south coast crustacean fisheries are being reviewed.
Fishery: **Specimen shell** *Date of certification:* 25 May 2005 *Approval type:* Export exemption *Expiry date*: 25 May 2010	Specimen shell species (spawning stock)	Preliminary acceptable catch range is from 10,000 – 25,000 shells; acceptable catch rate 10 – 40 shells per day.	Acceptable	
Fishery: **Western rock lobster** *Date of certification:* August 2002 *Approval Type:* Export exemption *Expiry date*: September 2007	Western rock lobster (spawning stock)	Spawning biomass at Abrolhos Islands and coastal regions to remain above 22% of unfished level.	Acceptable	
	Octopus (spawning stock)	Catch rate not to drop outside of historic range by greater than 10%.	Acceptable	
	Sea lion (captures)	No increase in rate of capture.	Acceptable	No sea lion captures were reported
	Leatherback turtle (captures)	No increase in rate of interactions.	Acceptable	
	Whales and dolphins (captures)	No increase in rate of interactions.	Not acceptable	Indicator requires revision as whale populations are increasing, hence the level of interactions will also increase.
Fishery: **West coast deep sea crab** *Date of certification:* March 2004 *Approval type:* Wildlife Trade Order *Expiry date*: March 2007	Champagne crab (spawning stock)	Catch to remain below historical high of 50 t per annum.	Acceptable	
	Crystal crab (spawning stock)	Catch to remain within range 100 – 250 t per annum.	Acceptable	

GLOSSARY OF ACRONYMS

AIMWTF	Abrolhos Islands and Mid West Trawl Managed Fishery
BPF	Broome Prawn Fishery
BRD	bycatch reduction device
CAES	catch and effort statistics
CAP	Commercial Access Panel
CPUE	catch per unit effort
CW	carapace width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DEH	(Australian Government) Department of Environment and Heritage
EPBC	(Commonwealth) Environment Protection and Biodiversity Conservation Act 1999
ERLF	Esperance Rock Lobster Managed Fishery
ESD	Ecologically Sustainable Development
FED	fish escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GSMH	Great Southern Marine Hatcheries
IBSS	independent breeding stock survey
IFAAC	Integrated Fisheries Allocation Advisory Committee
IFM	Integrated Fisheries Management
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IQF	individually quick frozen
ITE	individually transferable effort
ITQ	individually transferable quota
JANSF	Joint Authority Northern Shark Fishery
JASDGDLF	Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
KGBF	Kimberley Gillnet and Barramundi Managed Fishery
KPF	Kimberley Prawn Managed Fishery
LASCF	Lake Argyle Silver Cobbler Fishery
LML	legal minimum length
MAF	Marine Aquarium Fish Managed Fishery
MOP	mother-of-pearl
MPA	Marine Protected Area
MPP	Management Planning Panel
MSC	Marine Stewardship Council
NBPF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NPF	Northern Prawn Fishery
PER	Public Environmental Review
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
RCL	rostrum carapace length
RFAC	Recreational Fishing Advisory Committee
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
ROA	Reef Observation Area
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCEF	South Coast Estuarine (Interim) Managed Fishery
SFD	standard fishing day
SHL	sustainable harvest level
SLED	sea lion exclusion device
SMFG	size management fish ground
SRR	spawning stock–recruitment relationship
SSF	Specimen Shell Managed Fishery
TAC	total allowable catch
TACC	total allowable commercial catch
TAE	total allowable effort
TAFE	Technical and Further Education
TL	total length
TPSA	tiger prawn spawning area
VFLO	Volunteer Fisheries Liaison Officer
VMS	vessel monitoring system
WAFMRL	WA Fisheries and Marine Research Laboratories
WANCSF	WA North Coast Shark Fishery
WCBBF	West Coast Beach Bait Managed Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery