STATE OF THE FISHERIES REPORT 2007/08

Government of **Western Australia**
Department of **Fisheries**

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Produced by the Fisheries Research Division based at the WA Fisheries and Marine Research Laboratories
Published by the Department of Fisheries
3rd Floor, The Atrium
168 St Georges Terrace
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Website: www.fish.wa.gov.au
ABN: 55 689 794 771

ISSN 1446 – 5906 (print)
ISSN 1446 – 5914 (online)
ISSN 1446 – 5922 (CD)

Suggested citation formats:

Entire report:
Fletcher, W.J. and Santoro, K. (eds). 2008. *State of the Fisheries Report 2007/08*. Department of Fisheries, Western Australia.

Individual status report:
Hart, A., Brown, J. and Baharthah, T. 2008. Roe's Abalone Fishery status report. In: *State of the Fisheries Report 2007/08*, eds W.J. Fletcher and K. Santoro, Department of Fisheries, Western Australia, pp. 26–34.

Acknowledgments
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Cover photographs
Upper photograph: Herring. Photo: Henrique Kwong
Lower photograph: Abrolhos. Photo: Shannon Conway

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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 undertaken during 2007/08 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.

The structure of the report is consistent with the Department's Ecologically Sustainable Development (ESD) approach to the management of the State's fisheries and their associated aquatic environments. It also deals with fisheries and fishing-related activities on a bioregional basis, enabling Ecosystem-Based Fisheries Management (EBFM) issues to be more efficiently considered. Thus, 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 fishing does not present an unacceptable risks to the targeted stocks or the marine, estuarine and freshwater ecosystems underpinning them. Thus, the overwhelming majority of Western Australian fisheries have been assessed as only having negligible or minor risks of unacceptable impacts on bycatch species, protected species, habitats or the broader ecosystem. For the small number of fisheries which have been assessed as having a moderate risk to one or more elements, all met their annual performance targets.

The report documents that the majority of Western Australia's significant fisheries stocks continue to be in a healthy condition. For the managed fisheries, over 95% had catches that are considered to be appropriate based on the status of the stocks involved and the current environmental conditions. Moreover, approximately 80% of fisheries are targeting stocks whose abundance is considered to above the level where additional management is required. Of those not at acceptable levels, additional management is already in place to rectify the situation for Shark Bay snapper, Southern shark and Northern shark.

This year's report confirmed that the stocks of west coast demersal finfish (including dhufish and snapper) are being overfished. Management measures aimed at reducing the catch and effort by all sectors on these stocks are now under consideration. Furthermore, an intensive monitoring program for these stocks has now been funded and is underway.

Based on the poor status of blue swimmer crab stocks in Cockburn Sound that was identified last year, extensive research has been underway in this region and, for precautionary reasons, within the Peel-Harvey estuary. These studies have found that the crab stocks in Cockburn Sound have begun to improve, but are not yet to a level where the fishery should be re-opened. The status of the Peel Harvey stocks should be confirmed within the next year or two.

The information provided within this report is also used to assist management even where the breeding stock is still considered to be at acceptable levels. For example, this year's report outlines that there will be a decline in the predicted catch level of rock lobsters over the coming few years. This prompted a review of the management arrangements for the fishery and a series of proposed amendments are being progressed. These actions are designed to assist the breeding stock of rock lobsters remain at adequate levels. A close watch is now being made on future recruitment levels and conditions to ensure that the relationships that have held for the past 25 years which have been used to assist the management of this important fishery are continuing to hold.

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.

Stuart Smith
Chief Executive Officer

EDITOR'S INTRODUCTION

The *State of the Fisheries Report 2007/08* follows a fully bioregional format reflecting the Department of Fisheries' ongoing commitment to ecosystem-based management of Western Australia'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 based upon the well-established Ecologically Sustainable Development (ESD) reporting approach that has enabled 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 Fisheries Volunteer 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 Department's 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 being undertaken through the Government's Western Australian 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* 2007/08 to Parliament).

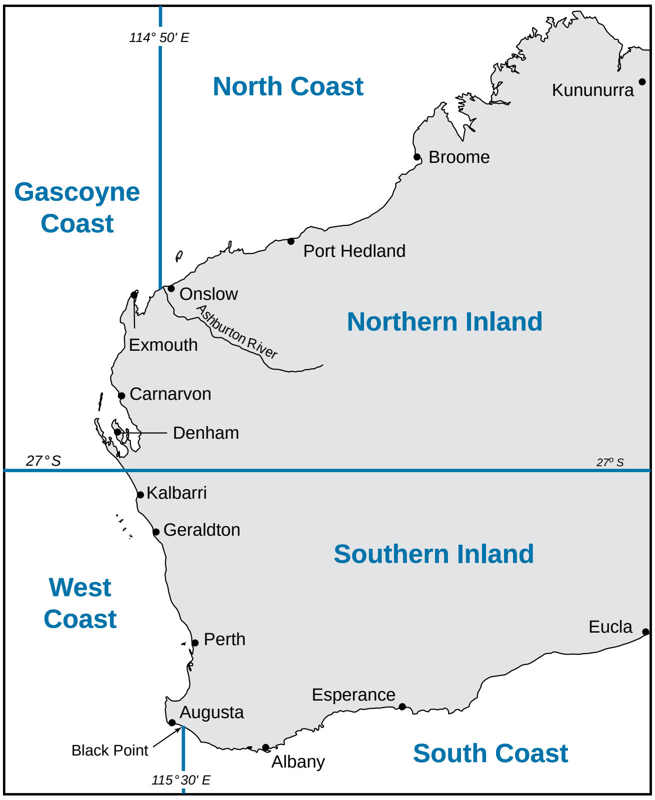
Many of these terms and headings follow the national Ecologically Sustainable Development (ESD) reporting structure (Fletcher *et al.* 2002). In addition to the explanations provided below, acronyms are expanded at their first occurrence in a section of the text and are also listed in a glossary at the 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 functional geographic separations 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 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 the breeding stock is depleted to levels that may affect recruitment.

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 2006/07 or the calendar year 2007, whichever is more appropriate.

Similarly, the statistics on compliance and educational activities are also for 2006/07, 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 2008.

Performance measures

As noted above, many of the State's significant 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 5.

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

PV Waterman. Photo: Henrique Kwong

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 the 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 Leeuwin 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 1 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.

Abrolhos Islands. Photo: Shannon Conway

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 have recently been developed. Demersal line fishers take a range of species including dhufish, snapper, baldchin groper and emperors from boats operating purely as 'wetliners' 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.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch has a number of important research initiatives underway. Ecological risk assessments undertaken on the western rock lobster fishery identified lobster fishing pressure in the deep water as being a moderate risk to communities in those depths. In addressing this concern, a recently completed Fisheries Research and Development Corporation (FRDC)-funded project provided critical information on the relationships between rock lobster abundance, size distributions and benthic habitat characteristics in deep water. That project also provided preliminary data on the trophic role of rock lobster in deep water ecosystems.

Further ecological research in deep waters, supported by funding from the Western Australian Marine Science Institution (WAMSI) and the FRDC, will compare fished and unfished areas using a deep water reference area. A key objective of this project will be to enable potential ecosystem impacts of lobster fishing to be quantified. Negotiation of a suitable reference area is underway, as is the development of sampling methodologies to effectively monitor benthic habitats in fished and unfished areas.

Further research into monitoring fished and unfished (sanctuary) areas was the basis of a recently completed project supported by the Swan Catchment Council (SCC) and the Rottnest Island Authority (RIA). This project established baselines for a long-term monitoring program to detect change through time to fish, rock lobster and benthic communities in three A-class marine reserves along the Perth metropolitan coast. The monitoring methods developed in this project are likely to be used in future surveys of other marine parks in WA to fulfill the Department of Fisheries and the Department of Environment and Conservation's marine park research obligations.

A collaborative project between the Department of Fisheries and the Western Australian Museum, which was also supported by the Swan Catchment Council, has been describing the community structure of the marine fauna in Cockburn Sound. This project aims to establish methods and identify key indicator species to facilitate the assessment of the current and future health of the marine ecosystem in this embayment. A particular focus will be the stocks of blue swimmer crab and snapper, for which Cockburn Sound constitutes an integral part of their life history. The acquisition of this information will be timely, considering the recent increases in urban and industrial development and proposals for future development in this area.

The largest of these proposed developments, with the highest potential for impact on the marine fauna in this area, is undoubtedly the proposed Outer Harbour Facility for the Port of Fremantle. The main purpose of this development is to alleviate the Port of Fremantle of some of its shipping operations, as it is expected to reach its optimal working capacity by 2015. The Port of Fremantle has provided funding to the Department of Fisheries to assess the potential impacts from this development on important aspects of the biology of the native fauna and to user groups in this area.

A research program monitoring the health of coral communities at the Houtman Abrolhos Islands has been expanded. This program, utilising permanent coral transects located at each of the island groups, will collect important baseline information on coral communities, allowing researchers to quantify whether lobster fishing with pots results in damage to sensitive coral habitats, and to determine the vulnerability of coral communities at the Abrolhos to climate change.

Researchers from the Biodiversity and Biosecurity Branch have also been involved in 'Marine Futures', a National Heritage Trust (NHT)-funded collaborative project managed by the University of Western Australia, which has been collecting 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 has been 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 has focused on 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 intertidal 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. These surveys were repeated in early 2007 with funding from the SCC to determine whether there were any changes in mollusc and echinoderm populations on intertidal platforms in the last quarter of a century. Data collected indicate that present populations are within the range of variability experienced in the 1980s, and present management regimes are working.

In December 2007 a similar survey was conducted at Radar Reef and Cape Vlamingh at Rottnest Island. Again, variability in mollusc populations was within the expected range. At the same time a study was undertaken of imposex in the genus *Conus* at Rottnest Island. In 1991 the finding of imposex in *Conus* at Rottnest Island was the first record in the state.

Imposex is a reproductive abnormality in female marine snails caused by tributyltin (TBT) used as an antifoulant in boat paints. Partly as a result of finding imposex in *Conus,* bans were imposed on the use of TBT on vessels smaller than 25 metres in 1991, and the rate of leaching permitted from larger vessels was decreased. A 1996 study showed some decrease in the level of imposex. In the December 2007 re-examination, no TBT could be found in sand on the platforms or in the snails. The proportion of snails affected by imposex had also decreased.

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. Recent research into the interaction between sea lions and the western rock lobster fishery at the Abrolhos Islands suggests that SLEDs may be required in this part of the fishery as well.

In concert with this research, the monitoring of the seasonal pup production at the four 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, with funding from Natural Heritage Trust a project commenced in 2006 to evaluate the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions. In the first two years, the project has developed considerable information on the status of introduced marine species in WA.

A major paper has been written drawing together information on 60 introduced marine species in the State, and where they have been found. While 60 is a substantial number, only three are on the national list of species of concern. Amongst the areas surveyed as part of this project was the Port of Geraldton, which was inspected for Caribbean species of snails and barnacles that could have been introduced by the dredge *Leonardo da Vinci* when it arrived from Jamaica in October 2002. Fortunately, no species that could be attributed to the dredge were found.

Other work in progress includes an assessment of whether a monitoring program should be established for introduced marine species in marine parks and Fish Habitat Protection Areas. The Swan River, Fremantle Harbour, Rous Head, and Cockburn Sound have been surveyed for four species of concern. A separate study is examining whether the 46 introduced species known from those areas have spread onto the adjacent open coast.

ENVIRONMENTAL MANAGEMENT

Regional Overview (West Coast)

The marine benthic habitat along the west coast is largely protected from any physical impact of commercial fishing by extensive closures to trawling. These closures were introduced in the 1970s and 1980s, in recognition of the significance of extensive areas of seagrass and reef as fish habitat (West Coast Habitat Protection Figure 1).

Fish habitat and biodiversity protection is also provided within individual marine protected areas along the west coast including:

- Fish Habitat Protection Areas (FHPAs) at the Abrolhos Islands, Lancelin Island Lagoon, Cottesloe Reef, and Kalbarri Blueholes;
- Reef Observation Areas within the Abrolhos Islands FHPA and closures to fishing under section 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).

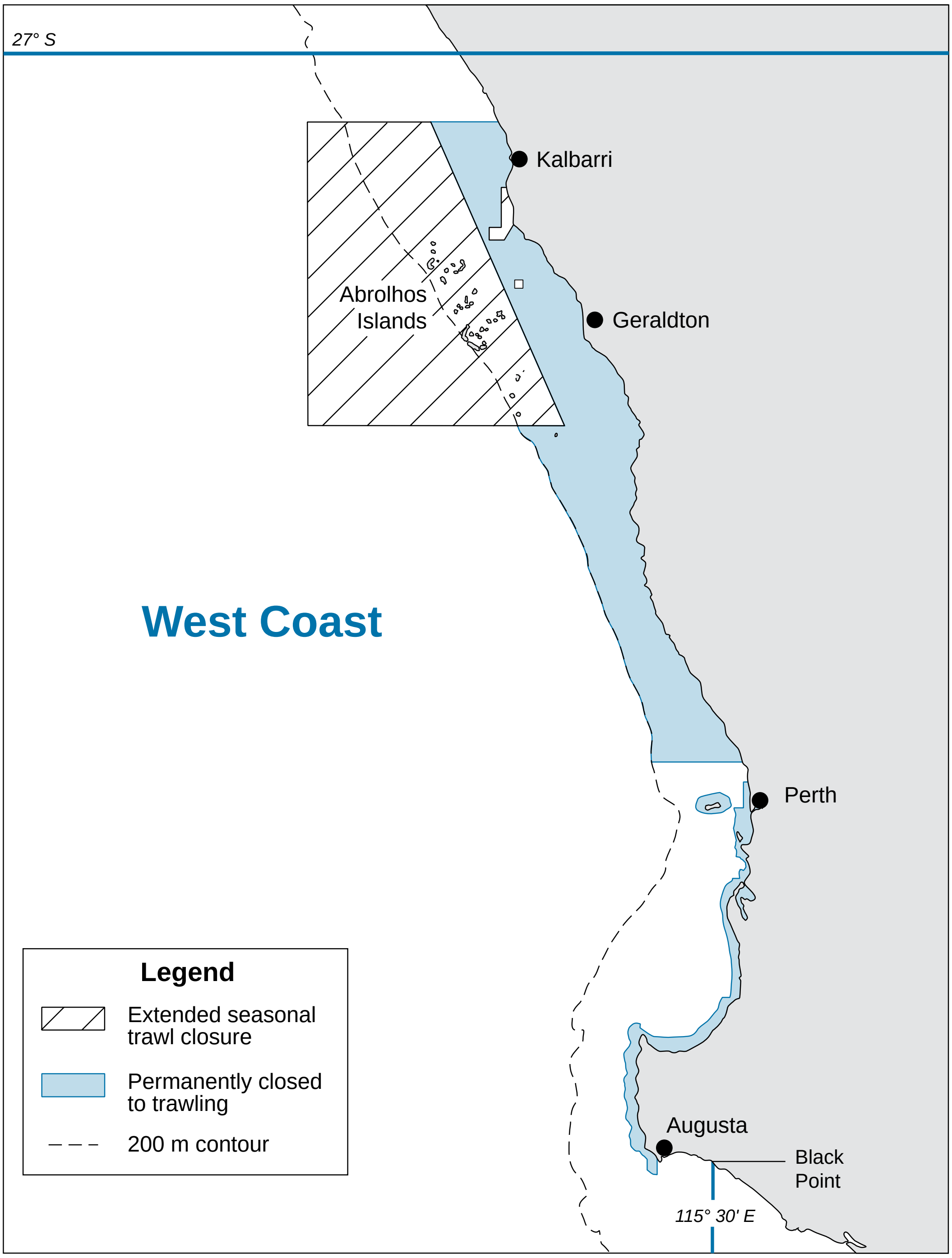
The Australian Government's Department of Environment, Water, Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay. The DEWHA plan to complete a draft South West Marine Bioregional Plan (MBP), which will contain individual marine protected areas, in mid 2009.

The marine habitat and biodiversity along the West Coast bioregion is in generally good condition. However, near-shore waters face increasing threats from coastal development through direct loss as a result of dredging and coastal infrastructure development, e.g. ports, reduced water quality through nutrient-rich and/or polluted terrestrial run-off impacting estuaries and some protected near-shore waters, and the risk posed by the introduction of exotic aquatic pests through international shipping movements.

In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has initiated an Ecosystem-Based Fisheries Management (EBFM) framework. The West Coast and Gascoyne bioregions have been selected to trial this process.

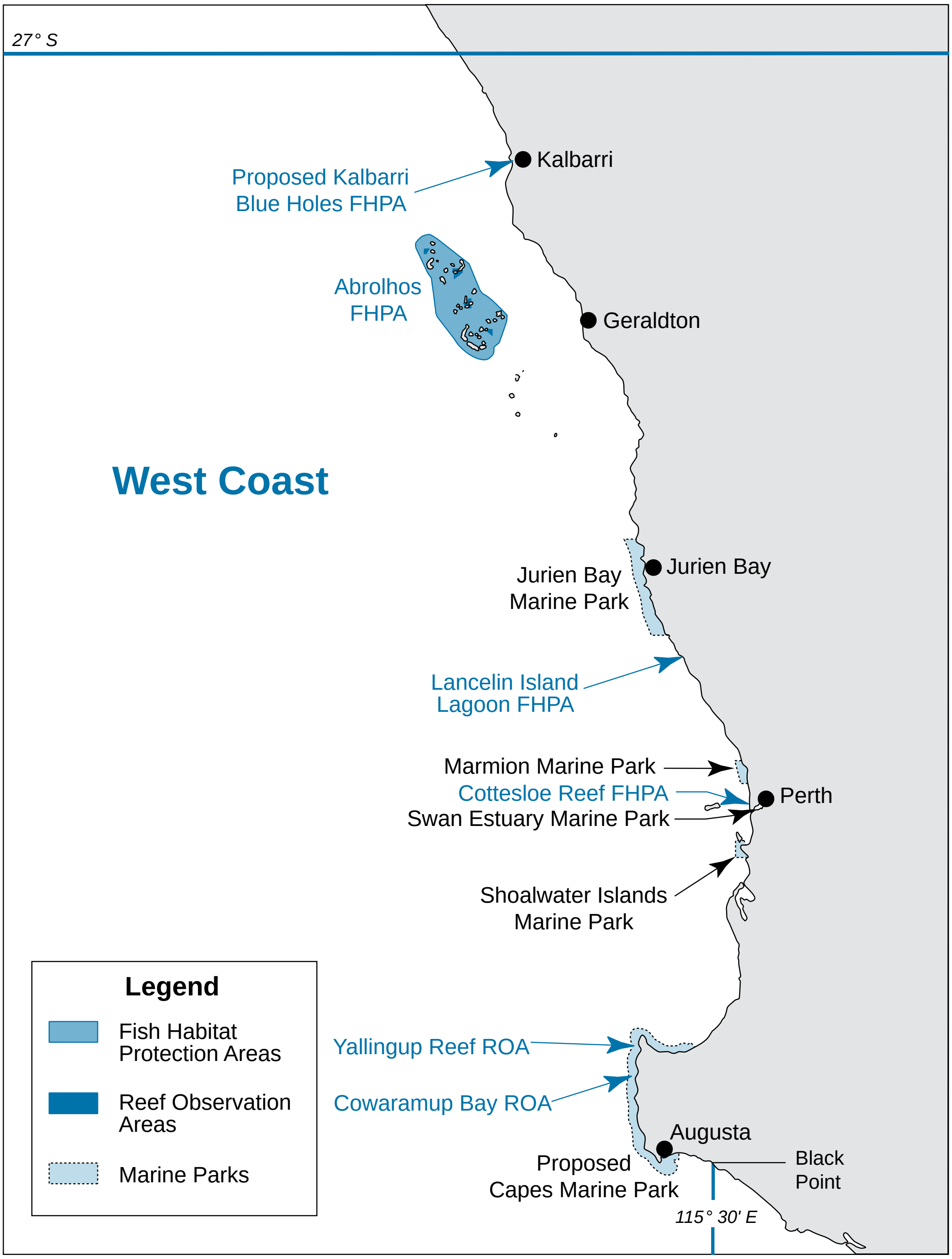
EBFM is a risk-based management approach that recognizes the social, economic and environmental values of the region, and the ecological links between exploited fish stocks and the broader marine ecosystem. EBFM will now guide fisheries management arrangements in the West Coast bioregion to ensure the sustainable management of fish stocks in the future. The Department of Fisheries also continues to provide advice to the Environmental Protection Authority on individual development proposals which, if implemented, have the potential to impact on the aquatic environment.

The Department also continues to actively engage with the natural resource management groups for the west coast to promote sustainable use of the aquatic environment, and has 'introduced aquatic organism incursion' and 'fish kill incident response' programs in place to minimise risks to the marine environment through the introduction of exotic aquatic organisms, or other incidents which have the potential to have an adverse effect



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

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. In 1993/94 the usage rate of these pots was reduced to 82%. This was further reduced in the northern part of the fishery to 72% for part of the season beginning in 2005/06 to keep the TAE at a sustainable level (see below).

The fishery is divided into 3 zones, which distributes effort across the entire fishery, reducing concentration of effort and the potential for unacceptable 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 21°44´ S and 30° S (northern region) and those larger than 115 mm between 30° S and 34°24´ S (southern region), excluding waters east of 115°08´.

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 from 15 November to 30 June annually, with the Abrolhos Islands zone operating from 15 March to 30 June. Additional effort reductions were introduced in 2005/06.

In the northern coastal region, pot usage was reduced to 72% from 15 November – 14 March and 82% from the 15 March to 30 June. The northern zone was also closed to fishing from 15 January – 9 February, with no fishing on Sundays (15 March – 30 June), Christmas Day and New Year's Day. Pot usage in Zone A was also reduced to 72% for the first four weeks of the season (15 March – 15 April), before returning to 82% for the remainder of the season. In the southern region, pot usage remained at 82% all season, the season began 10 days later (24 November), 3-day moon closures occurred 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 the fishery was closed for Christmas Day and New Year's Day.

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 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 the annual assessment of performance for 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 license (either a specific rock lobster license or an 'umbrella' license covering all licensed recreational fisheries). Fishers are restricted to 2 pots per license holder, although the total number of licenses 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.

Intergrated Fisheries Management

The IFAAC's Western Rock Lobster Allocation Report was released for public comment in November 2005. The IFAAC recommended an allocation of 4.9% and 95.1% of the western rock lobster resource to the recreational and commercial sectors, respectively. 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. In March 2008 the Minister finalized his decisions with respect to the allocation of the State's western rock lobster resource. His decisions, amongst other things, included approving an allocation of 5% and 95% of the resource to the recreational and commercial sectors respectively.

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 breeding stock levels and puerulus settlement. 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 and this has now been completed. This project provided critical baseline data on the relationships between the abundance and size distributions of rock lobster and the different benthic habitats located in deeper waters, plus preliminary data on diets and the trophic role of rock lobster within these depths.

Further ecological research in deep waters will be based on comparing fished and unfished areas using research closures. A new FRDC project will begin in 2009 after suitable fished and unfished areas within deep water have been established in collaboration with industry. This project will collect baseline information on lobster stocks, habitat and community structure to facilitate comparisons between fished and unfished areas. The ultimate outputs of this project will enable any impacts of lobster fishing on deepwater ecosystems to be quantified.

A further project focusing on the changes to lobster populations within unfished zones compared to fished areas funded by the Swan Catchment Council, will be completed in June 2008. Results from this project have identified the short-term impacts that 'no-take' areas have on lobster populations in shallow waters. Further funding will be sought to continue this monitoring.

A second FRDC project, which is to be completed in 2008/09, is investigating reproductive biology issues relevant to managing the western rock lobster broodstock. Results from this project, including temporal changes in the sizes at maturity and double breeding and the spatial distribution of egg production, have been published in peer reviewed journals.

A stock assessment workshop was held in July 2007 at the Department of Fisheries' Western Australian Fisheries and Marine Research Laboratories. The workshop provided the forum for a peer review of the integrated biological stock-assessment model that was being developed by the Department for use in providing future management advice for the fishery. A draft version of this model has since been used to assess the impact of possible future effort reductions on commercial catch and breeding stock levels. This workshop also enabled the assembled experts to complete the review of the Department's stock assessment methods and advice provided for 2004 and 2005 seasons, which was an MSC condition. A report on this workshop can be found on the Departments website.

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 20 years. These trends, together with data on puerulus settlement, are used to predict the recreational catch and effort in following seasons.

Since 2000/01, telephone diary surveys of recreational rock lobster fishers have been undertaken in most years. Estimates of recreational catch using this method are compared to the estimates from mail surveys. The results of the phone diary surveys are considered to be more accurate than those of the mail surveys because the former eliminate the recall bias in the mail surveys and additionally, there is a higher participation rate in the survey from random sample selection. Sample sizes for the phone diary surveys have been increased since the 2006/07 survey to improve the accuracy of the result.

Retained Species

Commercial landings (season 2006/07): 8,577 tonnes

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery (WCRLF) are shown in West Coast Rock Lobster Figure 1. The 2006/07 catch in the WCRLF was forecast from puerulus settlement 3 to 4 years previously to be 9,350 t. The actual catch from the WCRLF for the 2006/07 season was 8,577 t, which was 22.6% lower than the long-term average catch (1980/81 to 2005/06) of 11,083 t and 16.6% lower than the previous season's 10,326 t. In 2006/07, the catches in A Zone, B Zone and C Zone were 2,008, 2,957 and 3,611 t respectively, with A Zone 3.3% lower, B Zone 0.1% higher and C Zone 31.8% lower than the previous season.

Octopus are also caught in rock lobster pots, generally in shallow water (0 – 20 fathoms or 0 – 37 m), and a catch rate of 0.03 octopus per pot lift was recorded in the 2006/07 voluntary research log book data. This was 25% above the average of 0.024 per pot lift over the historical range (1985/86 to 2003/04).

This catch rate translates to an estimated 140,878 octopus caught in shallow regions of the fishery during 2006/07. Octopus catches were estimated for A, B and C Zones as 37,199, 52,604, and 51,074, respectively.

The catch rate of octopus (incidental landings) is a performance indicator for this fishery, and at 0.03 octopus per pot lift achieved the performance measure of being within 10% of the historical range. The historical range (± 10%) is 0.013 – 0.033 octopus per pot lift.

Recreational catch estimate (season 2006/07): 174 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. However, 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 2006/07 was estimated at 174 t based on the adjusted mail survey, with 117 t taken by potting and 57 t by diving. Comparative catch estimates for 2005/06 were 157 t by potting and 57 t by diving. The estimated recreational catch in 2006/07 was 18.7% below the 2005/06 catch. The 2006/07 season catch estimate was within the catch prediction confidence limits (i.e. 150 – 300 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 2006/07 the numbers of vessels fishing for lobster were 128 in A Zone, 111 in B Zone and 252 in C Zone. Thus, in comparison to the 500 active boats in 2005/06, a fleet of 491 vessels fished in 2006/07, which was a reduction of 1.8%.

The nominal fishing effort was 8.3 million pot lifts in 2006/07 – 5.7% lower than the 8.8 million pot lifts for 2005/06 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 in the 2005/06 season and reduced fishing due to lower catch rates and increased costs.

The 2006/07 nominal effort for A, B and C Zones was 1.2, 2.7 and 4.4 million pot lifts respectively, which was 7.7% less, 1.8% less and 7.4% less than the previous season's pot lifts.

Recreational

A total of 37,488 licenses were sold that permitted fishing for lobsters during some part of the 2006/07 season (made up of specific rock lobster licenses plus umbrella licenses), with an estimated 22,000 (59%) utilised for lobster fishing. License usage was forecasted to be 20,800 but came in above that prediction at around 22,000.

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 licenses 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. The number of licenses used for rock lobster fishing in 2006/07 was 5% higher than the number of active licenses (21,000) for the 2005/06 season.

The average rates of usage by active pot and diving fishers (i.e. excluding all those who held a license but failed to use it) were 15 and 5 days respectively during the 2006/07 fishing season. These rates were similar in the 2005/06 fishing season. 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 license 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.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected commercial catch next season (2007/08): 9,250 tonnes

Projected recreational catch next season (2007/08): 240 tonnes

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

Indices of breeding stock are the main indicators 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.

Under the current management arrangements introduced in 1993/94 and updated in 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 remains at, or above, the target levels of the late 1970s and early 1980s (West Coast Rock Lobster Figures 3 and 4).

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 2006/07 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. 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 (West Coast Rock Lobster Figure 6). 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 in this zone.

Catch per Unit Effort (CPUE)

A third 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.

Commercial

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 1.032 kg/pot lift in 2006/07 (around 13.3% 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.

Recreational

The average recreational pot and diving catch rates were 1.1 and 2.2 lobsters per person per fishing day in the 2006/07 fishing season. These catch rates are similar for potting to those in the 2005/06 fishing season and are slightly higher for divers compared to the 1.6 lobsters per person per fishing day recorded last season.

Juvenile recruitment and Catch Prediction

Post-larval (puerulus) recruitment to the fishery is monitored monthly and is affected by 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 2006/07 were below average at all sampling sites (West Coast Rock Lobster Figure 7). This reflects the negative Southern Oscillation Index (an indicator of El Niño conditions which affects the strength of the Leeuwin Current), which occurred in 2006. This low 2006/07 settlement will first impact on catches during the ‘reds’ of 2009/10 and the ‘whites’ throughout the fishery in 2010/11.

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 2007/08 and 2008/09 are expected to produce commercial catches of around 9,250 t and 9,550 t respectively (West Coast Rock Lobster Figure 7). Catches during the 2009/10 season are expected to decline to 8,450 t.

It is also forecast that the recreational rock lobster catch for the whole fishery will be around 240 t in 2007/08 (West Coast Rock Lobster Figure 8), with catches of about 277 t and 209 t expected in 2008/09 and 2009/10. Therefore, license sales and usage in 2007/08 are expected to remain at similar levels; the prediction is that sales will be approximately 40,300 and usage 23,000 in the 2007/08 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 125,150 fish and invertebrates other than rock lobster and octopus were captured during the 2006/07 fishing season, of which most were released (Table 1).

WEST COAST ROCK LOBSTER TABLE 1.

Catch rate of bycatch in lobster pots recorded during observer monitoring programs in 2006/07. The total number caught is an estimate based on the catch rate and the total number of pot lifts in 2006/07 fishing season (a catch rate of 0.06 equates to just one individual fish being caught during the monitoring program).

Bycatch Species	Catch/1,000 Pot Lifts	Estimated Total Number Caught (whole fishery)
Baldchin groper (*Choerodon rubescens*)	0.58	4,832
Black-banded seaperch (*Hypoplectrodes nigrorubrum*)	0.06	483
Blackspot pigfish (*Bodianus vulpinus*)	0.06	483
Blue-barred parrotfish (*Scarus ghobban*)	0.06	483
Boxfish (Ostraciidae)	0.06	483
Breaksea cod (*Epinephelides armatus*)	2.09	17,396
Bullseye (*Pempheris sp.*)	0.06	483
Chinaman cod (*Epinephelus rivulatus*)	0.81	6,765
Cobbler Carpetshark (*Orectolobus tentaculatus*)	0.06	483
Cuttlefish (*Sepia sp.*)	0.93	7,732
West Australian dhufish (*Glaucosoma hebraicum*)	0.17	1,450
Eel (Muraenidae)	1.4	11,598
Flathead (Platycephalidae)	0.06	483
Footballer sweep (*Neatypus obliquus*)	0.06	483
Gurnard (*Chelidonichthys sp.*)	0.17	1,450
Harlequin fish (*Othos dentex*)	0.06	483
Hermit crab (Paguroidea)	0.12	966
Leatherjacket (Monocanthidae)	0.52	4,349
Leopard wirrah (*Acanthistius pardalotus*)	0.7	5,799
Lined dottyback (*Labracinus lineatus*)	0.06	483
North-west blowfish (*Lagocephalus scleratus*)	0.06	483
Pink snapper (*Pagrus auratus*)	0.23	1,933
Port Jackson shark (*Heterodontus portusjacksoni*)	1.92	15,947
Queen snapper (*Nemadactylus valenciennesi*)	0.06	483
Scalyfin (*Parma mccullochi*)	0.06	483
Scorpion fish (Scorpaenidae)	0.81	6,765
Silver spot (*Threpterius maculosus*)	0.06	483
Skipjack trevally (*Psuedocaranx dentex*)	0.12	966
Spangled emperor (*Lethrinus nebulosus*)	0.06	483
Sweetlips emperor (*Lethrinus miniatus*)	0.76	6,282
Unknown fish	0.17	1,450
Urchin (Echinoidea)	0.06	483
Western foxfish (*Bodianus frenchii*)	0.12	966
Western wirrah (*Acanthistius serratus*)	0.12	966
Wobbegong shark (*Orectolobus spp.*)	1.69	14,014
Wrasse (Labridae)	0.7	5,799
Total		**125,153**

Protected species interaction: Low

Previously, the WCRLF interacted with the Australian sea lion, *Neophoca cinerea*, resulting in the accidental drowning of a small number of sea lion pups in rock lobster pots, as the pups attempted to retrieve bait or rock lobsters that were contained in lobster traps. 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 15 November 2006 all pots fished in waters less than 20 metres within approximately 30 km of the 3 breeding colonies (i.e. just north of Freshwater Point to just south of Wedge Island) were fitted with an approved Sea Lion Exclusion Device (SLED). Video trials have indicated that this device does stop sea lion pups from entering lobsters pots and drowning.

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: http://www.fish.wa.gov.au/docs/pub/SeaLionExclusionDevices/index.php

Monitoring of commercial pots in the SLED zone in 2006/07 showed that over 95% of pots checked had an approved SLED fitted.

A performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2006/07 western rock lobster season, no sea lion captures were reported, whereas the historical level is just over three 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 concluded to be above a negligible risk, and this was still rated as a low risk.

A performance measure for the fishery is that there is no increase in interactions with turtles. In 2005/06, no leatherback turtles were reported to have been entangled in lobster fishing gear. This incident rate is below the historical range of between 2 and 5 entanglements per season over the preceding five 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, but 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 – 2005), commercial lobster fishing has resulted in zero to 4 whale/dolphin interactions per season. During the 2006/07 lobster season, one whale was recorded as becoming entangled and subsequently successfully disentangled, therefore the fishery did meet this performance measure.

Ecosystem Effects

Food chain effects: Moderate

Overall, 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, due to the lack of information, the removal of lobster in deep-water regions might have some level of impact on their surrounding ecosystem. This forum subsequently classed this as a moderate risk. Consequently it has become a focus of research, with preliminary work, funded by the FRDC, almost completed. A second FRDC-funded project has been initiated 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 three 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 $245 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June.

A total of 491 vessels and 1,360 people were engaged directly in fishing for rock lobsters in 2006/07. This equates to 1 skipper and an average of about 1.76 deckhands per vessel, which is very similar to that recorded during the 2005/06 season. During the year, 5 processing establishments, located in the Perth metropolitan area (3) and Geraldton (2), serviced practically every location where western rock lobster fishing occurred.

Recreational

With around 22,000 people taking about 400,000 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 2006/07: $245 million

The price that commercial fishers received for the western rock lobster in 2006/07 was an estimated average of $28.50/kg in all zones of the fishery. This was a 1.8% increase on the $28.00/kg paid in 2005/06, and is mainly attributable to the smaller catch in 2006/07. The overall value of the fishery declined marginally from the previous season's value of $289 million as a result of the lower catch recorded.

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 2006/07 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.

Recreational

Current Fishing (or Effort) Level: Acceptable

Target recreational catch range: 115 – 468 tonnes

Between 1986/87 and 2006/07 commercial catches have averaged 239 ± 46 t (95% confidence intervals of the mean) and ranged from 115 t in 1987/88 to 468 t in 2002/03. Variation of these catches results primarily from variable levels of recruitment, which are driven by the environmental conditions as described above.

New management initiatives (2007/08)

A new management package, currently being developed by the Department of Fisheries and the Rock Lobster Industry Advisory Committee (RLIAC), will be implemented by the start of the 2008/09 season. This package will make use of the newly developed 'biological model' to ensure that the breeding stock for both southern and northern regions remains above the 1980 level, given the current poor recruitment period.

A draft paper outlining new 'decision rules' for the West Coast Rock Lobster Fishery was released in 2008. Key proposals contained in this paper are the addition of harvest rates and allowing for uncertainty into the decision rules framework. The inclusion of these two proposals will make the decision rules framework more robust. It also means that management decisions will be more consistent, predictable and transparent. The proposed framework is consistent with the recently released Harvest Strategy Policy for Commonwealth Fisheries.

The introduction of harvest rate into the existing framework was proposed by the Department of Fisheries in early 2007, and endorsed during a stock assessment workshop in 2007. The need to include uncertainty into the framework was recommended during the aforementioned stock assessment workshop, and formed part of a condition for the Marine Stewardship Council (MSC) re-certification of the fishery.

In parallel to the development of a new management package under 'input' controls, a RLIAC working group has been formed to develop a quota management system (output controls) business case. The business case will consist of two components:

1. a management paper that describes the proposed quota management settings if the fishery went to a quota management system; and
2. an interactive spreadsheet financial model for licensees to explore the impact of the proposed management settings on their business.

It is expected that the management paper will be released to industry for comment in August 2008.

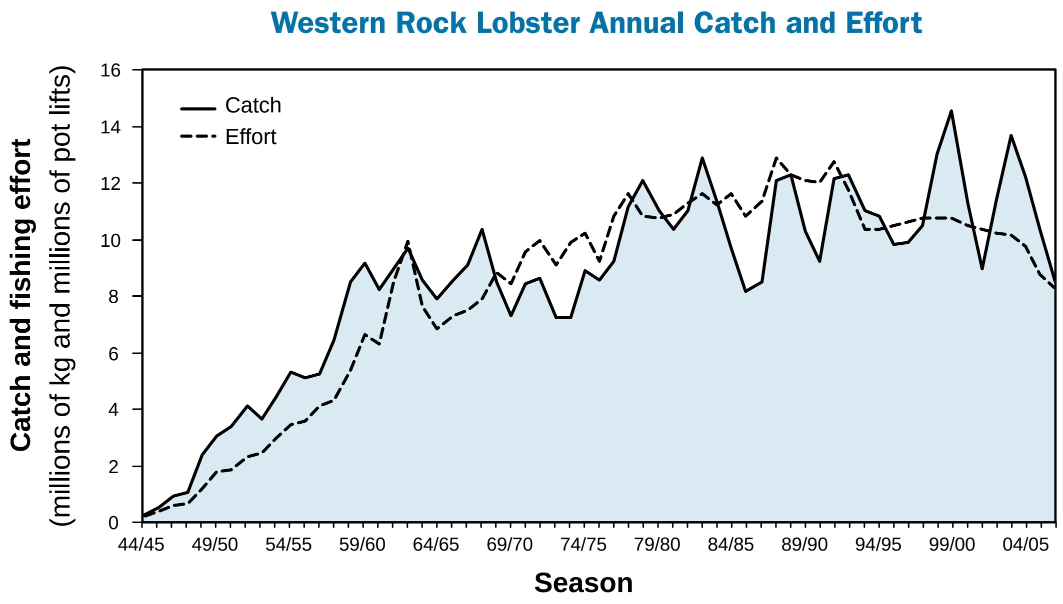
External Factors

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.

The fishery has been affected by seven years of El Niño or neutral conditions, which has generally resulted in average or below-average puerulus settlement, due to the weaker Leeuwin current strength.

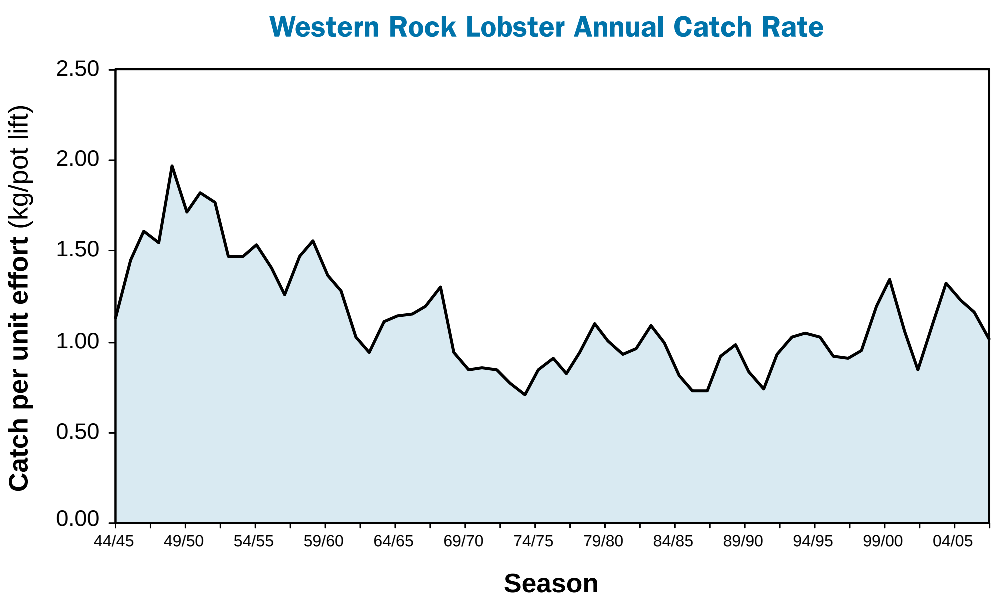
Increases in water temperatures over the last 30 to 40 years appear to be affecting some of the biological parameters such as size at maturity and size of migrating lobsters. These changes need to be taken into account in future stock assessments.

The economic performance of the fishery is being strongly affected by the high value of the Australian dollar (affecting the price of lobsters) and high fuel and labour costs. This has resulted in reduced fishing effort during periods of low catch rates.



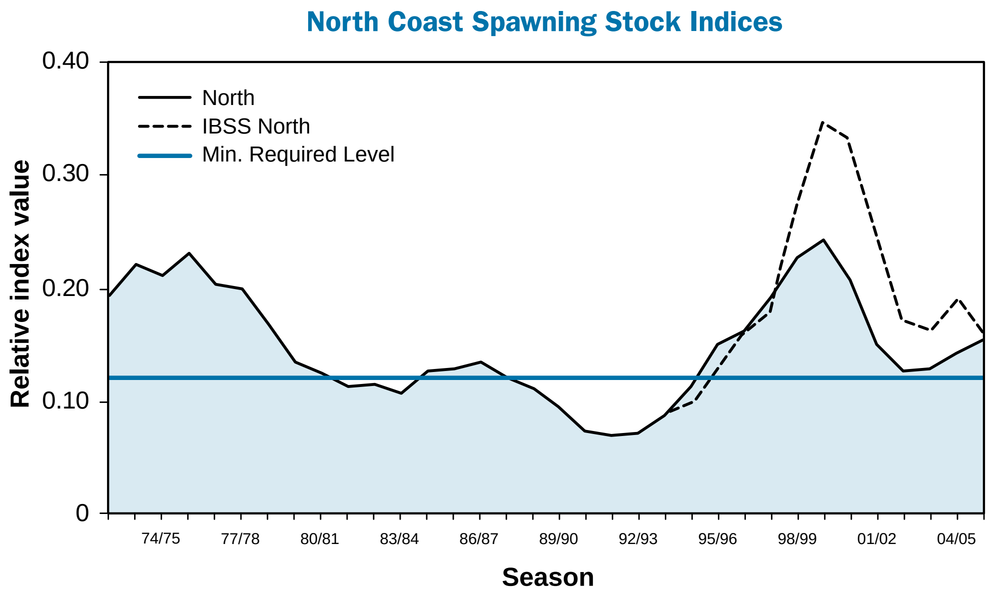
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2006/07.



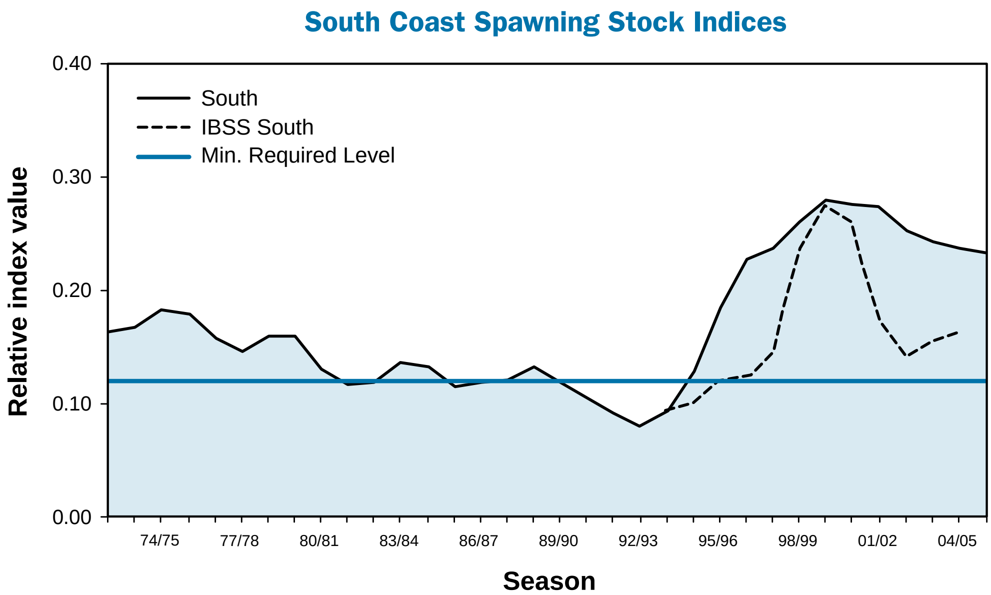
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2006/07.



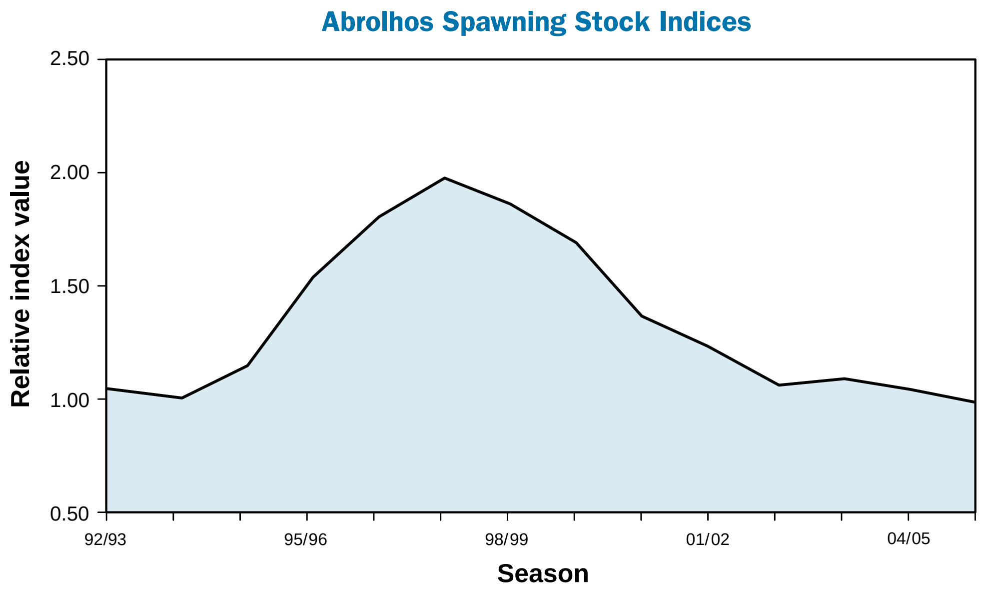
WEST COAST ROCK LOBSTER FIGURE 3

Three-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.



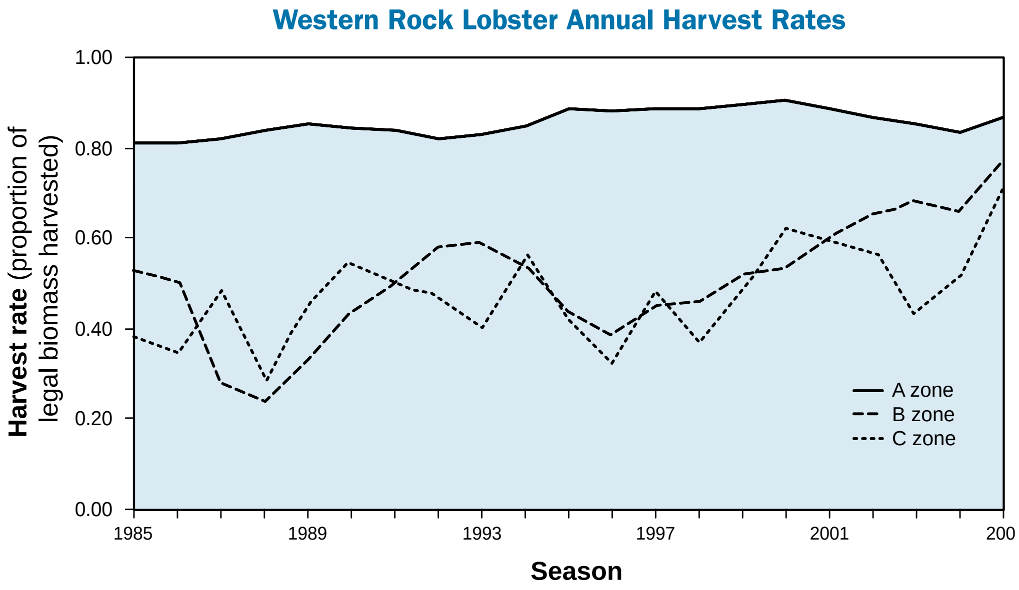
WEST COAST ROCK LOBSTER FIGURE 4

Three-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.



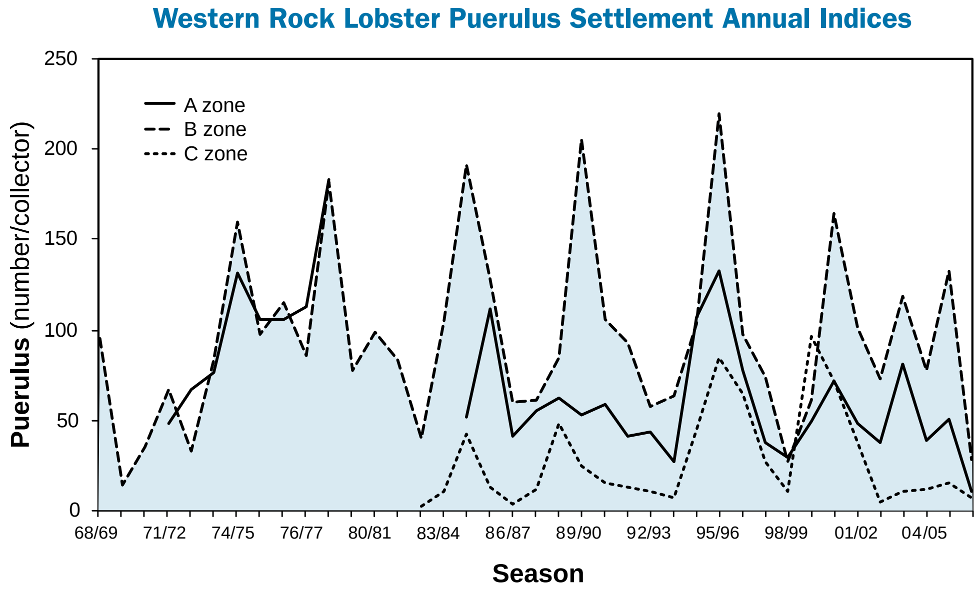
WEST COAST ROCK LOBSTER FIGURE 5

Egg production indices as measured by the independent breeding stock survey at the Abrolhos Islands smoothed by a moving average of 3 years.



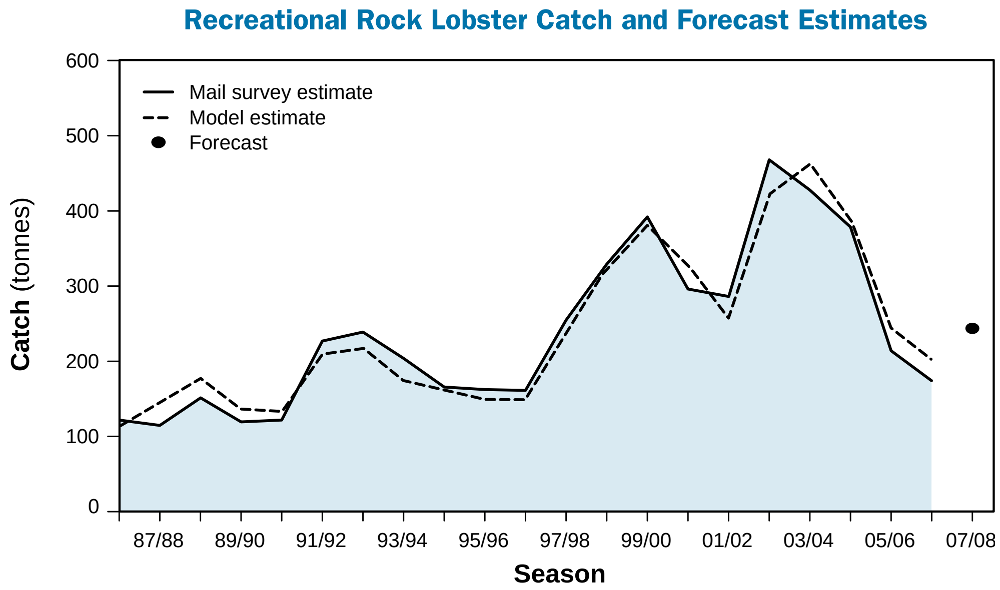
WEST COAST ROCK LOBSTER FIGURE 6

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 2007/08 based on puerulus settlement 3 to 4 years earlier and expected licence usage.

Roe's Abalone Fishery Status Report

A. Hart, J. Brown and T. Baharthah.
Management input from M. Holtz

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 a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks. Abalone divers operate from small fishery vessels (generally less than 9 metres 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 three 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 2007 was 109.7 t whole weight (note this small species is generally 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 (WA/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 7.00 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

Commercial

Commercial 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.

An annual standardized catch per unit effort (CPUE) model was developed that took into account diver and month of fishing, as well as technological improvements that aid fishing efficiency.

Current research is focused on stock assessment using catch and effort statistics, fishery-independent surveys of Perth metropolitan stocks, and digital video imagery (DVI) surveys by industry divers, who survey selected sites with an underwater video camera. Size and density of Roe's abalone across the near-shore sub-tidal reef habitat is measured annually at 11 indicator sites between Mindarie Keys and Penguin Island. Nine of these are fished while the other 2 are the Waterman's Reserve Marine Protected Area (MPA), and the Cottesloe Fish Habitat Protection Zone.

Recreational

Current annual recreational catch and effort estimates are derived from a field survey (West Coast Zone / 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, and estimates are based on average catch (weight and numbers), catch rates (derived from 1,000 interviews in 2007), and fisher counts conducted by Fisheries Volunteers 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 2007, around 500 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 every 3 months by telephone for the duration of the abalone season, or at the end of the season for those only involved in the Perth abalone season.

Retained Species

Commercial production (season 2007): 90.8 tonnes whole weight

The TACC for the 2007 quota year was 109.7 t whole weight for Roe's abalone. The catch of 90.8 t whole weight for 2007 (Roe's Abalone Table 1) was 8% lower than in 2006 and 18.9 t lower than the TACC. The overall TACC was not caught because of poor weather in Area 1 of the fishery (Roe's Abalone Figure 1), and catches below the TACC in Area 5 (80% of TACC caught) and Area 8 (50% of TACC caught). Total TACC is not usually caught in this fishery because of weather-related issues in the marginal regions (Area 1 and Area 8) of the fishery.

Recreational catch (season 2007): Roe's Perth Fishery 34.4 tonnes
Roe's rest of state 14.4 tonnes
22 – 36% of total catch

The catch estimate for Roe's abalone from the Perth metropolitan area in 2007 is 34 t, as estimated from the field survey (Roe's Abalone Table 2). This is an increase of about 11% from 2006, caused by a combination of increases in catch rates as a result of good weather conditions, and a 5% increase in license numbers (Roe's Abalone Figure 3).

Catch estimates of Roe's abalone from the phone diary surveys were 24.0 t (range: 18.8 – 29.3 t) in the Perth Fishery (Roe's Abalone Figure 4), 9.0 t (range: 5.6 – 12.4 t) in the West Coast Fishery, and 5.3 t (range: 1.3 – 9.4 t) in the South Coast Fishery (Roe's Abalone Table 3). These estimates are similar to the 2006 telephone diary survey estimates.

The Perth Fishery estimates from the telephone diary survey are lower than the estimates from the field survey as they were in 2006.

Recreational fishing represented about 22 – 36% of the total (commercial and recreational) Roe's abalone catch across the state in 2007. This is similar to the 2006 estimate of 21 – 34% of the total catch.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2007 was 585 diver days, which was the lowest effort on record (Roe's Abalone Table 1). The low effort is a combination of high abundance and only 83% of TACC being caught.

Recreational

For the 2007 season, 22,500 licences were issued. This was a 6% increase over the 2006 figure of 21,200 licenses, but overall license numbers have been stable for 7 years (Roe's Abalone Figure 4).

Effort in the 2007 Perth fishery of 12,433 hours was a 19% increase on 2006 effort of 10,433 hours (Roe's Abalone Table 2), but still at the lower end of the historical range. In both 2006 and 2007, daily season length has been shortened from 1.5 hours to 1 hour and this is likely to affect overall effort, but catch rates have increased, resulting in a minimal impact on overall catch.

Effort estimates for recreational abalone fishing from the 2007 telephone diary survey were 13,400 days (10,500 – 16,200 days) in the Perth metropolitan area, 6,300 days (3,800 – 8,800 days) on the west coast (excluding the Perth metropolitan area), and 4,900 days (1,700 – 8,000 days) on the south coast (Roe's Abalone Table 3).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

CPUE and TACC assessment: The commercial divers' catch rates are the principal indicator of the abundance of legal-sized abalone and are assessed annually

The catch rate for dedicated Roe's abalone divers in 2007 was 142 kg/day, which was higher than the 2006 catch rate of 136 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. However, market forces (preference for large-sized abalone) have impacted on Area 8, where there is only a limited area of habitat producing large-sized animals, and the current TACC is not being caught. As a result of this, a reduction in Area 8 TACC from 12 to 9 t was recommended for 2008, resulting in an overall TACC reduction to 106.7 t (Roe's Abalone Table 1).

The catch rate of recreational fishers in the Perth metropolitan fishery of 28 abalone/hour was the second highest since surveys began in 1999 (Roe's Abalone Table 2).

Stock surveys: Densities of sub-legal animals (less than 60 mm in size) on the platform habitat increased from 35 in 2007 to 42 abalone m^{-2} in 2008 (Roe's Abalone Table 4). This is the highest level since 2001. On the sub-tidal habitat, densities of sub-legal animals increased from 5.6. to 7.2 abalone m^{-2}, which is the highest density since the survey began in 1997.

Densities of legal-sized animals (60+ mm) on the platform habitat were slightly higher in 2007 (21 m^{-2}), compared to 19 m^{-2} in 2006 (Roe's Abalone Table 4). However, overall, densities 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 habitat, legal-sized densities increased from 11 in 2007 to 15 abalone m^{-2} in 2008, which is the highest level recorded (Roe's Abalone Table 4). With the increased abundance of sub-legal animals, densities of legal-sized animals are expected to be maintained into the future.

Mean densities of legal-sized Roe's abalone in the MPA (Marine Protected Area) are significantly higher compared with the fished stocks, for both platform and sub-tidal habitats. However, the difference is less evident for sub-legal animals.

Breeding stocks: 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 – which is 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 2007, 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 the fishing in the remote Area 1 and, to a lesser extent, in Area 5 (80% of TAC caught). A reduction in Area 8 TAC (12 t to 9 t) was recommended for 2008 to account for less productive 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 commercially fishing for Roe's abalone, employing approximately 50 people across WA. 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 22,000 licences were issued that would have allowed fishers to participate in the recreational abalone fishery (Roe's Abalone Figure 4). 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 2007: $2.2 million

The estimated average price for Roe's abalone in 2007 was $24/kg, a reduction from $29/kg in 2006, and $33/kg in 2005. On the basis of the average price, the fishery was worth approximately $2.2 million – a decrease from the 2006 value of $2.9 million. Overall, the price of Roe's abalone has dropped by over 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 $US0.58 in 2000 to US$0.90 in 2007, and to competition from abalone produced by aquaculture.

Fishery Governance

Target effort range: 620 – 750 diver days

To assess whether the catch quota set in 2007 is appropriate (sustainable) relative to the stock available, Roe's abalone catches should be taken within the range of effort (620 – 750 diver days) recorded over the 1999 – 2006 fishing years. This range reflects the acceptable variation in catch rates due to weather and recruitment cycles.

The effort value of 585 diver days in 2007 (Roes Abalone Table 1) falls below the expected effort range, suggesting stocks are at historically-high levels, however not all quota was caught (83% of the quota was taken), so a lower effort is expected.

New management initiatives (2007/08)

The main new management initiative in 2007/08 was the review of performance indicators for the Roe's abalone fishery. Substantial consultations and discussions of these performance indicators have taken place with stakeholders, and a draft report of the outcomes is being prepared. This process shall be completed within the 2008/09 fishing year, with TAC setting for 2009 being undertaken with revised performance indicators alongside existing indicators.

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

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 in direct competition with small hatchery-produced greenlip abalone, which are now being released onto the market.

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 (roei 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[6]	119,900	112,949	659	149
2000	115,900	107,735	647	144
2001	107,900	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	90,750	585	142
2008	106,700			

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.
5. Reduced quota for a 6-month season.
6. In 1999, fishing restrictions (100 kg daily catch limit) in the Perth metropolitan area were lifted. This had the immediate effect of doubling the catch rate (kg/day) in that area.

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)	Meanweight (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
2007	12,433	28	338,000	34.4	102

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, 2006, and 2007.

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)
	2007	13,400 (10,500 – 16,200)	17.6	24 (19 – 29)
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)
	2007	6,300 (3,800 – 8,800)	14.1	9 (6 – 12)
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)
	2007	4,900 (1,700 – 8,000)	10.8	5 (1 – 9)

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, density estimates calculated in 2008 vary from 2007.

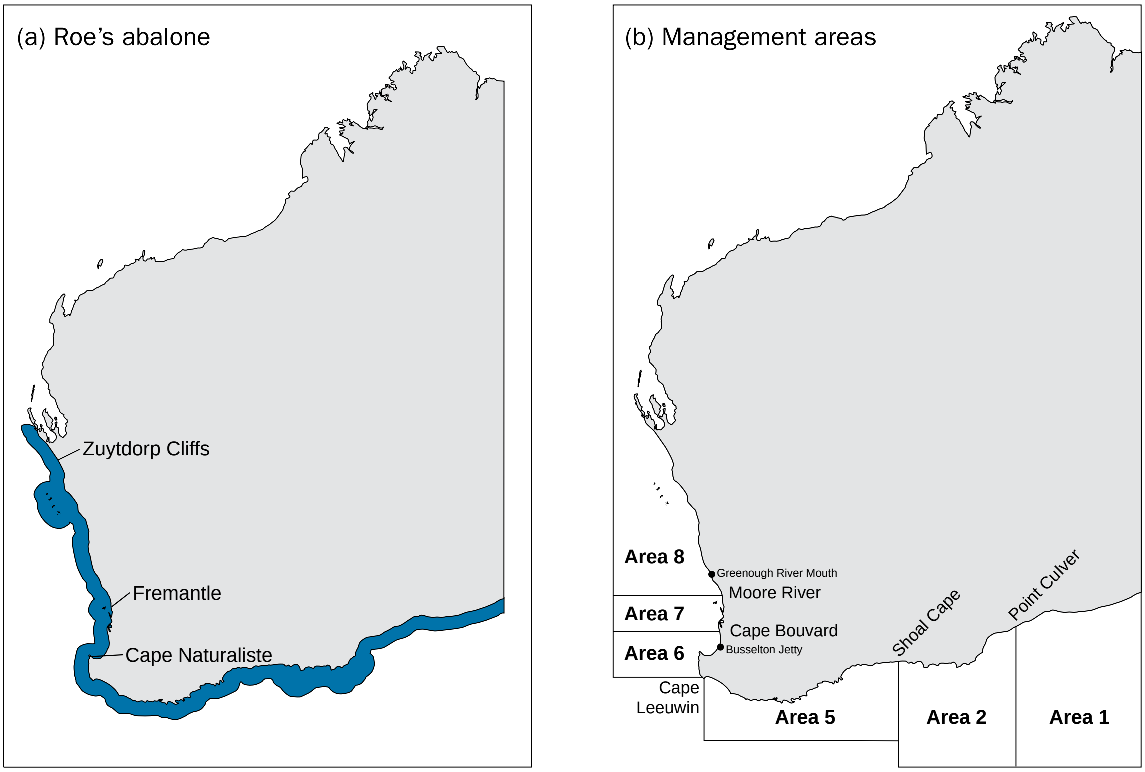
Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1997	32	29	44	26	4.2	12	9	21
1998	42	27	51	37	5.2	13	11	29
1999	47	26	52	26	3.8	7	12	27
2000	45	24	29	35	2.7	10	8	31
2001	44	25	38	34	3.7	10	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	35	19	42	35	5.6	11	7	23
2008	42	21	69	37	7.2	15	7	19

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2007.

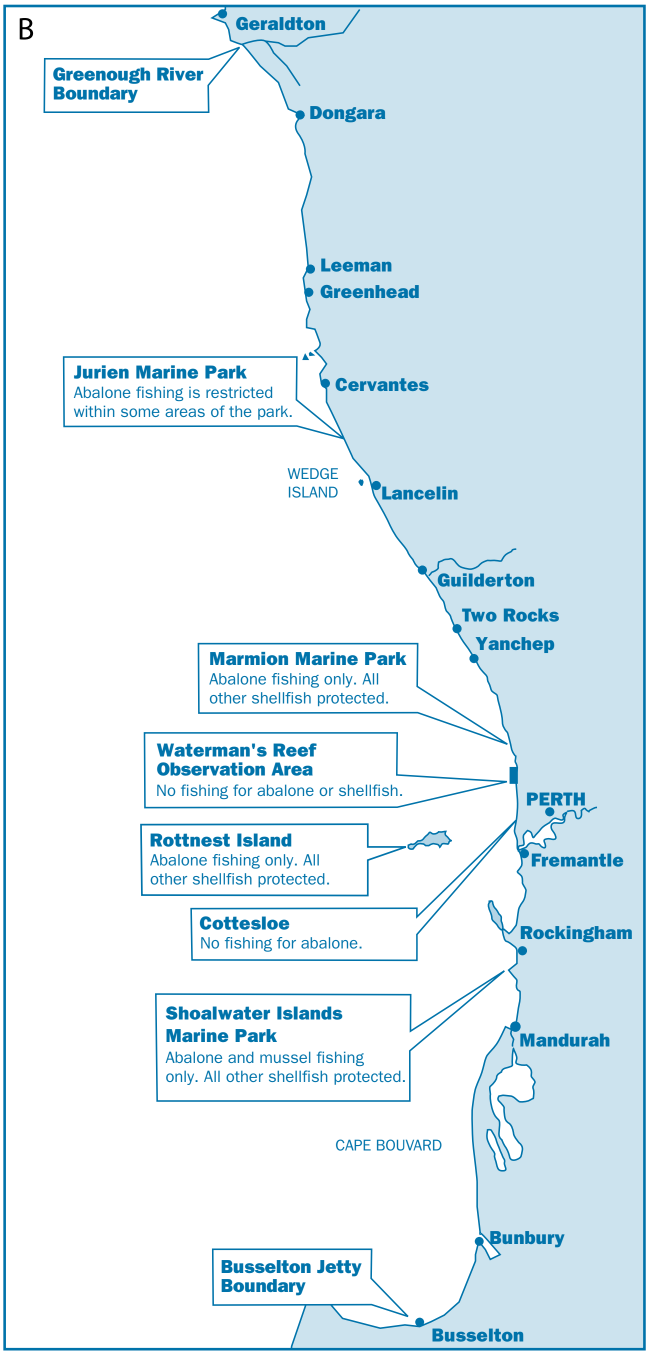
Performance Indicator	Performance Measure[1]	2007 Values	Assessment/Comments
Area 1			
Total catch (TACC)	9,900 kg	1,302	Exploratory quota – only a small percentage caught due to poor weather.
Total effort (diver days)	14 – 43	2	See above.
Area 2			
Total catch (TACC)	19,800 kg	18,940	Met – 99% of quota caught.
Total effort (diver days)	80 – 106	79	Met – within agreed level.
Area 5			
Total catch (TACC)	20,000 kg	16,094	Not met – 80% of quota caught.
Total effort (diver days)	100 – 140	90	Not met – below agreed level, but due to lower-than-average catch.
Area 6			
Total catch (TACC)	12,000 kg	11,980	Met – 99% of quota caught.
Total effort (diver days)	80 – 127	98	Met – within agreed level.
Area 7			
Total catch (TACC)	36,000 kg	35,998	Met – 98% of quota caught.
Total effort (diver days)	175 – 215	215	Met – within agreed level.
Area 8			
Total catch (TACC)	12,000 kg	6,444	Not met – 54% of quota caught.
Total effort (diver days)	140 – 200	101	Not met – below agreed level, but due to lower-than-average catch

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.



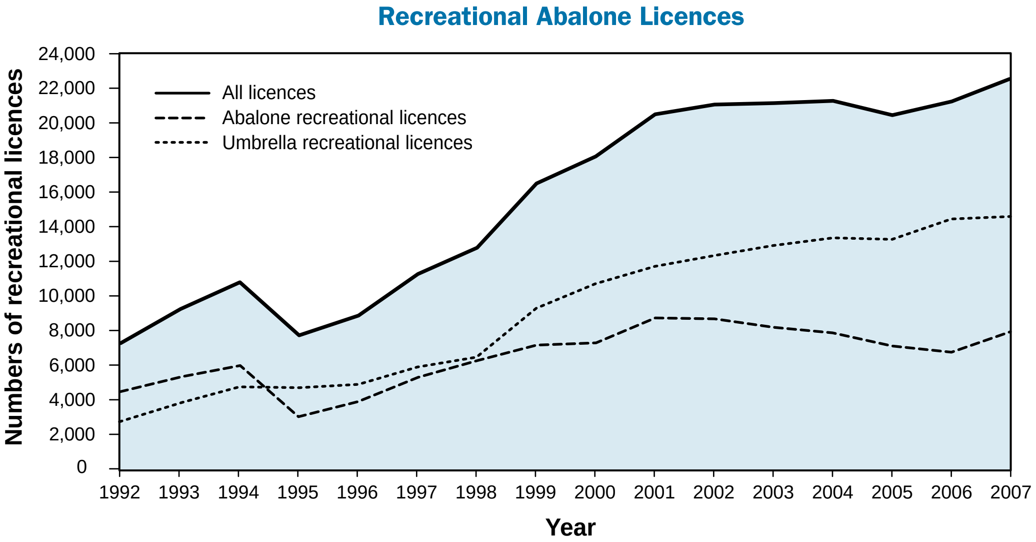
ROE'S ABALONE FIGURE 1

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.



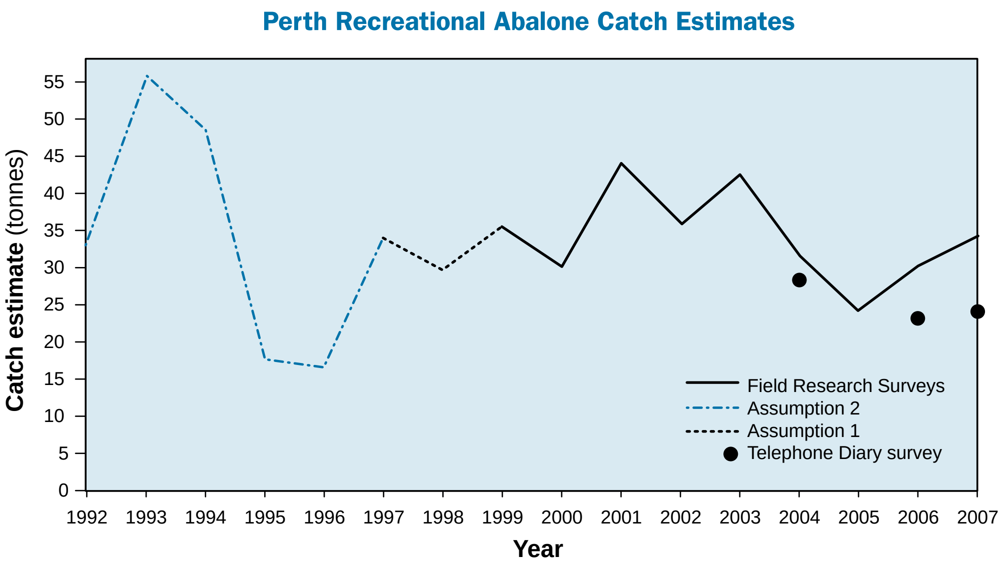
ROE'S ABALONE FIGURE 2

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

The number of licences issued in the recreational abalone fishery, by licence type, for the period 1992 to 2007.



ROE'S ABALONE FIGURE 4

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2007, including backwards projections through time, based on two assumptions. Error bars are SE.

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 and 2007, permissible fishing time per season day was 1 hour.

Abrolhos Islands and Mid West Trawl Managed Fishery

E. Sporer, M. Kangas S. Brown
Management input from J. Kennedy

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. The fishery operates to a threshold catch level to cease fishing for the season at 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 2007, the scallop season opened on 17 April and closed on 17 June. The Port Gregory prawn trawl area of the fishery also opened and closed in conjunction with the Abrolhos scallop season (i.e. 17 April – 17 June 2007).

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. All boats also complete detailed logbooks validated by processor returns. 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 industry.

Retained Species

Commercial landings (season 2007): 48 tonnes whole weight

The total landings for the 2007 season were 48 t whole weight (9.6 t meat weight) of scallops (Abrolhos Islands Scallop Figure 1). The predicted catch range for the 2007 season, based on a pre-season survey, indicated a low season total catch of scallops between 150 and 225 t whole weight. The total landings were below the predicted catch range. This was in part because boats ceased fishing at a catch rate threshold, whereas historically they may have fished to lower catch levels.

Recreational catch: Nil

Fishing effort/access level

For the 2007 season, 14 of the 16 licensed boats operated in the fishery, resulting in 176 fathoms of net headrope (out of a maximum of 184 fathoms) being utilised by the boats that operated. The swept area for this season was a total of 12 square nautical miles.

A total of 521 trawl hours (nominal effort) were recorded for the 2007 season (Abrolhos Islands Scallop Figure 1), equivalent to 468 standardised trawl hours (adjusted to 14 fathoms headrope length). The season effort in fishing days of 3 days was extremely low and similar to the low number (9 days) fished in 2006. The fleet ceased fishing by 20 April.

The effort applied in this fishery since 1997 is more in line with the available stock. The aim has been to reduce ineffective fishing effort by providing annual survey catch abundance and location reports to fishers so as to reduce search time and enable fishing effort to be applied where scallop abundance is high. Ceasing fishing at a catch rate threshold is also another factor in reducing effort.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected catch range next season (2008): 2,250 – 3,400 tonnes whole weight

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

This fishery is highly variable, being dependent on sporadic recruitment that 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 when recruitment settlement is widespread the prediction is likely to be conservative, but in years when recruitment is low the total catch is dependent on the level of effort that is applied. It should be noted that fishing ceases at a catch rate threshold level so that stock is left for spawning. This provides both economic and conservative fishing practice.

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 a collaboration between the Research Division and industry to protect areas of small scallops which will contribute to the breeding stock and catch the following year.

The survey index provided a catch prediction of 2,825 tonnes whole weight (565 tonnes meat weight) providing a catch range ± 20% for the 2008 season of 2,250 to 3,400t. The 2007 survey showed that most of the catch is mainly in the southern part of the fishery and is not widespread throughout the northern part of the fishery. Additional catches may be achieved in areas not covered by the survey.

The main performance measure for the fishery relates to maintaining breeding stocks of scallops. This is done in two ways – by setting the season fishing period according to the catch prediction and by closing the fishery at a threshold catch rate level. The 2007 fishing season was set at two months, consistent with the low yield predicted from the survey in November 2006. 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 2007, the total area of the fishery that was fished by scallop boats was approximately 1% (Abrolhos Islands Scallop Figure 2). The maximum area coverage has been 11%, which, occurred during the 2003 season when the scallops were widespread and in very high abundance. Owing to the focused nature of this fishery, the confined area fished in 2007 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 were always minimal and, now that grids are compulsory in the fishery, their capture should be eliminated. No records of turtle captures were made in 2007. 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 2007 and was confined to trawl grounds where fishable scallop abundance was indicated by the survey, rather than fishing 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

The boats in this scallop fishery generally have relatively high crew numbers – up to 13 per boat – in order to carry out on-board processing during the short period of fishing in the season. During the 2007 season, crew numbers were restricted to 10. The estimated employment for the year 2007 was 110 skippers and crew, as not all boats had the maximum number of crew for the 2007 season.

Economic Effects

Estimated annual value (to fishers) for year 2007: **$0.2 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 $3.60/kg whole weight or $18.00/kg meat weight. Meat weight is approximately 20% of the whole weight.

Fishery Governance

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

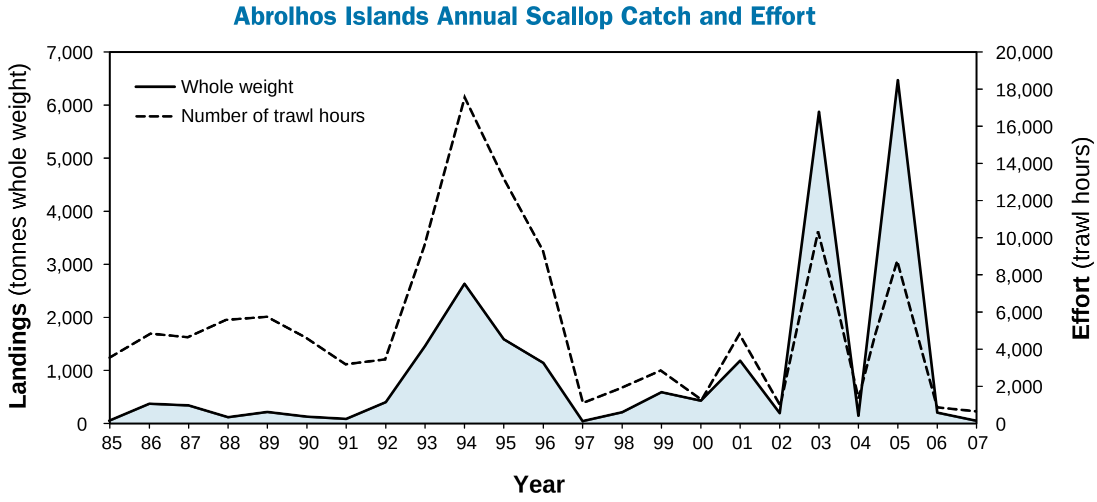
Current fishing level: **Acceptable**

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 tonnes whole weight. The catch in 2007 was predicted to be within the lower part of this range, due to a survey showing low pre-season recruitment.

New management initiatives (2007/08) **None**

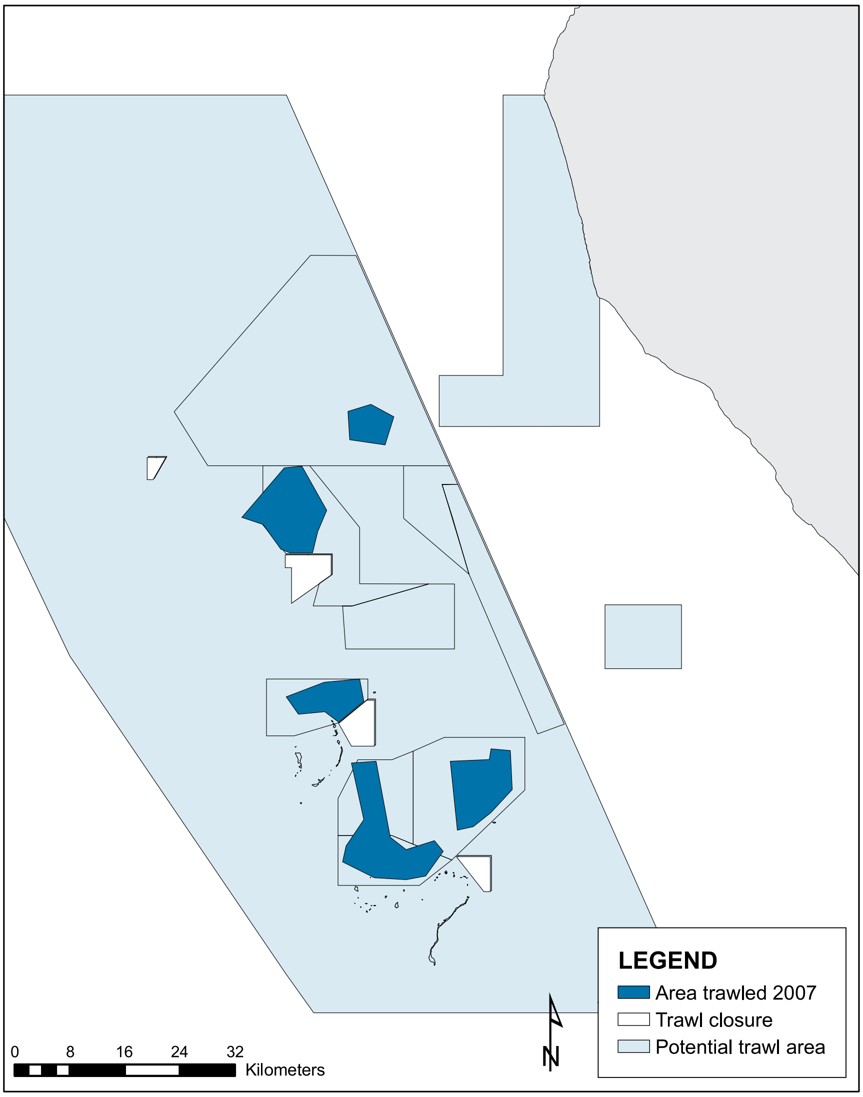
External Factors

The high level of recruitment seen in late 2002 and 2004, following very low catch in previous seasons, and then followed by low recruitment in 2005 and 2006, highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current, rather than spawning stock levels. It also illustrates the extreme level of annual variability in recruitment. The relationship between environmental factors and recruitment success is being evaluated.



ABROLHOS ISLANDS SCALLOP FIGURE 1

Annual scallop landings and nominal effort for the Abrolhos Islands and Mid West Trawl Managed Fishery, 1985 – 2007.



ABROLHOS ISLANDS SCALLOP FIGURE 2

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery and trawl area in 2007.

South West Trawl Managed Fishery Status Report

M. Kangas

Management input from J. Kennedy

Fishery Description

This fishery includes two of the state's smaller scallop fishing grounds – Fremantle and Geographe Bay. It is a multi-species fishery that 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 four 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 that limits boat numbers, gear sizes and fishing areas. A total of 14 boats are licensed to operate in this fishery, some in more than one 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 four 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 2007): Prawns 6 tonnes; Scallops 3 tonnes whole weight

Landings

The total landings for the season were 6 t of western king prawns and 3 t whole weight of scallops. The catch of king prawns was low, representing only about 40% of the average catch over the last five years, with scallop catches also being low, but slightly up on 2005 and 2006. The fishery also lands a mixture of by-product species of which the most abundant species recorded was 5 t of western sand whiting and 2 t of blue swimmer crabs (*Portunus pelagicus*). All other landings of by-product species were less than 1 t each.

Fishing effort/access level

A total of 175 days were recorded as being fished – only slightly up on 2006, which had been the lowest effort recorded in the fishery since 2002. This low level of effort reflects the continued and increasingly 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 that are 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 (< 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 2007 was 6 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2007:

Prawns Negligible
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 $12.00/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 $3.60/kg whole weight or $18/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 (2008/09)

Although a legislative amendment to provide for the introduction of the Department of Fisheries' vessel monitoring system (VMS) has been approved, it has continued to be 'on-hold', pending the 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 the fishing grounds and the product price paid to fishers, as well as the rising costs of fishing. Variations in recruitment are naturally high in scallop stocks. In other Western Australian scallop fisheries, these variations 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 N. Harrison

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 metres in depth.

However, the majority of the commercially and recreationally-fished stock 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 WA's commercial inshore crab landings, with more than three quarters of the annual catch now coming from Shark Bay, following the temporary closure of the Cockburn Sound Crab Fishery.

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 recreationally-fished inshore species in the south-west of WA in terms of participation rate. 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. Separate reports for crab fisheries in the Gascoyne and North Coast bioregions can be found in the appropriate sections of this document.

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 the commercial fishing sector (WAFIC)

Meetings between the Department of Fisheries and the Recreational Fishing Advisory Committee (RFAC) 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 and the waters of the Peel Inlet and Harvey Estuary, together with the Murray, Serpentine, Harvey and Dandalup Rivers.

The Mandurah to Bunbury Inshore Experimental 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 four 60-pot exemptions (in the 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.

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 male crabs in Shark Bay, which mature at 115 mm carapace width, blue swimmer crabs become sexually mature below 100 mm carapace width. The legal minimum size range varies between 127 – 130 mm carapace width 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 carapace width applies in State waters, along with a bag limit of 20 crabs per person or 40 crabs per boat.

As of November 1, 2007, the recreational bag limits in the West Coast bioregion have been halved to 10 crabs per person and 20 crabs per boat.

Restrictions also govern gear types that can be used to take blue swimmer crabs, along with localised spatial and temporal closures. Interim management measures have been introduced in August 2007 to include a seasonal closure to both commercial and recreational fishers in the Peel-Harvey Estuary for the months of September and October to protect pre-spawning female crabs.

Following several years of rapidly-depleting commercial blue swimmer crab catches in Cockburn Sound, the Minister for Fisheries closed the fishery to both commercial and recreational fishing in December 2006. Commercial fishers were prohibited from taking crabs in the whole of the Cockburn Sound Managed Crab Fishery, while recreational fishers were prohibited from taking crabs south of a line from Woodman Point across to Garden Island. The closure remained in place for the 2006/07 season.

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 in July 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

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 population dynamics are assessed using fishers' compulsory catch and effort returns, voluntary daily log books from fishers in the Mandurah to Bunbury Inshore Experimental Crab Fishery, and data from on-board catch monitoring conducted by the Department of Fisheries' research staff.

Trawl programs in Cockburn Sound aboard 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.

Studies are currently being undertaken to investigate the relationships between environmental variables and the success of spawning of blue swimmer crab stocks. In Cockburn Sound, an Egg Production Index model is being developed which attempts to correlate water temperature, in the pre-spawning months of August and September, and the size of the breeding stock with the following season's commercial catch.

Following the closure of the Cockburn Sound crab fishery in December 2006, research funding (from the Development and Better Interest Fund) was granted to:

a. undertake additional sampling in Cockburn Sound to provide a finer resolution to the assessment of recruitment and breeding stocks during the recovery of the resident stock;

b. maintain the Cockburn Sound commercial catch monitoring program during the fishery closure;

c. develop a commercial catch monitoring program in Warnbro Sound and the Swan River;

d. examine the genetic relationship between the Cockburn Sound stock and those in Warnbro Sound and the Swan River;

e. develop a commercial catch monitoring program in the Peel-Harvey Estuary and Comet Bay (Area 1 of the Mandurah to Bunbury Inshore Experimental Crab Fishery);

f. develop a fishery-independent sampling program to assess the status of the Peel-Harvey crab stock; and

g. undertake a 12-month recreational (creel) survey in the Peel-Harvey Estuary to provide an estimate of total recreational catch and effort.

Retained Species

Commercial landings (season 2006/07): 140 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2006/07 (July to June) was 947 t (West Coast Blue Swimmer Crab Figure 1) – a 6% increase on the 896 t taken in 2005/06. However, total landings from the West Coast bioregion declined 12% over the same period from 160 t in 2005/06 to 140 t in 2006/07.

This reduction in catch was primarily caused by the significant decline of the Cockburn Sound crab stock. The commercial catch from dedicated trap fishers in Cockburn Sound decreased from 53 t for the 2005/06 season to 2 t, due to the low recruitment and the closure of the fishery in December 2006 (West Coast Blue Swimmer Crab Figure 2).

In contrast, the commercial catch from the Peel/Harvey Estuary (Area 2 of the West Coast Estuarine Fishery) for 2006/07 of 95 t represented a 31% increase from the previous year and the highest commercial catch for this fishery (West Coast Blue Swimmer Crab Figure 3).

This trend was repeated in the Mandurah to Bunbury Inshore Experimental Crab Fishery, with reported landings of 28 t representing a 64% increase on the 2005/06 catch of 17 t similar to 2003/04 (West Coast Blue Swimmer Crab Figure 4).

Recreational catch estimate (season 2006/07):

Recreational catch: approximately 70% 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 in the vicinity of 70% of the total catch.

The recreational take is dominated by catch from the Peel/Harvey Estuary. A 12-month creel survey in 1998/99 estimated the recreational catch to be 289 t, or 80% of the total catch from the estuary in that year. 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. However, the recreational take of blue swimmer crabs in Cockburn Sound for the 2005/06 financial year was estimated to be just 3 t.

The Minister for Fisheries closed the Cockburn Sound crab fishery to recreational fishing south of a line between Woodman Point and the northern end of Garden Island in December 2006. The closure was still in effect on 30 June 2007.

A 12-month survey of recreational fishing in the Swan/Canning Estuary Basin between August 1998 and July 1999 estimated the total recreational blue swimmer crab catch to be 7.3 t. This compares with a commercial catch during the 1998/99 financial year of 24 t. In subsequent years, commercial catches have ranged between 10 t and 20 t, but 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 – previous surveys have found their catch was between 7 – 11 t per year.

Fishing effort/access level

Due to the low recruitment of the blue swimmer crab stock in Cockburn Sound, little fishing effort was expended during the second half of 2006 before the fishery was officially closed in December of that year. A single fisher operated at the weekends from July through September, accounting for just 2,786 trap lifts. This level of effort compares to 109,138 trap lifts during 2005/06 (West Coast Blue Swimmer Crab Figure 2).

Commercial fishers in the Peel-Harvey Estuary reported 66,114 trap lifts during the 2006/07 season – a 21% increase on the 54,522 trap lifts reported the previous year (West Coast Blue Swimmer Crab Figure 3). This represents the highest annual commercial effort since the fishery converted to purpose-designed hourglass crab traps in the late 1990s. The annual fishing effort in the estuary has been found to follow variations in the abundance of the resident crab stock.

Commercial effort in the Mandurah to Bunbury Inshore Experimental Crab Fishery almost doubled in 2006/07, with a total of 24,006 trap lifts reported compared to 12,200 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 4).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Cockburn Sound – Inadequate; Other West Coast fisheries – Adequate

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

Cockburn Sound: Due to the low fishing effort, the CPUE for 2006/07 is not available. Historically, the annual commercial catch of blue swimmer crab in Cockburn Sound has experienced large fluctuations (e.g. 362 t in 1996/97 versus 92 t in 2001/02), with the catch (and effort) reflecting stock abundance. Inter-annual variations observed since 1977 are presumably related to variable recruitment, while the shift by commercial fishers from set nets to crab traps in the mid-1990s coincided with a marked increase in mean annual crab landings.

A preliminary stock-recruitment-environment relationship has been developed to investigate the factors affecting recruitment. The minimum legal size for both the commercial and recreational crab fishery (130 mm carapace width and 127mm carapace width respectively) are set well above the size at sexual maturity (98mm carapace width), allowing crabs to spawn at least once before entering the fishery. It appears that the 3 years of reduced recruitment since 2003, most likely due to below-average water temperatures during spawning months, coupled with continued high levels of fishing pressure, resulted in a significant reduction in the relative levels of egg production.

The introduction of traps in the 1990s led to catches increasing significantly over the winter months (April to September), which had previously been a period of minimal effort as unfavourable weather meant set nets could not be used. Length frequency analysis has shown that catches in these months are predominantly females, which increased the impact on egg production levels for this stock by removing these individuals 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 recover the breeding stock, the Cockburn Sound fishery was closed to both commercial and recreational crab fishing in December 2006. The juvenile recruitment was, while slightly improved, still low, so the closure has been continued to December 2008.

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.

Peel Harvey: The mean catch rate for 2006/07 in the Peel-Harvey estuary was 1.43 kg/trap lift – a steady increase on the 1.33 kg/trap lift recorded the previous year (West Coast Blue Swimmer Crab Figure 3). Other than 2002/03 (1.06 kg/trap lift), catch rates for the past 6 years have been markedly consistent at around 1.3 – 1.4 kg/trap lift. As with catch and effort, the 2006/07 catch rate was the highest on record since the conversion to hourglass traps (West Coast Blue Swimmer Crab Figure 3).

A recreational creel survey conducted in 1998/99 estimated that the commercial take accounted for only 20 per cent of the total catch. Consequently, it was recognized that commercial catch data alone may not be providing an accurate indication of the status of crab stocks in this estuary.

In recent years, members of the Mandurah community have expressed concern over the status of blue swimmer crab stocks in the Peel-Harvey Estuary. This concern has been highlighted by apparent declines in recreational catch rates identified in Fisheries Volunteers data, and through anecdotal evidence from the community. However, it was not clear whether these observations were an indication of overall crab numbers, or a reflection of increasing numbers of recreational fishers.

In light of these concerns and the Cockburn Sound stock collapse, the Minister for Fisheries approved a grant from the Development and Better Interest Fund for a three-year project to adequately assess the crabs stocks in the Peel-Harvey Estuary and a 12-month survey to provide accurate estimates of recreational catch and effort.

Mandurah-Bunbury: Trap catch rates in the Mandurah to Bunbury Inshore Experimental Crab Fishery have increased steadily since the commencement of exploratory fishing along the coast south of Mandurah to Bunbury in 2002. This increase reflects more efficient fishing of 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 2006/07 in the Mandurah to Bunbury fishery was 1.05 kg/trap lift – a marginal increase on the 2005/06 catch rate of 1.03 kg/trap lift (West Coast Blue Swimmer Crab Figure 4).

Non-Retained Species

Bycatch species impact: Negligible

The shift from using set nets 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 macro-benthos.

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 2006/07, approximately 33 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion. However, this employment has been adversely affected by the closure of the Cockburn Sound Crab Fishery in November 2006, which accounts for as many as 14 commercial fishers.

Blue swimmer crabs also provide a highly popular recreational fishery, particularly in the Peel-Harvey and Geographe Bay region, where they dominate the inshore recreational catch. The recreational fishing has also been affected by the closure of the Cockburn Sound crab fishery.

Economic Effects

Estimated annual value (to fishers) for year 2006/07: $0.7 million

The value of commercial blue swimmer crab fishing across the State for the 2006/07 season was estimated to be $4.3 million – up slightly on the $4 million generated in 2005/06.

Despite the minimal catch from the Cockburn Sound crab fishery, the blue swimmer catch in the West Coast bioregion was again valued at $0.7 million. This was attributed to a record catch in the Peel-Harvey Estuary and a slight increase in the beach price for blue swimmer crabs from the West Coast region because of the tightening of local supply caused by the Cockburn Sound closure. The catch from the West Coast bioregion was sold largely through local markets.

Fishery Governance

Target catch (or effort) range: Under review

In the light of recent recruitment failures in the Cockburn Sound fishery, the target range will need to be reviewed when the fishery is re-opened.

Current fishing (or effort) level

Cockburn Sound: Under development

Other West Coast Bioregion fisheries: Under development

New management initiatives (2006/07)

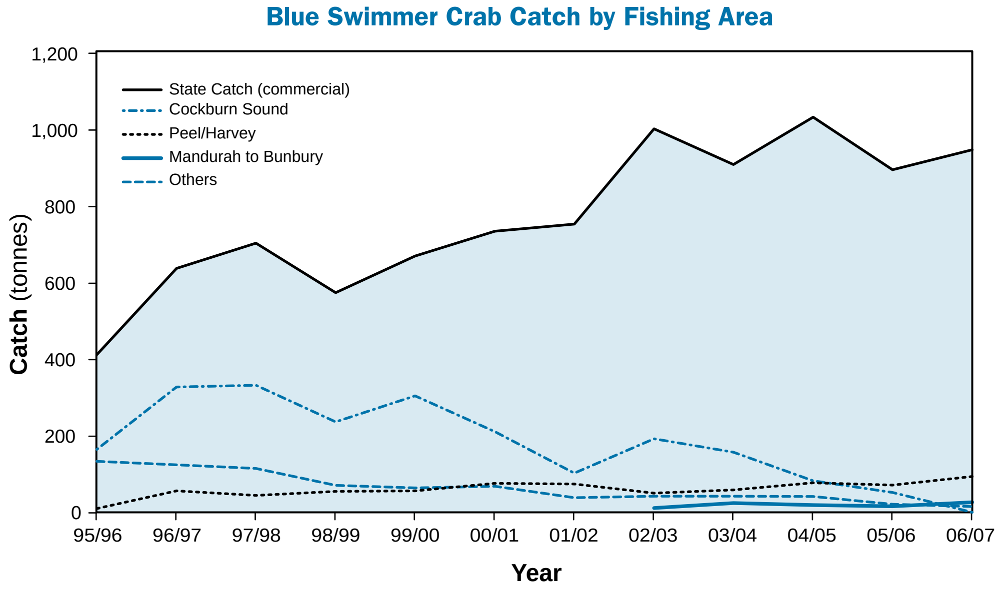
Several interim management arrangements have been put in place following the decline of the Cockburn Sound crab stocks, and in response to concerns raised by the Mandurah community regarding anecdotal evidence of declines in recreational catch rates of blue swimmer crabs in the Peel-Harvey Estuary. An annual closure has been introduced in the Peel-Harvey Estuary to provide protection for pre-spawning females. The closure, which took effect on 1 September 2007, covers the months of September and October and applies to both recreational and commercial fishers. As of 1 November 2007, the recreational bag limits for the whole of the West Coast bioregion have been halved to 10 crabs per person and 20 crabs per boat.

These arrangements will be reviewed following the completion of the research programs being carried out in both Cockburn Sound and the Peel-Harvey Estuary.

Effort levels in the Mandurah to Bunbury Inshore Experimental Crab Fishery have been assessed as part of the Developing New Fisheries review process. Outcomes of this assessment are expected in 2008.

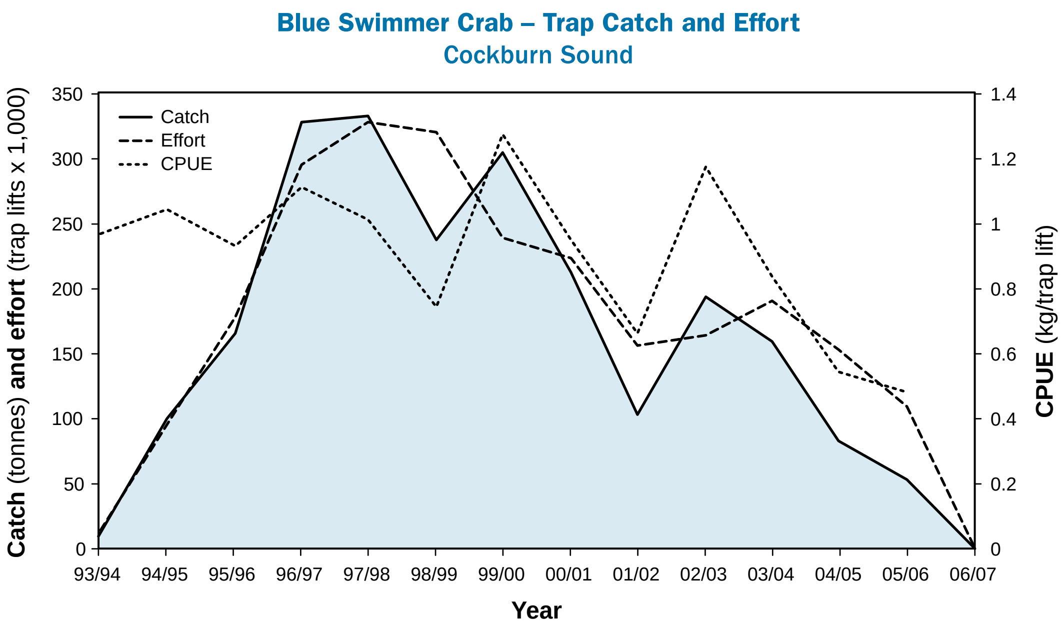
External Factors

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



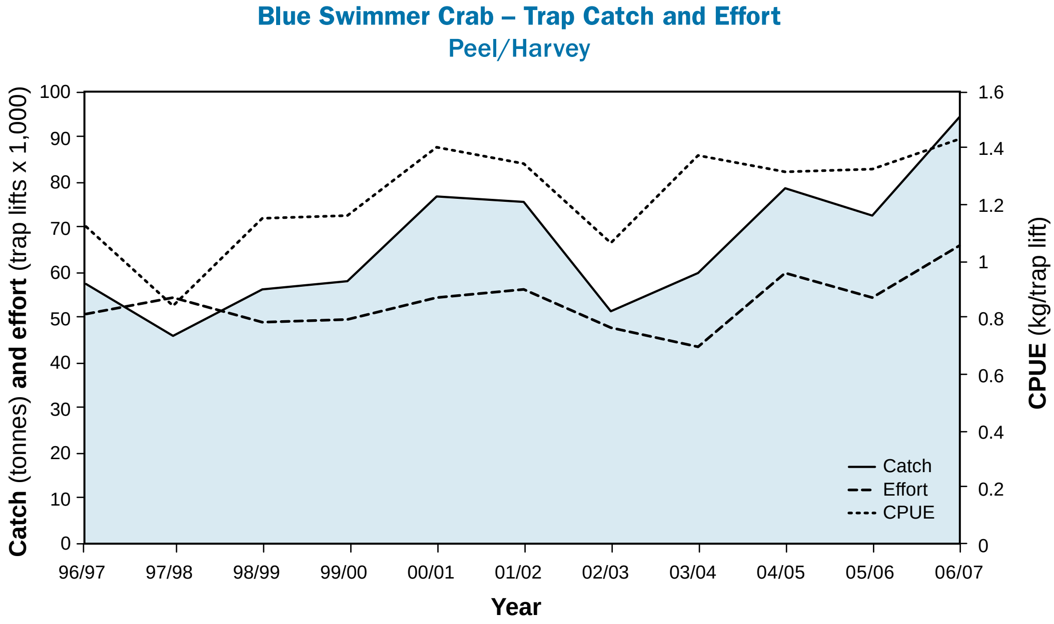
WEST COAST BLUE SWIMMER CRAB FIGURE 1

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



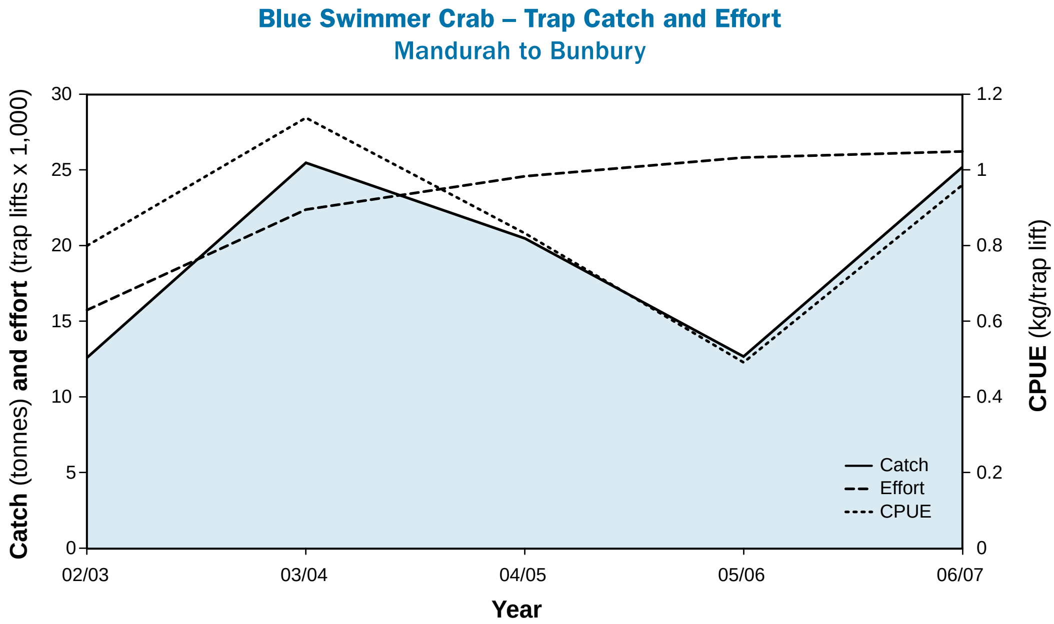
WEST COAST BLUE SWIMMER CRAB FIGURE 2

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 2006/07 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 1996/97 and 2006/07 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 Inshore Experimental Crab Fishery between 2002/03 and 2006/07.

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

R. Melville-Smith and P. Unsworth
Management input by N. Harrison

Fishery Description

The West Coast Deep Sea Crab (Interim) Managed Fishery targets giant (king) crabs (*Pseudocarcinus gigas*), crystal (snow) crabs (*Chaceon albus*) and champagne (spiny) crabs (*Hypothalassia acerba*) using baited pots operated in a long-line 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 (2007) 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-metre 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 metres, with the only allowable method for capture being baited pots ('traps'). 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 five full-time permits and two part-time permits to operate in the fishery. The existent interim management plan expired 31 December 2007 and was replaced by a new interim management plan on 1 January 2008.

The new interim management plan introduced 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.

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 became available in September 2004 and the Department of Fisheries component in mid-2007.

Retained Species

Commercial landings (season 2007): 233 tonnes

A catch of 233 t of crystal crabs was taken in the fishery in 2007 – an increase of 24% on the catch taken in the 2006 season (188 t) (Deep Sea Crab Figure 1). This is the highest annual catch that has been made in the short history of this fishery. There were no catches of giant crabs or champagne crabs landed by the fishery during the 2007 season.

Recreational catch estimate (season 2007): Nil

Fishing effort/access level

Effort increased by 7% from an estimated 115,000 pot lifts in the 2006 season to 123,000 pot lifts in the 2007 season. The effort estimate in this fishery is based on detailed catch and effort research logbook returns, which were required to be completed by fishers in this fishery during its developmental status.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

In recent years the research data obtained from research logbooks has become increasingly reliable and for the last four years the research logbook catch data has closely matched the Catch and Effort Statistics obtained from statutory monthly returns. As the effort data from research logbooks has always been used in the analysis of Catch Per Unit Effort (CPUE) for the fishery, it has been decided that all data since 2003 used in the catch and effort analysis will be obtained from research data. The analysis and graphs presented in this report reflect this change.

The standardised catch per unit of fishing effort for crystal crabs increased by 6%, from 1.39 kg/pot lift in 2006 to 1.48 kg/pot lift in 2007 (Figure 2). .

Decreases and increases in nominal CPUE were recorded in different zones in the fishery. However, there would not appear to be cause for concern at this stage because catch rates per pot lift have been fluctuating over a range of about 20% since 2003. 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.

Fisheries Research and Development Corporation-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 'Landings' section).*

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 to 800 metres in 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

This fishery is based on mobile vessels that employ a skipper and two or three 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 2007: **$2.9 million**

The beach value of the fishery was about $3.0 million in 2007, based on an average beach price of $13/kg for crystal crab. The majority of the catch is exported live to south-east Asia.

Fishery Governance

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

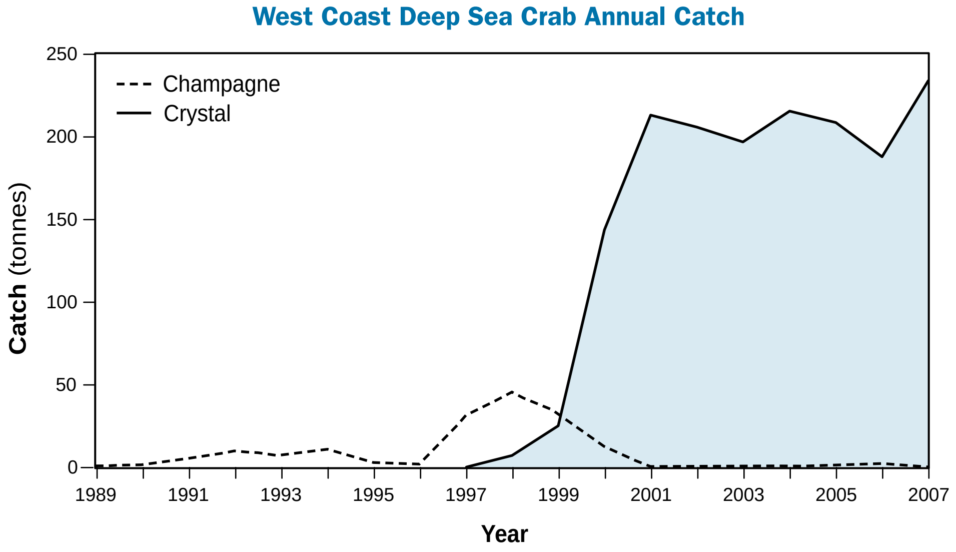
The effort in this interim managed fishery during 2007 was restricted to 3 full-time and 1 part-time fishers spread throughout the range of the fishery. Not all these permits are being used. The fishery has probably been fully exploited since about 2000 and at current levels of fishing a catch of 100 – 250 t would be expected in the next few years.

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

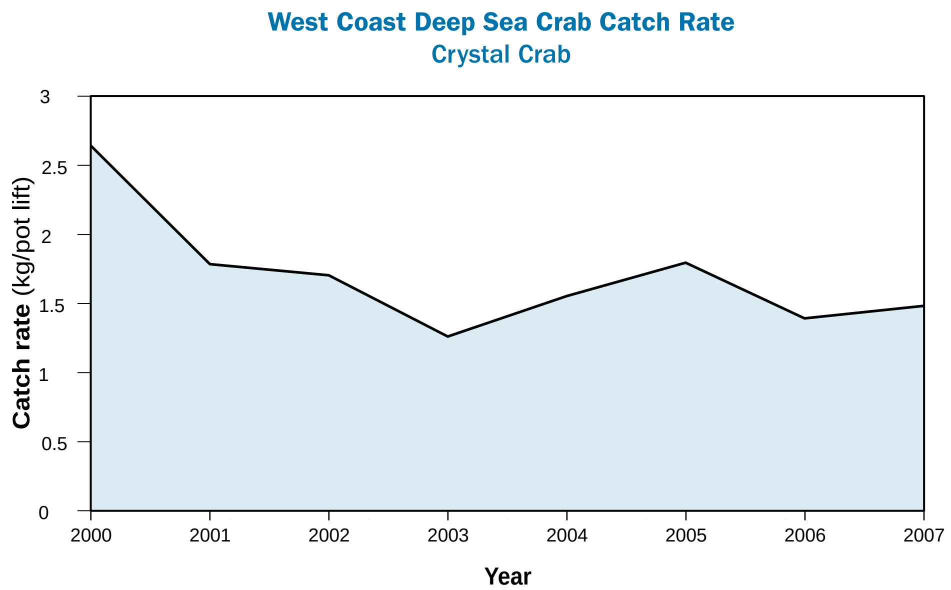
The catch in the crystal crab fishery has fluctuated between 186 and 233 t over the last 7 years. Over this same period, fishing effort has been more variable. This is a new commercial fishery that has only been fished on a full-time basis since 2000 and the target is a long-lived species. Given its recent history, sustainable levels of fishing are still being determined.

New management initiatives (2008)

The fishery has moved to a new unitized, quota-based interim management plan in early 2008, set at 140 tonnes for the fishery. The new interim plan will run for a further 5 years and provide for 7,000 individual transferable units (1,000 per permit holder).



WEST COAST DEEP SEA CRAB FIGURE 1
Annual catches of crystal and champagne crabs since 1989. Annual giant crab 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 N. Harrison

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 elsewhere in this document.

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 estuarine fisheries.

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, industry and peak body members (e.g. the Western Australian Fishing Industry Council and Recfishwest).

Boundaries

Swan/Canning and Peel/Harvey Estuaries: The management plan encompasses all estuaries on the west coast between 27º S and 33º11´ 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.

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 Department of Fisheries' 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 in west coast estuaries 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 of Fisheries. 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 2007): 199 tonnes

In 2007, the total catch from west coast estuaries was 199.1 t, including the following catches of key target species:

Blue swimmer crabs	*Portunus pelagicus*	87.8 t
Sea mullet	*Mugil cephalus*	58.3 t
Yellow-eye mullet	*Aldrichetta forsteri*	22.2 t
Western sand whiting	*Sillago vittata*	10.2 t
Australian herring	*Arripis georgianus*	8.2 t
Perth herring	*Nematalosa vlaminghi*	5.6 t
Tailor	*Pomatomus saltatrix*	1.5 t
Black bream	*Acanthopagrus butcheri*	0.9 t
King George whiting	*Sillaginodes punctata*	0.9 t
Cobbler	*Cnidoglanis macrocephalus*	0.7 t
Other species		2.6 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. From the year 2000 to 2005, the total catch, along with fishing effort, remained relatively stable. In 2006 and 2007, the catch and effort both declined.

The total fishery catch in 2007 was slightly lower than in 2006 (actual figure not reportable owing to the small number of operators).

The 2007 catch was composed primarily of blue swimmer crab, Perth herring and sea mullet, with small quantities of yellow-eye mullet, black bream and yellowtail perch (*Amniataba caudavittata*). In total, at least 18 different species were caught in the Swan/Canning estuary during 2007.

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 2007, the total Peel/Harvey estuary catch was 165 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 2007, approximately 50% of the total Peel/Harvey catch consisted of blue swimmer crabs, with sea mullet, yellow-eye mullet, Australian herring and western sand whiting making up 96% of the finfish catch.

Hardy Inlet: The total fishery catch in the Hardy Inlet in 2007 was slightly lower than in 2006 (actual figure not reportable owing to the small number of operators). The catch level trend has been relatively stable since 1996. In 2007, the Hardy Inlet catch consisted of 6 different species. Western sand whiting and black bream comprised the majority of the catch (69 and 21%, respectively), with small quantities of blue swimmer crabs, black bream, cobbler and King George whiting 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 2007, although the amount caught in the latter was minimal. In the Swan/Canning estuary, the catch in 2007 was lower than in 2006, and well below the 10-year (1997 to 2006) average for this species in this estuary. The 2007 black bream catch in the Hardy Inlet, while up slightly on the previous year, was also well down on the 10-year average.

Cobbler: In 2007, cobbler was primarily caught in the Peel/Harvey estuary, with a minor amount caught in the Hardy Inlet estuary (a prohibition to catch cobbler in the Swan/Canning estuary was introduced on the 6 July 2007 in order to protect the species). 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. The situation is similar in the Peel Harvey estuary, where cobbler catches have also declined following a peak in 1980 of 232.8 t. Since 2000, annual catches have not exceeded 5 t, with the 2007 catch of 498 kg being the lowest on record.

King George whiting: In 2007, commercial landings of King George whiting were reported from the Peel/Harvey Estuary and Hardy Inlet. 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. The

2007 catch of King George whiting in the Peel Harvey estuary was only 772 kg.

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 May 2007. 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 license buy-back scheme applied to commercial fishing licenses 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 2007.

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 2,033 days fished per year between 2000 and 2007 (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 2007.

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): Inadequate

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 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 2007, there was an average of 14 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 2007: $1.55 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 (2007): 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.

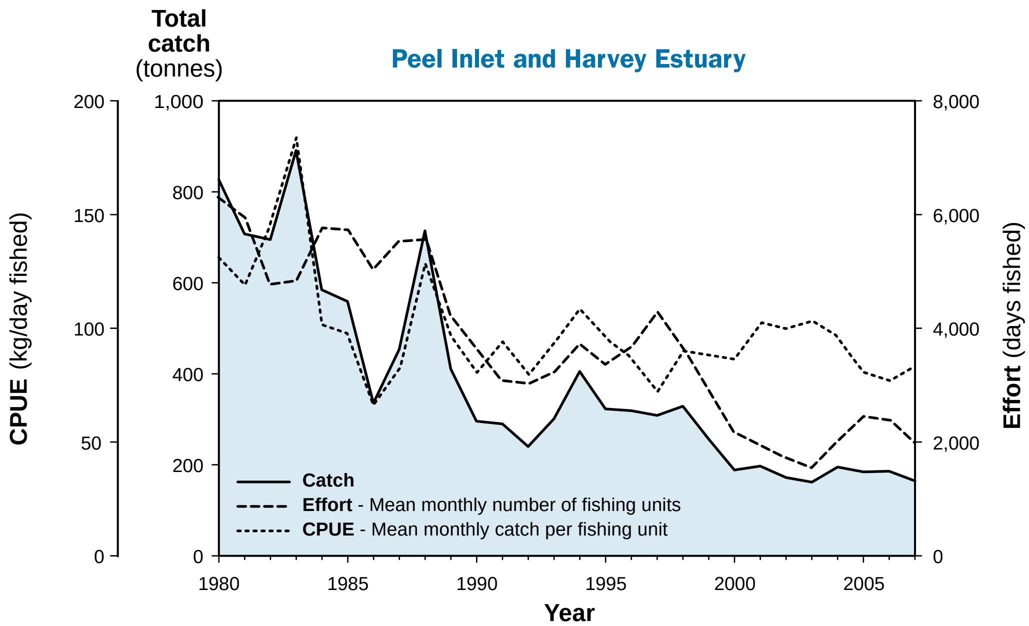
New management initiatives (2007/08)

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 (e.g. black bream, cobbler).



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 – 2007.

Cockburn Sound Fisheries Status Report

K. Smith and J. Brown
Management input from N. Harrison

Fishery Description

Cockburn Sound is a large marine embayment, approximately 10,000 hectares 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 69% by weight) have been baitfish taken by the West Coast Purse Seine Fishery (mainly scaly mackerel *Sardinella lemuru* and pilchards *Sardinops sagax*). 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 blue sprat *Spratelloides robustus* and whitebait *Hyperlophus vittatus*).

Historically, 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) Fishery (mainly octopus *Octopus tetricus* and squid *Sepioteuthis australis*), and by aquaculture (mussels *Mytilus edulis*).

Cockburn Sound is a very popular recreational fishing area and 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.

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 in 2007 by the Cockburn Sound (Line and Pot) Fishery include handlines, 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 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 two 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, the pink snapper 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 2007, the closure was extended from the 1 October to 31 January 2008.

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.

Due to poor recruitment and low numbers of blue swimmer crabs, Cockburn Sound was closed to commercial and recreational fishing for crabs on 15 December 2006, and remained closed for all of 2007.

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 that 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 (RAP), 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, King George whiting (*Sillaginodes punctata*), tailor (*Pomatomus saltatrix*) 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 (e.g. Pink Snapper). 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 of Fisheries in 1996/97 (Sumner and Williamson 1999) and 2005/06 (Sumner *et al*. 2008). 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 2007): 35 tonnes of finfish (non-baitfish)
39 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 123 t in 2007. 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 which was closed in all of 2007 following low recruitment numbers) (Cockburn Sound Figure 2).

Between 1995 and 2007, annual landings of baitfish declined from 655 to 49 t and crab landings declined from 194 to 44 t in 2006 (the crab fishery was closed in 2007, and therefore no catch was recorded). Over the same period (1995-2007), non-bait finfish landings declined from 120 t to 35 t, while the annual catch of cephalopods increased from 8 t to 39 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 five 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. In 2007, the catch was marginally higher at 35.2 t.

The 2007 finfish catch included at least 12 teleost species. Approximately 84% of the 2007 catch consisted of Australian herring and southern sea garfish, which were caught primarily by gill netting. The next most abundant components of the catch were yellowtail scad (*Trachurus novaezelandiae*), Western Australian salmon (*Arripis truttaceus*), and pink snapper.

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 2007, the herring catch was higher than in the previous year (actual figures cannot be reported as there are fewer than five operators catching this species) and was only just below the 10-year average for the period 1997 to 2006. 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 2007, 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 a peak of 36.9 t in 1999. Landings of garfish then declined to 13.8 t in 2001 and have since remained relatively stable, fluctuating between 10 t and 20 t per year. The 2007 catch was at the lower end of this range, only slightly above the 2006 level, which was the lowest recorded in the last 10 years.

Octopus: For the period 1995 to 2000, the annual commercial catch of octopus in Cockburn Sound averaged 3.3 t per year. Since 2001, the octopus catch has averaged 27.7 t per year. In 2007, the total Cockburn Sound octopus catch was 35.6 t – down from the 45.2 t reported in 2006 (Cockburn Sound Figure 5). About 19% of the total west coast commercial catch of octopus in 2007 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 2007 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, but 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 and then declined again in 2007 to 409 boat days. 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 440 boat days per year from 2003 to 2007 (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. The recent increase in effort is 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.

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. In 2007, the effort declined to 274 days, as some licensees chose to operate in the ocean blocks outside of Cockburn Sound.

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.

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, WA, 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 2007 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 was stable from 2003 to 2006 but increased in 2007. This can be attributed to a combination of reduced effort and improved fisher knowledge and gear technology.

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 2007, 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 9. 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 2007: **$159,223 (finfish)**
$142,380 (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 2007 catch of 35.2 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, although recent research indicates that nearly all of the Cockburn Sound octopus catch are juveniles that are yet to reproduce. In 2007, 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 2000. 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 (2007/08)

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.

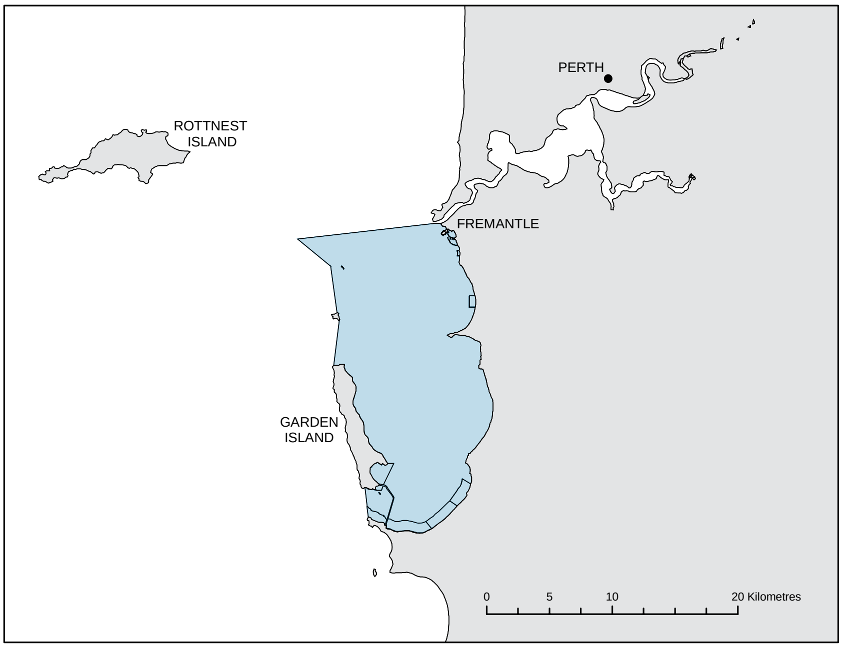
The abundance of sea garfish, octopus and other target species in Cockburn Sound is likely to be affected by the quantity and quality of coastal habitats (especially seagrass) that are available for spawning, feeding and/or nursery areas. Since the 1950s, approximately 80% of the seagrass meadows in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

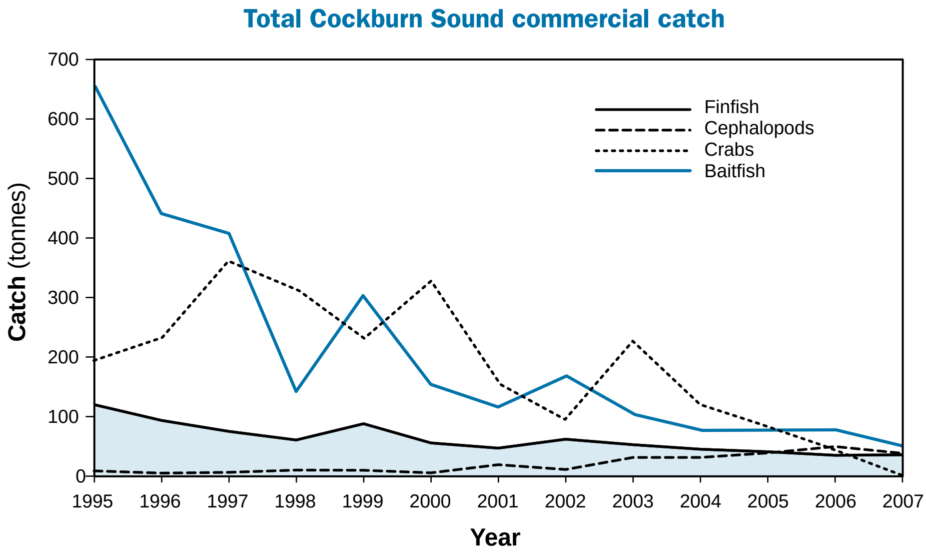
	Estimated Recreational Catch 2000 – 2001		
Finfish Species	**Tonnes (t)**	**Percentage from shore**	**Percentage from boat**
Australian herring	62	76	24
Skipjack	27	57	43
Whiting	26	20	80
Garfish	18	99	1
Tailor	17	98	2
Dhufish	14	0	100
Pink snapper	11	0	100
Silver bream	7	95	5
Cephalopod	**Tonnes (t)**	**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.



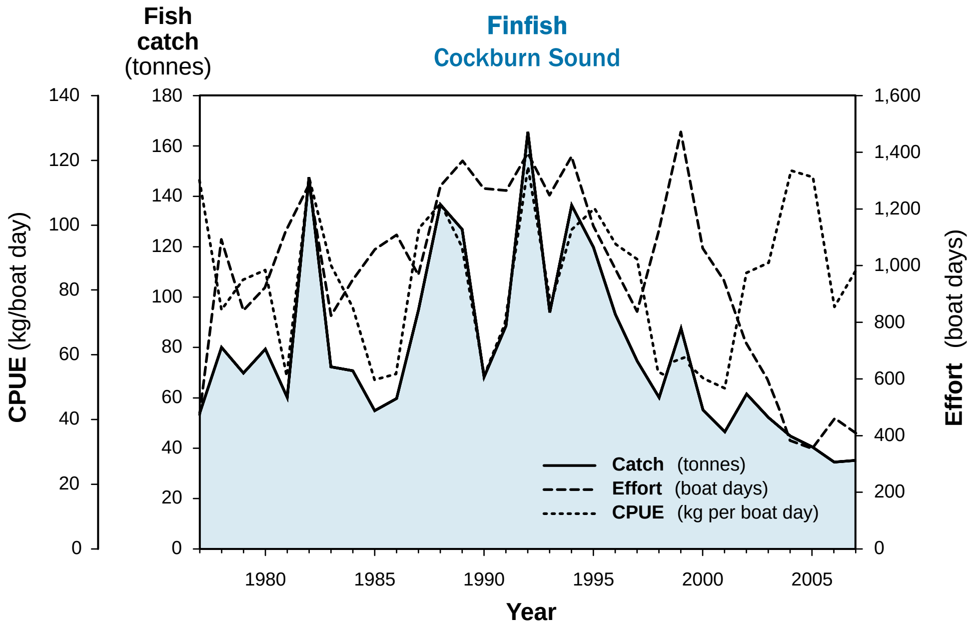
COCKBURN SOUND FIGURE 1.

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



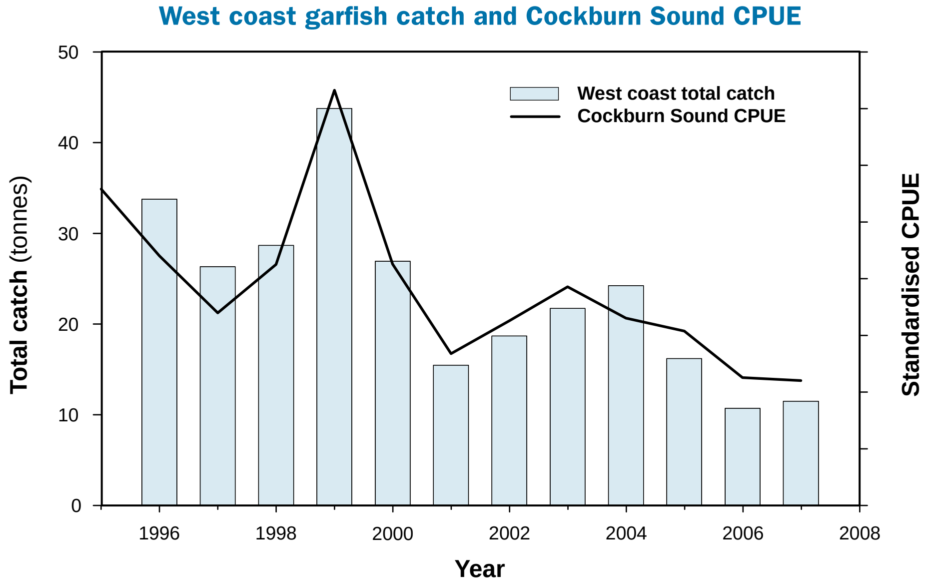
COCKBURN SOUND FIGURE 2

Total annual landings in Cockburn Sound by all commercial fisheries from 1995 to 2007. 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.



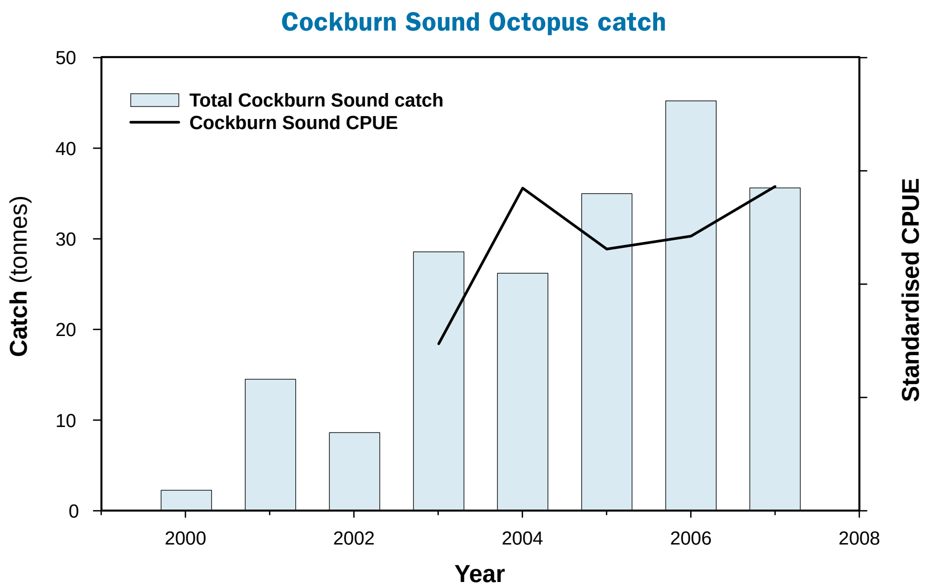
COCKBURN SOUND FIGURE 3

The annual catch, effort and catch per unit effort (CPUE) for finfish (excluding bait fish) for the Cockburn Sound fisheries over the period 1977 – 2007.



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 – 2007.



COCKBURN SOUND FIGURE 5

Annual Cockburn Sound commercial catch and standardised Cockburn Sound commercial log book CPUE for octopus over the period 2000 – 2007.

West Coast Beach Bait Managed Fishery Status Report

T.Leary and B.Molony
Management input from N. Chambers

Fishery Description

The West Coast Beach Bait Managed Fishery is reported together with the much larger South West Beach Seine (SWBS) Fishery, as both primarily target whitebait (*Hyperlophus vittatus*). In addition to whitebait these fisheries also captures blue sprat (*Spratelloides robustus*) and mullet (*Mugil cephalus* and *Aldrichetta forsteri*).

The main fishing method is beach seine netting, although non-powered purse seining from small boats is also undertaken. Many of the fishers involved in the SWBS fishery are also involved in the South West Coast Salmon Managed Fishery, which operates in the same area and primarily targets western Australian salmon (*Arripis truttaceus*) using larger beach seine nets than are used for whitebait fishing. Other fish species caught and also reported elsewhere includes Australian herring, tailor and minor incidental captures of squid and octopus.

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 West Coast Beach Bait Managed Fishery 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 beach seining fishing activities 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 West Coast Beach Bait managed Fishery is managed primarily through input controls (limited entry and gear restrictions). 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 West Coast Beach Bait Fishery (Metropolitan and Mandurah areas).

Research summary

A significant research project on the biology and stock assessment of whitebait was completed in 1996. Based on this research, the annual catch of whitebait, obtained from the information supplied by fisher's monthly returns, is used as an 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 2007):

All species 160 tonnes
Whitebait 101 tonnes

The main target species in this fishery is whitebait, of which 101 t were caught in the 2007 season (West Coast Beach Bait Figure 1). Catches of whitebait are discussed here according to the region in which they were landed. Metropolitan and Mandurah landings form part of the West Coast Beach Bait Managed Fishery, while Bunbury landings are from the 'south-west fishery'. Catches in each of the regions have varied significantly from the previous year and large inter-annual fluctuations in catch of whitebait are typical of this fishery (see 'Breeding stock levels').

Metropolitan: There were no whitebait reported catch in this fishery in 2007. This is a continuation of the decline in catches over recent years, reflecting low effort from the remaining fishers. The previous four seasons in the Metropolitan region have all returned minimal catches of below 2 t.

Mandurah: The 2007 whitebait catch at Mandurah was 4 t – half the previous years catch but similar to the 2005 landings.

Bunbury: In contrast to last season's decadal high catch of 221 t, whitebait captured in 2007 totaled 97 tonnes. This is below the long term average for the Bunbury region of 165 t, but not outside of the range of catches observed during the past 20 years.

The total catch of all other species in all regions in this fishery was 59 t, which was dominated by blue sprat, sea and yellow-eye mullets (West Coast Beach Bait Table 1). The catch of blue sprat increased significantly to 28 t from 12 t in 2006, while the catch of sea mullet further decreased to 8 t, down from 13 t landed in 2006.

The catch of yellow-eye mullet (5 t) was a feature of the 2007 season. 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.

Recreational catch estimate (season 2007): 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 West Coast Beach Bait Managed Fishery and the South West Beach Seine Fishery, have recently been estimated. Total catches (i.e. boat-based and shore-based) by recreational fishers in the West Coast bioregion were found to be significantly larger than the commercial beach seine catches of these species.

Fishing effort/access level

Overall, for the two fisheries, 23 boats participated during 2007, with 16 reporting catches of whitebait. This is less than the previous year's total of 19 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 using CPUE as an index of abundance for the whitebait stock.

The annual assessment for whitebait stocks utilises total catch as an indicator of abundance, on the 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 currently contributes nearly all of the total whitebait catch and thus catches from the 'Bunbury' region now dominate overall trends (West Coast Beach Bait Figure 1).

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 one to two years of low catches, suggests that breeding stocks may become a limiting factor in years following environmentally-driven low recruitment.

The combined fishery catch of 101 t whilst at the lower end of the range of the acceptable catch is not unusual for this fishery, given the strong influence that environmental conditions appear to have on the recruitment of whitebait.

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 catch is 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 mainly sandy habitats. Data from monthly returns now include mandatory wildlife interaction reports, but are not currently available for this reporting period and will be reported in future years.

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 metres of the shore in accessible areas. However, stocks of whitebait are more widely distributed, suggesting that natural predators have greater access to whitebait 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 species of birds (e.g. little penguins) and fishers. However, in comparison to increasing environmental pressures, and under current licensing arrangements and effort levels, this is unlikely to be a significant issue.

Habitat effects: Negligible

All fishing occurs over shallow sandy substrate. Near-shore sand habitats are naturally dynamic environments and resident infauna are adapted to cope with regular 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 2007 a total of 23 boats, involving 59 crew, participated in the beach bait fishery.

Economic Effects

Estimated annual value (to fishers) for year 2007: $400,000

The majority of whitebait landed were relatively small fish destined for the human consumption market, typically selling for approximately $4.00/kg. Thus, in spite of the fall in catch, returns to fishers were on par with last year due to the increase in fish price/kg. A small amount of larger-sized fish from the managed fishery was utilised for recreational bait. Additionally, there was a large catch of high-value blue sprat this year.

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 2008

The Department of Fisheries continues to progress the south-west beach seine fishing sector to more formal management arrangements, including initiatives raised in and resulting from submissions to the discussion paper, '*Management of the Proposed South-West Beach Seine Fishery*' (Fisheries Management Paper No. 184).

External Factors

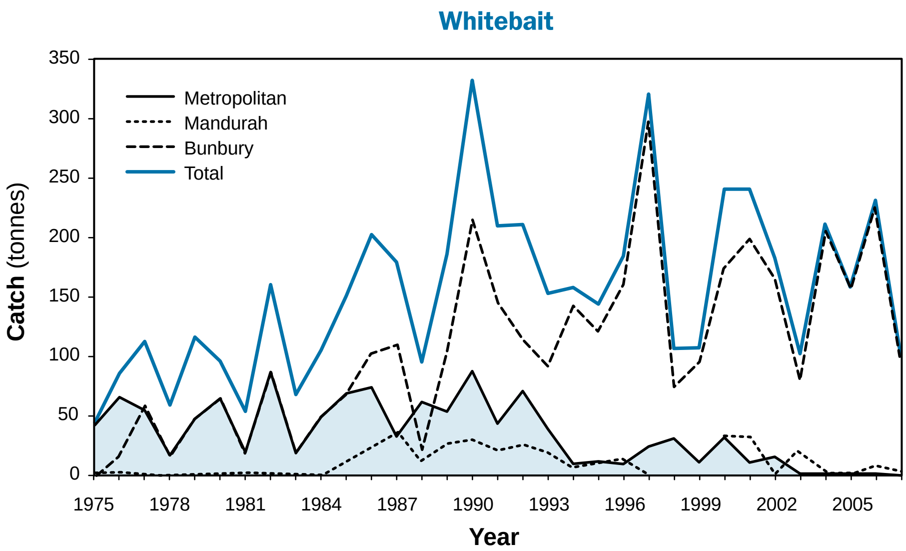
Annual catches in this fishery will most likely continue to exhibit large fluctuations under the influence of oceanographic factors. The fishery will therefore continue to be regulated through limited entry access and gear restrictions.

Increasing urbanisation of WA's south-west region continues to impact on both the fish and this fishery. The increasing trend toward ocean in-fill, marina development and higher use of small vessels in nearshore areas may be affecting fish behaviour. There remains a push for restricted vehicle access to beaches, including those used by commercial fishers, reducing access to fishing areas.

WEST COAST BEACH BAIT TABLE 1

Catches in 2007 of retained species other than whitebait from the West Coast Beach Bait Managed Fishery and south-west beach seining sector.

Species		Catch (tonnes)
Blue sprat	*Spratelloides robustus*	28
Western sand whiting	*Sillago schomburgkii*	9
Sea mullet	*Mugil cephalus*	8
Yellow-eye mullet	*Aldrichetta forsteri*	5
Anchovy	*Engraulis australis*	2
Trevally	Carangidae	1
Other fish varieties		1
Total		59



WEST COAST BEACH BAIT FIGURE 1

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

West Coast Purse Seine Managed Fishery Status Report

T. Leary and B. Molony

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

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 two purse seine development zones currently operating north and south of this area. The Southern Development Zone, for which there are three 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 one 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 and another for other small pelagic species. These TACs are divided amongst the fishery participants, but are not able to be traded. For the 2006/07 licensing period (1 April 2007 – 31 March 2008) there was a TAC of 2,328 t for pilchards, with another 672 t TAC allowed 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 have previously been regularly sampled to estimate population age structure of pilchards and sardinella. The age structure data is not available for this reporting period.

Retained Species

Commercial landings (season 2007): 139 tonnes

The combined catch of pilchards, sardinella and other minor species for the Perth metropolitan and Southern Development Zone fishery areas decreased 72% in the 2007 reporting season. Last seasons catch was 494 t and in 2005 the catch was 379 t. This year's metropolitan catch comprised of pilchards (46%) and sardinella (35%); and there was a small amount of anchovy and some yellowtail scad landed. Other species landed in the Southern Development Fishery by purse seine method, but reported in the West Coast Beach Bait Managed Fishery (see elsewhere in this document), included 14 t of blue sprat and 2 t of whitebait and nearly 1 t of 'combined other species'.

Recreational catch estimate (season 2007): N/A

Fishing effort/access level

Fishing effort for the Fremantle fleet comprised 168 days – a decrease in effort of 19% from the previous year's 207 days (see 'External Factors' below). It is not possible to estimate effort separately for the different species targeted.

The combined purse seine/beach seine fleet in the Southern Development Zone fished 170 days during 2007 – a doubling of the previous season's effort. However, it is not possible to apportion the amount of effort dedicated solely to purse seine due to the multi-method (and multi-species) nature of the reporting 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 tonnes. However, the estimates of spawning biomass in the vicinity of 40,000 tonnes 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.

Fluctuations in biomass level are driven by highly variable recruitment, along with environmental factors that may lead to 'replacement' in the Perth metropolitan fishing grounds of pilchards by sardinella in some years. It is believed that at times when both species are present, the pilchard spawning biomass can typify the 'carrying capacity' of the region. For 2007, the catch data, albeit biased by market preference, indicates pilchards and sardinella in roughly equal abundance.

The relatively small catch of pilchards in 2007, well below the accepted harvest rate of 10%, is likely to have negligible effect on the west coast pilchard stock. The small catches of sardinella, in the context of this species' predominantly tropical distribution, are also expected to have a minimal impact on the overall spawning stock for this species

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 that are predators of the target species or other fish species accidentally captured when the net contacts the benthos.

Protected species interaction: Low

There is no evidence to indicate any major interactions between protected species and the purse seine industry in the west coast region. Data from monthly catch returns now include mandatory wildlife interaction reports, but are not currently available for this reporting period and will be reported in future years

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, including penguins.

Catches of small pelagics on the west coast are carefully constrained so as to leave a 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. The current catch is also significantly lower than the 10% limit.

Habitat effects: Negligible

Purse seining generally has little direct effect on the habitat. Although the purse seine gear used in this fishery will 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 as it is hazardous to the fishing gear.

Social Effects

The Fremantle fishery employed approximately 10 full-time equivalent workers (crew and processors) – a drop of 45% over last season. The workforce required to catch, process and distribute the purse seine catch from the Bunbury region is difficult to separate from the workforce employed by the larger beach seine fishery. Operators from the combined Geographe Bay fishery employed 20 crew in the 2007 season.

Economic Effects

Estimated annual value (to fishers) for year 2007: $149,000

Small pelagic fish caught on the west coast were destined for human consumption (as 'Fremantle sardines'), recreational bait, commercial rock lobster and finfish trap bait. The price paid to the boats in 2007 amounted to an average price per kilogram of $1.20 for both pilchards and sardinella destined for human consumption and angling bait, while pilchards sold for rock lobster bait attracted a lower price of $0.80/kg. The number and size of operators in the nationwide recreational bait market and the relatively lower cost of imported product have adversely affected the margin on bait and thus the viability of fishing operations.

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 was set in 2004/05 and has been carried over in future years. The irregular behaviour of this fishery in recent years precludes 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 small catch of pilchards, well below the maximum 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 (2007/08)

A future management plan for the west coast incorporating the Southern and Northern Development Zones has received Ministerial approval. These two areas along with the Perth Metropolitan fishery, will be managed as three zones within the 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 (ITQ) units and a TAC. The ITQ unit values will be reviewed annually and changed as required, depending on stock levels.

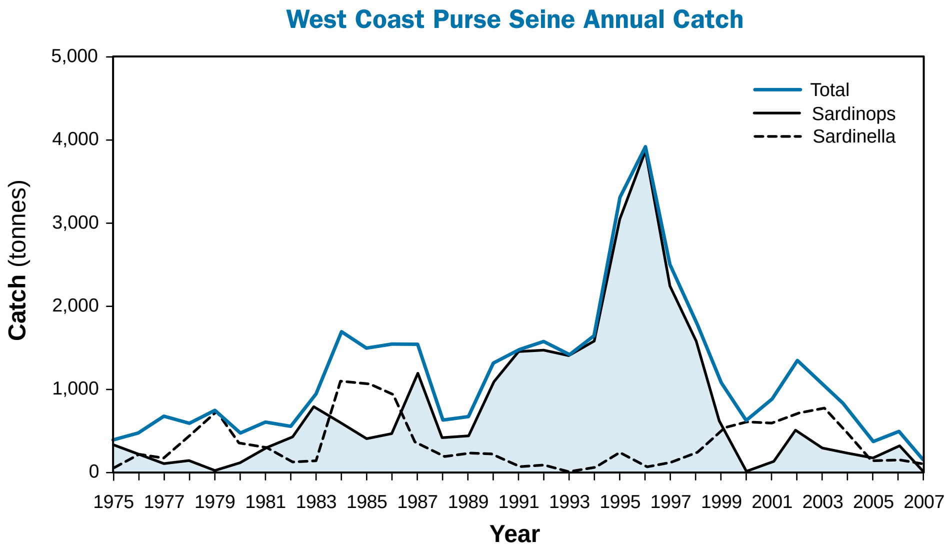
External Factors

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. The rising Australian dollar has made it more competitive for bait wholesalers to import bait products at relatively lower prices.

Intra-state competition from the south coast (in particular Albany) has taken a share of the west coast market, due to an ability to supply pilchards on a consistent basis. A small specialist market remains for human consumption products, most typically sold as 'Fremantle sardines'. The demand for sardinella is also variable, predominately determined by the price and availability of alternative commercial trap and line baits.

Like other fisheries in WA, there is a problem with maintaining trained crew and processing staff.

The behaviour of both sardinella and pilchard populations are reported by fishers as being less predictable than in past decades. It appears that the influence of oceanographic variation plays a strong role in determining the relative availability and 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

D. Fairclough, I. Keay, C. Johnson and E. Lai
Management input from N. Harrison and T. Nicholas

Fishery Description

The West Coast Demersal Scalefish Fishery (WCDSF) includes line fishing by commercial, charter and recreational sectors. Fishers in each sector primarily target West Australian dhufish (*Glaucosoma hebraicum*) and pink snapper (*Pagrus auratus*), but also catch substantial numbers of other species, such as emperors (*Lethrinus nebulosus*, *Lethrinus miniatus*), baldchin groper (*Choerodon rubescens*) and breaksea cod *Epinephelides armatus*.

Commercial

During the first six months of the 2007/08 financial year (1 July 2007 through 31 December 2007), commercial fishing in the WCDSF comprised open-access wetlining by both wetline-only vessels and the wetline activities of vessels with licences for other managed commercial fisheries. From 1 January 2008, the fishery ceased to be "open-access" and vessels operating in the West Coast Demersal Scalefish (Interim) Managed Fishery do so under a permit.

Handlines and droplines are the main fishing methods used in this fishery, although demersal species are also caught by demersal gillnet and demersal longlines used in other managed commercial fisheries, e.g. the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery.

Fishing and Aquatic Tour Industry (Charter)

Demersal scalefish are targeted by the fishing activities of the charter boat industry in the West Coast bioregion. Line fishing is the main method used by operators in the charter industry.

Recreational

Recreational fishers that target demersal species in the WCDSF are almost exclusively boat-based. Line fishing is the main method used by recreational fishers, although spear fishing also occurs in relatively shallow waters, i.e. less than 20 metres deep.

Governing legislation/fishing authority

Commercial

Fish Resources Management Regulations 1995

Fishing Boat Licence
West Coast Demersal Scalefish (Interim) Management Plan 2007
West Coast Demersal Scalefish Interim Managed Fishery Permit

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

Permit holders in the West Coast Demersal Scalefish Interim Managed Fishery

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

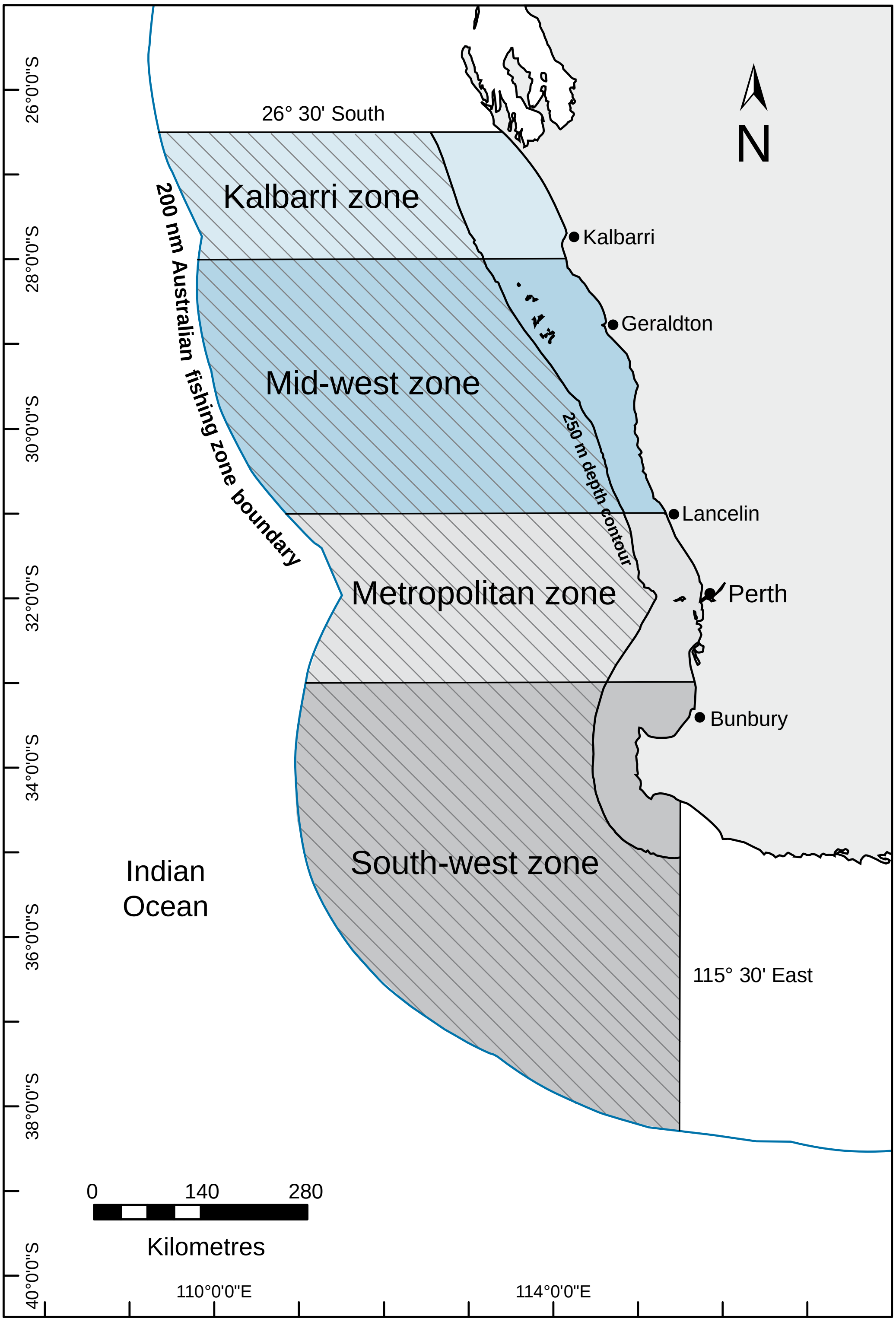
On 1 January 2008, the West Coast Demersal Scalefish (Interim) Management Plan 2007 commenced operation. This brought to a close the open-access wetline fishery in the West Coast bioregion. Since that time, only those persons authorised under a West Coast Demersal Scalefish Interim Managed Fishery Permit have been permitted to fish by line, store and transport demersal scalefish in, or sell demersal scalefish taken from, the waters of the fishery.

The commercial fishery encompasses the waters of the Indian Ocean on the west coast south of 26°30´ S and west of longitude 115°30´ E and extending seaward to the boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management zones, comprising four inshore zones and one offshore zone. The inshore zones, i.e. Kalbarri (26°30´ S to 28° S), mid-west (28° S to 31° S), metropolitan (31° S to 33° S) and south-west (33° S to 115°30´ E), extend outwards to the 250-metre depth contour, while the offshore zone includes waters from 26°30´ S to 115°30´ E and from the 250-metre depth contour to the boundary of the AFZ (West Coast Demersal Scalefish Figure 1).

A closure to commercial fishing was introduced on 15 November 2007 in the Metropolitan Inshore zone (extending between 31° S and 33° S and between the shoreline and the 250-metre depth contour) to operators in the West Coast Demersal Scalefish Interim Managed Fishery and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Demersal Scalefish Figure 1).

Fishing and Aquatic Tour Industry (Charter)

The West Coast bioregion for the purposes of charter fishing currently encompasses the waters of the Indian Ocean south of latitude 27° S and west of longitude 115°30´ E, although it is proposed to change the northern boundary to 26°30´ S in line with the commercial sector. The bioregion is divided into four main management zones – Kalbarri, mid-west, metropolitan and south-west. Each zone extends from the coastline to the 200 nautical mile boundary of the AFZ (West Coast Demersal Scalefish Figure 1).



WEST COAST DEMERSAL SCALEFISH FIGURE 1

Map showing the boundaries of the West Coast Demersal Scalefish Fishery. Note the northern boundary of 26°30' S applies to the commercial fishery as at January 1 2008 and is the proposed future boundary for the charter and recreational fishery. The Kalbarri (□), Mid-west (□), Metropolitan (□) and South-west (□) zones applicable to the recreational and charter sectors extend from the coast seawards to the Australian Fishing Zone boundary, while for the commercial sector those four zones extend from the coast to the 250 m depth contour. The commercial fishery also comprises an offshore zone (▧), which encompasses the waters from the 250 m depth contour outwards to the boundary of the 200 nmile AFZ and from 26°30' S to 115°30' E.

Recreational

The boundaries and management zones applicable to the recreational sector of the WCDSF are the same as those for the charter sector.

Management arrangements

Commercial

In the years prior to the 2007/08 financial year and in the first half of 2007/08, catch in the WCDSF had been limited only by the overall ceiling on the number of fishing boat licences. This "open-access" arrangement allowed fishers in the WCDSF to operate under the authority of a Fishing Boat Licence and a Commercial Fishing Licence, rather than a managed fishery licence or other form of explicit authorisation (management plans, regulations and orders) to take species and use methods which are not otherwise prohibited under the *Fish Resources Management Act 1994*.

The management rules included minimum and maximum legal length limits, some gear limitations and closures to fishing for some or all species at specific locations, e.g. seasonal spawning closures for baldchin groper at the Houtman Abrolhos Islands and pink snapper in Cockburn Sound and "no-fishing" zones in marine parks.

On 29 May 2007, after considering the submissions and comments put forward by the community, the Minister announced his decisions for the future management arrangements of the west coast demersal wetline fishery (Fisheries Management Paper No. 224). The new management arrangements for the 'West Coast Demersal Scalefish Fishery' are being implemented in two stages. The first stage commenced at the beginning of 2008, with the introduction of the *West Coast Demersal Scalefish (Interim) Management Plan 2007*.

Under the management plan, fishing will be controlled through input controls (in the form of permits), which restrict access to the different management areas of the fishery, gear restrictions (in the form of maximum numbers of lines and hooks), and Vessel Monitoring System (VMS) requirements. In the second stage, which will occur at the beginning of 2009, transferable entitlement for each zone will be allocated to permits in the form of units that provide entitlement in "hours" and further VMS arrangements will be introduced to allow fishing effort to be monitored and entitlement acquitted accordingly.

Fishers are now required to report their catch using daily/trip statutory fishing returns, which provide the Department of Fisheries with fine-scale reporting (10nm x 10nm blocks) for enhanced catch and effort analyses.

Fishing and Aquatic Tour Industry (Charter)

There are three types of fishing and aquatic tour licence categories.

- **Fishing Tour Operators Licence:** The focus is on fishing, with fishers able to take their fish home at the end of the tour.
- **Restricted Fishing Tour Operators Licence:** The focus is on eco-tourism activities, with clients able to catch fish for a meal during a tour, but no fish are to be taken home at the end of the tour.
- **Aquatic Eco-Tourism Operators Licence:** The focus is entirely on eco-tourism activities and fishing is strictly prohibited.

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. There is a limited number of fishing tour operator licences, which is aimed at managing growing effort in this sector. All fishing is subject to recreational fishing regulations (see below).

In Fisheries Management Paper No. 231 *'A Strategy for Managing the Recreational Catch of Demersal Scalefish in the West Coast Bioregion'*, which was released in June 2008, the Minister stated that he is considering a 'days fished' regime to control effort, as opposed to reducing catch via a seasonal restriction for fishing of the "Vulnerable Five" species of demersal scalefish. This will help to maintain a viable charter industry. However, any decision will only be made following a consultation process.

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 scalefish is currently managed through a mix of input controls (e.g. seasonal and spatial closures and size limits), and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats).

Modifications to existing management arrangements and the introduction of new management arrangements for the recreational sector of the WCDSF were proposed (Fisheries Management Paper Numbers 225 and 228). The aim of the new arrangements, in conjunction with the rationalisation of the commercial sector, was to reduce effort and thus catch in the WCDSF.

Following a public consultation process, the Minister's decisions were released in June 2008, which are fully described in Fisheries Management Paper No. 231 and include a number of new fishing rules which, where applicable, were due to come into effect on 15 October 2008 for the West Coast bioregion.

These new rules represent an adaptive management approach that is being adopted for the WCDSF. The overall management package will be reviewed as to its effectiveness based on ongoing research that is being conducted to assess the stock recovery.

Research summary

The WCDSF is managed via the use of indicator species. In other words, the health of the stocks of those species is a reflection of the health of stocks in the WCDSF in general. In 2007, results of research identified that overfishing was occurring of the stocks of dhufish and pink snapper in the west coast bioregion and of baldchin groper at the Abrolhos Islands (Wise *et al*., 2007). These results highlighted the increasing pressure on fish stocks on the west coast as a result of population growth and improving fishing efficiency via the use of modern technology, such as GPS.

A Fisheries Research and Development Corporation (FRDC)-funded project to investigate the variation in age compositions, growth, reproductive biology, mortality and stock structure of dhufish and pink snapper populations was completed in 2006. This detailed the stock assessments of the key indicator species dhufish, pink snapper and baldchin groper in the WCDSF (Wise *et al*., 2007). A second part, which reports on the results of the biological studies, is being prepared (St John *et al*., in prep.).

Monitoring of the age structure of dhufish and snapper from the commercial and recreational sectors in the different management zones of the West Coast bioregion (Kalbarri, Mid-west, Metropolitan and South-west) was conducted in 2006/07 and 2007/08. The age data will be used to update the stock assessments from the above FRDC project and assess the current levels of fishing effort on the stocks, following the range of management changes that occurred in 2007/08.

An FRDC-funded study of the effects of barotrauma on west coast demersal indicator species found that dhufish display high rates of post-release mortality, with almost 90% mortality of fish caught and released in ≥ 45 m of water (St John and Keay, submitted). Pink snapper are more resilient, with little mortality in waters ≤ 30 m deep. However, post-release mortality increased to > 60% of fish caught and released in 65 m of water.

Numerous anecdotal reports indicate that baldchin groper are highly susceptible to barotrauma. Post-release mortality is influenced not only by the depth of water in which demersal species are caught, but also by the speed at which fish are brought to the surface and by their physical handling and release.

The results of a 12-month recreational creel survey of boat-based fishing in the West Coast bioregion in 2005/06 were published in 2008 (Sumner *et al*., 2008). The estimated catches of dhufish, pink snapper and baldchin groper caught in 2005/06 increased substantially from the catch in 1995/96 and the effort was more widely dispersed along the west coast. There was a 15.5% increase in nominal effort between the 1995/96 creel survey and this survey, but this result did not account for the increased efficiency of fishing derived over that 10-year period from improving technology, *e.g.* GPS and sounders.

A 12 month phone-diary survey was carried out during 2005/06 to clarify the recreational sector's catch share of the demersal finfish stocks. A follow-up creel and phone-diary survey in the West Coast bioregion commenced in 2008.

The results of a 12-month survey during 2006 of finfish caught by recreational fishers, tour operators, commercial lobster fishers and commercial wetline fishers in the Houtman Abrolhos Islands Fish Habitat Protection Area were published in 2008 (Sumner, 2008). The study found that the majority of fish taken at the islands are caught by commercial fishers, with pink snapper, sweetlip emperor and dhufish constituting a large proportion of that catch. Catches of baldchin groper by rock lobster fishers staying at the islands during the three month rock lobster fishing season are significant.

The collection of commercial wetline and charter catch and effort statistics continued in 2007/08. The 'West Coast Demersal Scalefish Fishery' changed from monthly catch records to daily/trip catch records at the beginning of 2008. A trial of the daily/trip logbooks was conducted in 2006/07 to identify any issues and to ensure that the information collected fulfils research needs for this fishery. The results of this trial are reported in Appendix 4.

Bycatch of demersal scalefish species in the rock lobster fishery was determined from logbooks and at-sea monitoring in 2006/07. Substantial numbers of demersal species, such as breaksea cod and baldchin groper were caught as bycatch in the rock lobster fishery. Full details are reported in the West Coast Rock Lobster Fishery status report elsewhere in this document.

An FRDC-funded project on spawning aggregations of samson fish and other west coast species was completed (Mackie *et al*., 2008). This documented the occurrence of spawning aggregations of demersal species such as dhufish, pink snapper and Bight redfish in the West Coast bioregion, which make these species highly susceptible to fishing during their spawning seasons. It also highlighted the importance of incorporating the dynamics of such aggregations into stock assessments and provided a basis for redefining monitoring programs for such species.

A research project funded by the Western Australian Marine Science Institution (Project 4.4.2) and involving the collaboration of the Department of Fisheries, the CSIRO and the Centre for Fish and Fisheries Research at Murdoch University commenced in 2008 to investigate the stock structure of West Australian dhufish, pink snapper and baldchin groper. This project will elucidate the spatial relationships between the different life history stages of those three species. Murdoch University and the CSIRO are using genetic techniques to assist in identifying any sources or 'sinks' of recruitment and how the Western Australian populations are subdivided, if at all, while the Department of Fisheries will use otolith microchemistry to investigate the environments occupied by individual dhufish and snapper during their life.

Retained Species

Commercial production (season 2006/2007):	**725 tonnes**
Pink snapper:	**232 tonnes**
Dhufish:	**139 tonnes**
Baldchin groper:	**29 tonnes**

Landings

Fishers in the West Coast Demersal Scalefish Fishery (WCDSF) catch a suite of demersal scalefish species, such as West Australian dhufish, pink snapper and baldchin groper. Note that the total catch reported for the WCDSF does not include seafood groups such as cephalopods, mackerels, tunas, sharks and rays that are reported within other managed fisheries and are no longer permitted to be retained by WCDSF wetliners.

In 2006/07, the total catch of demersal scalefish was 725 t, 250 t less than in 2005/06. This decrease in catch was due to the reduced effort in the fishery in 2006/07, as a result of the fewer number of boats fishing in that year (191) compared to the previous year (227).

More than 77 species are caught by wetliners in the WCDSF. Ten species or species groups comprise 91% of the total catch (tonnes) in 2006/07, which includes the three indicator species, i.e. dhufish, pink snapper and baldchin groper. Of those species/groups, four typically occupy relatively shallow waters (< 100 m deep), five occur in deeper waters (> 100 m) and one, the Samson fish, is pelagic, but has been recorded in waters up to approximately 200 m deep.

In 2006/07, pink snapper, dhufish and the emperor group (spangled emperor *Lethrinus nebulosus* and sweetlip emperor

Lethrinus miniatus), which primarily occur in shallow waters, contributed 231 t, 139 t and 123 t, respectively, to the total catch of the WCDSF and comprised the majority (68%) of the total catch for the year. Sweetlip emperor constituted 99 t of the catch in the emperor group. Redfish, which includes all of the reported *Centroberyx* species, Samson fish, baldchin groper and ruby snapper comprised 43 t, 36 t, 29 t and 25 t, respectively.

Although catches of most species were lower in 2006/07 as a result of the reduced effort, the catch of ruby snapper doubled from the 12 t reported for 2005/06. Of the other deep water species retained, the catches of hapuku declined approximately 50% from 18 t in 2005/06 to 9.5 t in 2006/07, while those of deepsea trevalla decreased slightly and grey-banded cod increased slightly. Catches of breaksea cod also declined slightly.

As procedures for validating new daily/trip logbook data from the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDGDLF) and Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) have yet to be developed, demersal scalefish catches from those fisheries for 2006/07 are currently unavailable.

Dhufish: The reported total commercial catch of dhufish by the WCDSF in 2006/2007 was 139 t, close to the lower boundary of the target catch range of 125 t. The catch has continued to decrease from that of 2005/06 (181 t) and the recent maximum of 234 t recorded in 2002/2003. Furthermore, the total catch for 2006/07 is well below the average catch for the last 10 years (1997/98 to 2006/07) of 193 t and the long-term average of 171 t (since 1989/90).

In 2006/07, approximately 62 t (45%) of the commercial catch of dhufish was from the mid-west zone, while 35 t (25%) and 29 t (21%) was landed in the south and metropolitan zones, respectively. Only 9% of the catch, *i.e.* 12 t, was landed in the Kalbarri zone in 2006/07 (West Coast Demersal Scalefish Figure 2). Although catches in each of the four zones decreased from those of 2005/06, the largest decrease of 26 t occurred in the mid-west. In contrast, the catch in the south-west only decreased by 3 t.

The percentage of the total catch of dhufish in 2006/07 that was retained in the Kalbarri, mid-west, metro and south-west zones were similar to the long term averages (since 1989/90) for those zones, *i.e.* approximately 10%, 50%, 20% and 20%, respectively. However, since 1989/90, the percentage of the total catch has gradually increased in the Kalbarri zone, while it has decreased in the mid-west and remained relatively stable in the metro and south-west zones.

Pink snapper: The total commercial catch of pink snapper reported in 2006/07 (232 t) decreased from 2005/06 (278 t), a further decline from the high catches of 2003/04 (340 t) and 2004/05 (333 t). The catch in 2006/07 was within the target total catch range of 153 – 254 t, but below the 10 year average of 252 t (1997/98 to 2006/07) and the long-term average since 1989/90 of 250 t (West Coast Demersal Scalefish Figure 3).

Historically, the majority of pink snapper have been caught in the Kalbarri and mid-west zones. In 2006/07, 111 t were retained from the Kalbarri zone and 71 t from the mid-west, representing 48% and 31% of the total catch, respectively. Catches in each of the four zones were between 75% and 85% of the 2005/06 catch.

While the percentage of the total catch of pink snapper in 2006/07 that came from the Kalbarri zone was close to the long-term average of 47% for that zone, there has been an increasing trend since 1989/90. In contrast, the percentage of the total pink snapper catch from the mid-west has been gradually decreasing since 1989/90 and was below the long-term average of 38%. The percentage of the total catch derived from the metropolitan and south-west zones, while still relatively low, has gradually increased.

Baldchin groper: The commercial catch of baldchin groper in 2006/07 was 29 t – a decline from the previous year's catch of 34 t, but which was within the target catch range of 27.5 – 35.5 t. The catch in 2006/07 has continued to decrease since the maximum recorded catch of approximately 41 t in 2002/03 (West Coast Demersal Scalefish Figure 4).

Recreational catch estimate (2006/07): Not available

Last available recreational catch estimate (2005/06): (including charter)
Dhufish 207 tonnes
Pink snapper 57 tonnes
Baldchin groper 38 tonnes

Estimates of recreational catch via creel surveys were not determined during 2006/07, but in terms of the relative importance in catches of commonly targeted species, e.g. dhufish and pink snapper, they are likely to have been similar to those of the 2005/06 year. The creel survey of recreational boat-based fishing conducted in 2005/06 demonstrated that catches of the demersal species dhufish, wrasse/gropers (as a group), breaksea cod, pink snapper and baldchin groper retained by recreational fishers ranked 6th, 7th, 9th, 10th and 11th, respectively in terms of numbers (Sumner *et al*., 2008). Dhufish, pink snapper, baldchin groper, samson fish, breaksea cod and blue morwong ranked 1st, 3rd, 6th, 7th, 9th and 11th, respectively, in terms of weight (tons) in that year.

An estimated 186 t of dhufish were retained during that survey, much greater than the 40 t of pink snapper and 28 t of baldchin groper retained. The majority of the catches of dhufish (78 t) and baldchin groper (19 t) were reported from the mid-west zone, with substantial catches of dhufish (≥ 50 t) in both the metro and south zones. Between 10 t and 15 t of pink snapper was retained from each of those three zones. For the majority of species, there was an increase in the numbers of fish released in comparison to the 1996/97 boat-based fishing survey, which presumably reflects the increased effort in the fishery as a result of increases in the number of people fishing.

Estimated catches of target species by the charter sector in 2006/07 from logbooks submitted were similar to those of 2005/06. Thus, approximately 24 t and 18 t of pink snapper and dhufish were caught, respectively, while 11 t of baldchin groper, 7 t of emperors and 4 t of breaksea cod were taken in that year.

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 between 'effort' as time spent targeting or fishing for individual species, but is reported as the number of days when each of those species was caught. Therefore, the number of 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.

In the West Coast bioregion during 2006/07, 191 licensed fishing boats line-fished for demersal finfish and 44 of these boats were licensed as 'wetline-only' boats. This represents a decrease from the 227 boats fishing in 2005/06 and the 51 "wetline-only" boats. The lower number of boats fishing in 2006/07 is reflected in the total number of days fished in that year, i.e. a decrease from 10,665 (2005/06) to 8,486 days (2006/07). In 2006/07, 174 boats reported catching dhufish, 181 caught pink snapper and 122 caught baldchin groper.

Dhufish: The number of effort days reported for dhufish (days when dhufish were caught) has steadily increased in each year from 1991/92 until 2002/03, after which, the number of effort days has been declining. In 2006/07, the number of effort days reported was 6,654, a decrease of almost 1,950 fishing days from 2005/06 (West Coast Demersal Scalefish Figure 4).

Pink snapper: Effort days for pink snapper gradually increased from 1991/92 until 2000/01, after which the number of days increased rapidly and have remained elevated at approximately 10,000 days per year until 2005/06 (West Coast Demersal Scalefish Figure 4). In 2006/07, the number of days when pink snapper were caught (effort days) was 7,680, a similar decrease in effort (1,859 days) from 2005/06 as for that of dhufish.

Baldchin groper: The number of days on which catches of baldchin groper were reported gradually increased between 1991/92 and 2002/03, after which the number of days that catches were made has declined. A closure to fishing for baldchin groper during its spawning period, which was introduced in the Abrolhos Islands Fish Habitat Protection Area in 2003, has been partially responsible for the decrease in effort. The number of days fished for baldchin groper decreased from 5,165 in 2005/06 to 3,938 in 2006/07 (West Coast Demersal Scalefish Figure 4).

Fishing and Aquatic Tour Industry (Charter)

Fishing effort for the charter sector in the West Coast bioregion during 2006/07 was 25,787 fisher days, which is similar to previous years.

Recreational

Total recreational fishing effort for the West Coast bioregion was not estimated in 2006/07.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels **Pink snapper: Low**
Dhufish: Declining

The results of recent research on the levels of exploitation of both dhufish and pink snapper in the WCDSF demonstrates that those levels are above international benchmark standards across all zones of the West Coast bioregion (Wise *et al.*, 2007). This is also the case for baldchin groper at the Abrolhos Islands, which, coupled with declining catch rates, indicated that localised over-fishing of this species was occurring. Thus, the stocks of dhufish and pink snapper in the WCDSF and of baldchin groper at the Abrolhos Islands are currently experiencing over-fishing and are depleted to levels below those necessary to ensure their long-term sustainability.

The breeding stock levels of dhufish and pink snapper in 2006/07 were based on the fact that catches of dhufish are dominated by only a few strong year classes while those of pink snapper have a truncated age distribution, i.e. there are few older and thus larger fish in the population. The decreasing numbers of dhufish in the dominating year classes indicates that the breeding stock is also declining, while the lack of older pink snapper indicates that their spawning stock would be low.

Stock assessments have not been conducted on shallow water species such as sweetlip emperor and spangled emperor in the West Coast bioregion, which form an important part of the WCDSF catch, or on deepwater, long-lived, demersal species, such as grey-banded cod, hapuku and redfish.

Non-Retained Species

Bycatch species impact: **Negligible**

Line fishing is a highly selective fishing method that targets demersal species using baited hooks. Only a small proportion of the overall catch is discarded and includes inedible species (e.g. silver toadfish) or small fishes (e.g. wrasses). While some of these bycatch species are unlikely to be affected by this fishery, other demersal species, such as wrasse, suffer from the effects of barotrauma (D. Fairclough, pers. obs.).

Protected species interaction: **Negligible**

Owing to the high selectivity of the fishing gear, commercial line fishing is highly unlikely to interact with protected species. New logbooks for commercial and charter fishers were introduced at the end of 2007 that include specific sections for recording protected species interactions. No protected species interactions were reported by the recreational or charter sector in 2006/07.

Ecosystem Effects

Food chain effects: **Not assessed**

Habitat effects: **Negligible**

The main fishing method used in the commercial and recreational fishery for demersal species (line fishing), has little physical impact on the benthic environment. The loss of fishing rigs, i.e. line, sinkers and hooks, is currently not quantified but is likely to have a negligible effect on habitat.

Social Effects

Commercial

Employment in this fishery is difficult to assess as 77% (147) of the boats in the wetline fleet are also licensed to fish in other fisheries. Only 44 boats in the wetline fleet hold no other licences and thus are 'wetline-only'. On average, each boat fished for 44 days during 2006/07 and employed two crew members.

Fishing and Aquatic Tour Industry (Charter)

There are 161 charter operators who are licensed to operate in the West Coast bioregion via a Fishing Tour Operators Licence, Restricted Fishing Tour Operators Licence or an Aquatic Eco-Tourism Operators Licence. The number of people employed in the charter industry has not been estimated.

Economic Effects

Estimated annual value (to commercial fishers) for year 2006/07: $4.8 million

The estimated value of the West Coast Demersal Scalefish Fishery in 2006/07 includes all demersal scalefish species caught by handlines and droplines in the West Coast bioregion. West Australian dhufish and pink snapper comprised 39% and 24% of the total value of the fishery ($4.8m), contributing $1.9m and $1.2m, respectively. Other important species include the lethrinids, which comprised 13% of the total value of the fishery in 2006/07, where baldchin groper comprised 6% and Bight redfish 4%.

Prices used to calculate the value of the fishery in 2006/07 were $13.50/kg for dhufish $4.95/kg for pink snapper and $10/kg for baldchin groper. At $12.50/kg, coral trout commanded the second highest average price of all species in the fishery.

Prices vary as demand and supply for popular fish species fluctuate greatly; prices used to calculate estimated value are likely to be conservative.

Fishery Governance

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

Commercial

The target catch range for the WCDSF in 2006/07 was based on the mean from catches in the decade 1990/91 to 1999/2000 using 80% confidence limits around that 10-year mean and was thus calculated to be 558 – 798 t. For the indicator species, target catch ranges were 125 – 179 t for dhufish, 153 – 254 t for pink snapper and 27.5 – 35.5 t for baldchin groper.

The total commercial catch of 725 t in 2006/07 fell just below the upper boundary of the target catch range, primarily reflecting a reduction in effort in the WCDSF. Catches of dhufish (139 t), pink snapper (232 t) and baldchin groper (29 t) were within their target catch ranges.

As the stock assessments conducted on dhufish, pink snapper and baldchin groper by Wise *et al.* (2007) revealed that over-fishing of those indicator species was occurring and recommended that there be at least a 50% reduction in catch and effort, the target catch range in 2006/07 is inappropriate and the catches and fishing effort in 2006/07 are unacceptable.

Current fishing (or effort) level: Unacceptable

New management initiatives (2007/08)

The West Coast Demersal Scalefish Fishery (WCDSF) became a managed fishery at the beginning of 2008, following the outcomes of the Wetline Review process. The management arrangements include limited entry to the fishery and restrictions on the areas each permit holder can operate. In 2009 each boat will be allocated a share of the total effort. This will allow the fishery to be managed to catch settings for each area.

Recent stock assessments on the major indicator species – dhufish, pink snapper and baldchin groper – demonstrated that their stocks have been experiencing over-fishing due to increasing catch and effort. Thus, monitoring of stock status will continue in order to evaluate the impacts of the new management regime and the effective reductions in catch and effort that will occur.

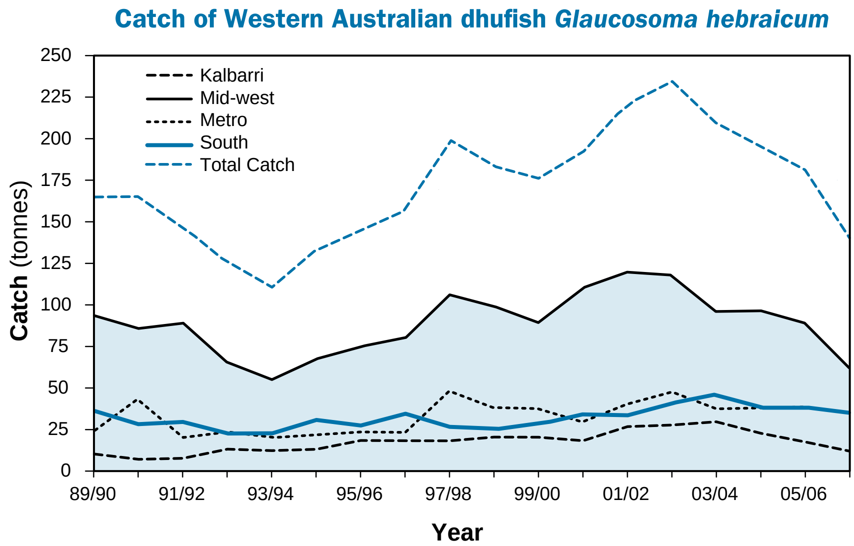
External Factors

The productivity of the West Coast Demersal Scalefish Fishery (WCDSF) 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; these four age classes are currently supporting the entire fishery for dhufish.

A correlation is evident between higher salinity and stronger recruitment, which may indicate that recruitment along the west coast may be influenced by the strength and timing of the Capes Current. The Capes Current flows during the spring and summer months, when dhufish spawn. Studies of the reproductive biology of dhufish suggest that the spawning of individual females may not have been as successful in recent years. Dhufish spawn in pairs (i.e. one female and one male) and thus with the reduction in the size of the stock that is evident from research, females may not be encountering males as frequently as they once did, resulting in a reduction in spawning events.

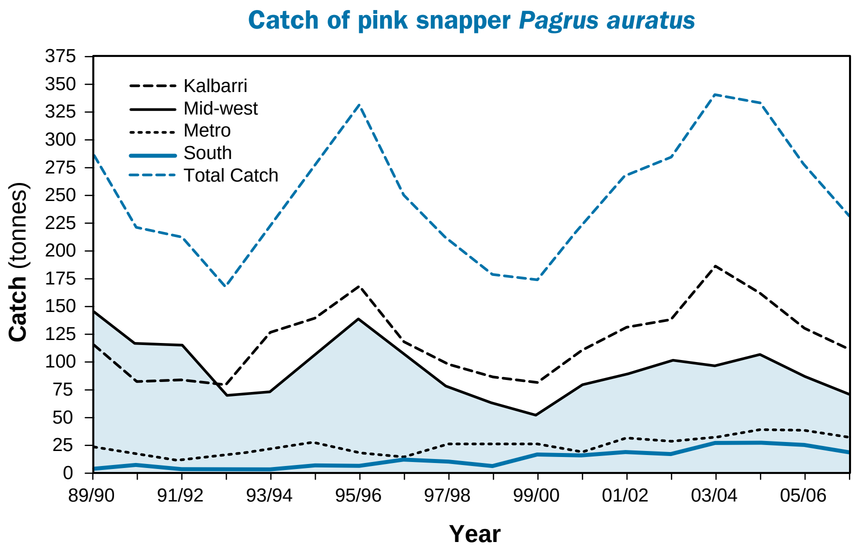
In contrast to the recruitment spikes of dhufish, no such strong recruitment events are evident in the snapper stocks, but this may not be as pronounced, due to the limited number of age classes in the population.

The spawning aggregation of pink snapper in Cockburn Sound contains the largest and most fecund pink snapper in the West Coast bioregion and is thus considered to be the most important spawning and nursery location for the productivity of this species in this fishery.



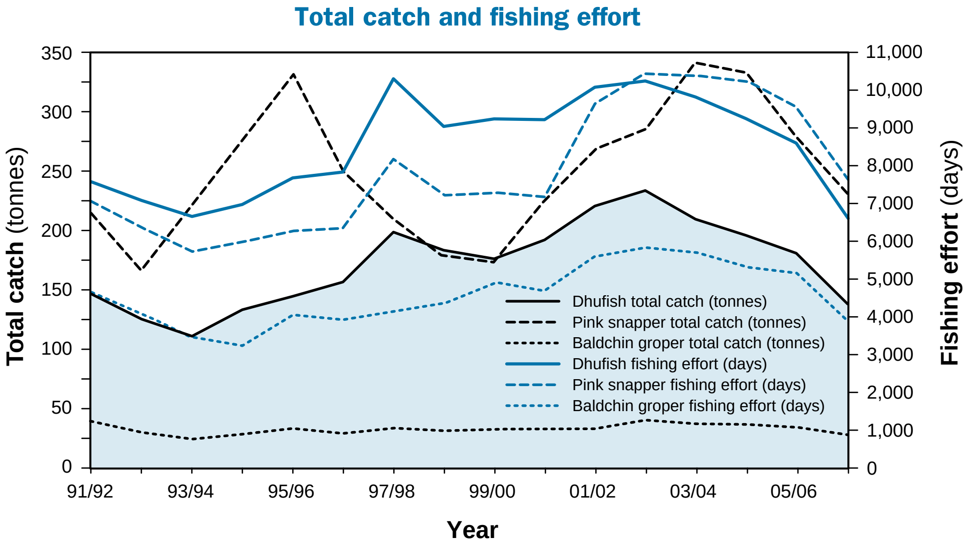
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total commercial catch of Western Australian dhufish *Glaucosoma hebraicum* in the West Coast Demersal Scalefish Fishery and commercial catch of dhufish in each zone in each year between 1989/90 and 2006/07.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Annual commercial catch of pink snapper in the 4 zones of the West Coast Demersal Scalefish Fishery from 1989/90 to 2006/07.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

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 2006/07.

Baldchin groper (*Choerodon rubescens*). Photo: David Fairclough

West Coast Tailor Fishery Status Report

K. Smith, J. Brown and M. Hammond
Management input from N. Harrison

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 per person.

The majority of the recreational catch of tailor in WA is taken from the metropolitan area in the west coast region, while the bulk of the commercial catch comes from Shark Bay in the Gascoyne region. 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
Regional Recreational Fishing Advisory Committees
Meetings between the Department of Fisheries and industry

Boundaries

Tailor inhabit coastal and offshore waters. The species is mainly found between Shark Bay and the lower west coast, but also occurs 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 in the west coast and south coast regions that only 2 of these fish may be over 600 mm.

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 of tailor 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 two separate stocks.

Following concerns about increasing recreational fishing pressure on tailor in the greater Perth metropolitan area in the early 1990s, two research studies were instigated (a tagging 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 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 logbooks (RAP) 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 (Sumner *et al.* 2008).

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-flowing Leeuwin Current and the northward-flowing Capes Current) that disperse eggs and larvae 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 (RAP), a recreational fisher daily logbook was implemented in 2004. Logbook anglers now provide important annual information about the size structure of the recreational tailor catch and logbook 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 2007): 26.3 tonnes

In 2007, the total state commercial catch of tailor was 26.3 t – up 2.3 t from 2006. The vast majority of landings occurred in the Gascoyne region (92.5% of total landings), with the West Coast and South Coast bioregions contributing 6.7% and 0.8%, respectively.

In the West Coast Bioregion, 83.9% (1.5t) of the total 2007 commercial catch was reported from the West Coast Estuarine Managed Fishery. The remainder was reported by wetline fishers in coastal areas between Kalbarri and Cape Naturaliste (15.6%) and within the Cockburn Sound (Line and Pot) Managed Fishery (0.5%).

Recreational catch: 76% of total State catch 94% of total West Coast catch

An estimate of the total recreational tailor catch for WA is not available for the current year (2007). 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 bioregion, with minor quantities taken in the Gascoyne and South Coast bioregions. An estimated 88% of the West Coast recreational catch during the survey was from shore-based fishing.

In the boat-based creel survey undertaken by the Department in 2005/06, the number of tailor retained by boat-based recreational fishers in the West Coast region was 4,826 fish during the 12-month survey period. This was significantly less than the 24,251 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 two creel surveys, resulting in a higher proportion of fish being released in 2005/06 (42.6%) compared to 1996/97 (12%). Though a higher proportion of fish were released in 2005/06, the boat-based catch rate of tailor on the West Coast still appears to have declined significantly since 1996/97.

Fishing effort/access level

Commercial

In 2007, the majority (86.4%) of the State's commercial catch of tailor was caught in the Shark Bay Beach Seine and Mesh Net Managed Fishery – see the separate report on this fishery for further details.

In the West Coast bioregion, the West Coast Estuarine Managed Fishery, the Cockburn Sound (Line and Pot) Managed Fishery and the wetline fishery in coastal waters took 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. In inshore waters of the West Coast bioregion, where most recreational tailor landings are reported, 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.

Two 12-month creel surveys undertaken by the Department of Fisheries in 1996/97 and in 2005/06 estimated the total fishing effort expended by boat-based recreational fishers in the West Coast bioregion. The boat-based recreational line fishing effort estimate increased 15.5% from1996/97 (1,348,000 fisher hours) to 2005/06 (1,557,000 fisher hours). Recent estimates of shore-based recreational effort, which accounts for the majority of tailor landings, are unavailable for the West Coast bioregion.

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Uncertain

Tailor become susceptible to capture by line fishing at 150 to 200 mm total length and ~1 year of age, but do not attain the legal minimum length of 300 mm until ~3 years (Ayvazian *et al.* 2001, K. Smith unpubl. 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). 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); this component of the stock is dominated by large, reproductively-active 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 14 continuous years up to 2008, have revealed highly 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.

Logbook 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 the lower recruitment estimated between 1998 and 2004. Recreational catch rates reported by logbook fishers have been relatively stable since the RAP logbook program commenced in 2004.

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, reproductively-active 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 bioregion. A survey of shore-based recreational catch levels in the West Coast is urgently required to estimate the total catch of tailor.

While 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 (Commercial): Unacceptable

Current fishing level (Recreational): Unacceptable

Shore-based recreational fishers catch the vast majority of tailor in the West Coast region. The current recreational fishing level in the region is uncertain, due to 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 (2007/08)

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 a limit of only two 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 maximum legal size limit from 600 mm to 500 mm and that the 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. The future management of tailor and nearshore species will be considered in 2009.

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 2006/07, the value of aquaculture increased by around 9% and aquaculture tonnage decreased by 9% compared to equivalent data for 2005/06 (excluding marine algae and all pearl oysters). This is the third consecutive annual period during which aquaculture production has dropped, from a peak in 2003/04.

The results of previous research indicate there may be commercial potential for the grow-out of wild-caught western rock lobster pueruli. During 2007, the Ministerially-appointed Western Rock Lobster Puerulus Aquaculture Working Group met to progress the development of a policy framework to allow for the collection and grow-out of western rock lobster pueruli. An Interim Policy Paper was forwarded to the Minister for Fisheries in December 2007 for his information. Over the last six months, a Fisheries Research and Development Corporation (FRDC)-funded project considering the economics and market implications of rock lobster aquaculture has been underway. Two separate reports have been received which, once endorsed, will inform the working group in its deliberations. It is hoped the final policy may be complete by the end of 2008.

The framework to allow for the granting of leases for aquaculture has progressed significantly in 2007-08. Currently, the Minister has granted 16 leases for the mussel growers in Cockburn Sound, with another application in progress. It is hoped that the final policy, incorporating the process for granting and renewal of leases as well as setting out the fees and charges, should be finalised by July 2008.

The Department's review of aquaculture licence conditions is continuing. 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 registration completed) 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 (in Italy). The control box for the automated feeding system has now been contracted to an external company.

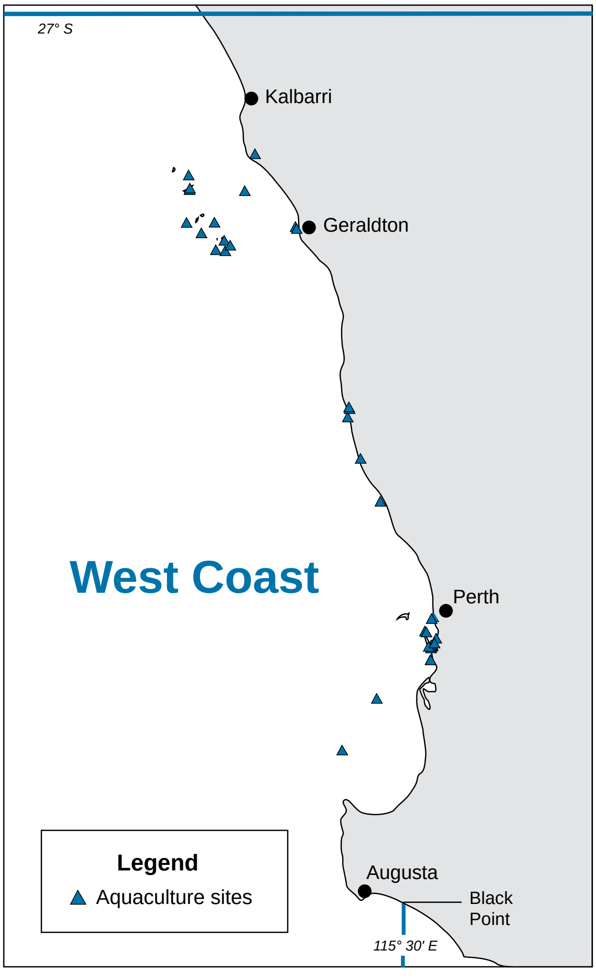
With financial support from the FRDC, the current microdiet research is focusing on easily-digested proteins, feed attractants, and the physical and chemical properties of the particles. The research team is collaborating with research and development centres in Tasmania, Spain, Portugal, Japan, Malaysia and Mexico.

Work also continued on the commercialisation of *Artemia* (brine shrimp) production at Hutt Lagoon, Port Gregory. 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 (*Dunaliella salina*) at Hutt Lagoon.

Current work is building on the outcomes of previous research that 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 'domestic-grown' *Artemia* products will be available commercially during 2008, reducing the reliance on unpredictable supplies of imported product for aquaculture feeds.

The Aquaculture Development Council is determining the feasibility of open-ocean production systems for growing marine finfish in unsheltered, WA coastal waters. In co-operation with the Department and industry, it is also planning a major project to determine the environmental carrying capacities of several locations on the WA coast.

A number of new aquaculture projects have been, or are in the process of being, established off the west coast. These include a project off Jurien, which is presently licensed to grow 200 tonnes of fish, and one near the Abrolhos Islands, licensed to grow 270 tonnes per annum. The former operator has been issued a Ministerial Exemption to collect a small number of rock lobster pueruli for research purposes. A proponent has applied for a licence and lease in Cockburn Sound to undertake octopus aquaculture.



WEST COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the West Coast bioregion.

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*.

Specific education programs are delivered by Community Education Officers based in Busselton and Fremantle with the assistance of Volunteer Fisheries Liaison Officers based in Busselton, Bunbury, Mandurah, Fremantle, Hillary's, Dongara, Geraldton and Kalbarri.

Services provided by land-based officers include processing inspections, landing and gear inspections, licensing checks, wholesale/retail checks and inshore sea-based patrols, utilizing vessels ranging in length from 5 metres to 12 metres. They also give 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). Outside of this area marine safety is unfunded and inspections are carried out in combination with fisheries compliance inspections.

Activities during 2006/07

During 2006/07, FMOs delivered a total of 14,518 hours of compliance and community education services in the field (West Coast Bioregion 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-based and intelligence-based approaches to compliance planning and prioritization.

The 12-metre patrol vessel *Chalmers* was a welcome addition in undertaking compliance operations and research projects at the Abrolhos Islands. The *Chalmers* was used extensively throughout the year and proved valuable in accessing the shallow water areas of the Abrolhos Islands, as well as patrolling the associated Reef Observation Areas.

Compliance planning for the West Coast Rock Lobster Managed Fishery focused on the Compliance Risk Assessment conducted with industry members in 2005. Compliance operations targeted one of the major risks of fishers interfering with other fishing gear, which resulted in a number of apprehensions.

Targeted operations were also conducted to address other issues, which included 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.

In the Mid-west region, FMOs undertook several successful compliance operations targeting commercial western rock lobster fishers. A number of offences were detected ranging from fishing in closed waters to obstructing escape gaps in rock lobster pots. Of considerable concern was the apprehension of two fishing operations operating more pots than their pot entitlement. The *PV Chalmers* was a great asset in conducting these operations.

In the Perth metropolitan region, a number of covert operations were conducted targeting interference with gear, with one commercial fisher being prosecuted for interfering with another commercial fisher's gear.

Compliance in commercial fisheries was similar to previous years, although the 25 prosecutions for the second year running is a positive sign, down on the 49 prosecutions from 2004/05. Similar numbers of infringement notices and warnings were issued compared to previous years, with a total of 325 warnings, and 78 notices being given out.

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 six checks per vessel throughout the fishery (West Coast Compliance Table 2). On average, 17 baskets were inspected per vessel, which is similar to the number in 2005/06 of 21 baskets per vessel.

The percentage of total catch inspected was almost identical to the previous season with approximately 2.4 to 3.0% of the catch inspected (compared to 2.4 to 3.1% in 2005/06). The observed per-animal non-compliance rate for the catch remained stable, with an estimated range of 0.0013 to 0.0019 – that is an estimated 1.3 to 1.9 illegal animals for every 1,000 rock lobster checked. This range has been used to estimate that between 10.8 and 16.7 tonnes of illegal rock lobster were consigned during 2006/07.

In addition to the rock lobster fishery, FMOs focused their activity on ensuring high levels of compliance in other commercial fisheries such as abalone, wetline, crab, shark, scallop, pilchard and estuarine fisheries.

Considerable compliance activity was directed towards recreational fisheries within the West Coast bioregion, with FMOs achieving 35,465 field contacts with recreational fishers – a slight decrease on the previous year. The majority of the compliance effort focused on rock lobster, abalone, marine finfish and crabs.

Throughout the West Coast bioregion, a total of 467 infringement warnings, 172 infringement notices and 90 prosecutions were instigated for recreational offences during 2006/07. This is similar to 2005/06 and still represents a significant decrease in warnings and infringement notices, (from 676 and 235 respectively in 2004/05) and a drop in prosecutions from 103 in 2004/05. This sustained decrease is likely due to the continuing high presence of FMOs at boat ramps, as recreational fishers become more educated about fishing regulations.

The Department continues to work collaboratively with the Department of Environment and Conservation (DEC) in delivering compliance services to marine parks throughout the bioregion. The levels of non-compliance encountered in these parks is low and is likely a testament to the efforts of FMOs and DEC officers in educating marine park visitors about the new regulations in the marine parks.

This collaborative approach has worked very effectively, particularly during the Perth metropolitan abalone season that occurs predominantly within the Marmion Marine Park, where DEC officers undertake joint patrols with FMOs, thereby increasing the effectiveness of compliance service delivery within that fishery.

As part of the collaborative approach towards marine park compliance service delivery, additional officers from DEC have undertaken fisheries compliance training and are now authorized as Honorary Fisheries Officers. The Department has also extended the commitment to maximize efficiency of fisheries compliance service delivery across government by providing training to other agencies including the Water Corporation and the Rottnest Island Authority. Many of the field staff of these agencies are now also authorized as Honorary Fisheries Officers.

Throughout the year, FMOs continued to undertake joint patrols with other agencies including the Department for Planning and Infrastructure, the Australian Customs Service and the WA Police Service.

The 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.

VFLOs', together with FMOs, attended the Mandurah Crab Fest and the Mandurah Boat Show respectively, to provide advice regarding fishing regulations to the large number of boating enthusiasts and recreational fishers attending these very popular events.

VFLOs and FMOs visited the Abrolhos Islands in May 2007 and conducted school talks and patrols, as well as assisting with carrying out a clean-up and maintenance around Big Rat Island.

Initiatives in 2007/08

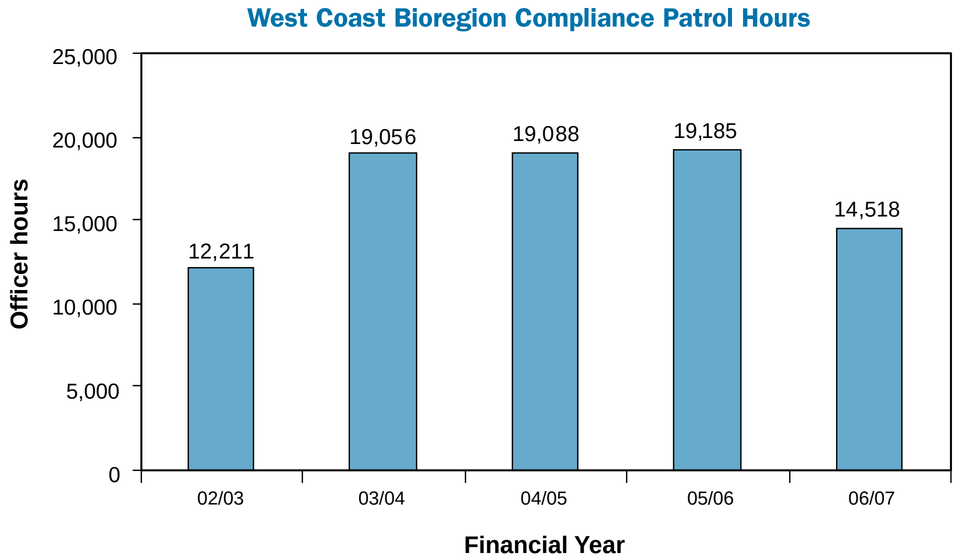
Drawing on an improved intelligence capacity, a number of targeted rock lobster compliance operations are planned during the 2007/08 rock lobster season, with a focus on over-potting and gear-related offences.

The Department of Fisheries continues to improve its at-sea patrol capability with the design of a new 12-metre rigid inflatable boat (RIB) being constructed. The RIB will be based at the Hillarys district and used to deliver fisheries and marine safety compliance services throughout the Perth metropolitan area, including the Marmion Marine Park.

The construction process is well underway for the 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.

A major maintenance project was undertaken on the Abrolhos Islands' three airstrips. A full risk assessment for the Abrolhos Islands estate is planned with the outcomes expected to assist in mapping of work priorities at the Abrolhos.

The introduction of the limited-entry West Coast Demersal Scalefish Interim Managed Fishery is expected to keep FMOs busy throughout the West Coast bioregion ensuring that only licensed wetline fishers are taking fish for a commercial purpose.



WEST COAST COMPLIANCE FIGURE 1*

'On Patrol' Officer Hours showing the level of compliance patrol activity delivered to the West Coast bioregion over the previous 5 years. The 2006/07 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, etc.)

* This does not include 2,980 'on-patrol' hours delivered in 2006/07 by the PV Hamelin and the PV MacLaughlan. In the version of Figure 1 published in the previous edition of State of the Fisheries, the hours patrolled by PV Hamelin and PV MacLaughlan were included in the West Coast totals, leading to consequent higher totals for each financial year.

The total on-patrol hours for each of the Department's three large patrol vessels is reported in the compliance summary of the most relevant bioregion: PV Walcott in the North Coast bioregion, and PV MacLaughlan and PV Hamelin in the West Coast bioregion.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the west coast bioregion during the 2006/07 financial year.

Patrol Hours Delivered to the Bioregion	14,518 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries & Marine Officers	429
District Office contacts	2,771
Infringement warnings	325
Infringement notices	78
Prosecutions	25
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	35,465
District Office contacts	10,867
Infringement warnings	467
Infringement notices	172
Prosecutions	90
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY***	
Field contacts by Fisheries & Marine Officers	300
District Office contacts	7,665
Fishwatch reports***	414

* 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" 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 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 the 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, Hillary's, Lancelin, Jurien, Dongara and Geraldton district staff.

WEST COAST COMPLIANCE TABLE 2

Summary statistics for commercial West Coast Rock Lobster Fishery compliance in all bioregions in the 2006/07 fishing season.

Total compliance hours*	23,309 Officer Hours
Field contacts by Fisheries & Marine Officers	3,411
District Office contacts	1,877
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 **	17
Proportion of total commercial catch inspected	2.4 – 3.0%
Non-compliance rate (per-animal basis) ***	0.0013 – 0.0019
Total consigned commercial catch ('000 kg)	8,609
Estimated total illegal catch consigned ('000 kg)	10.8 – 16.7

* Includes all time spent on compliance related tasks, e.g. investigations, prosecutions, etc.

** 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

Beach fishing in Shark Bay. Photo: Richard McKenna

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 greater 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 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.

Photo: Andrew Cribb

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.

ENVIRONMENTAL MANAGEMENT

Regional Overview (Gascoyne Coast bioregion)

Extensive trawl closures in the Shark Bay and Exmouth region provide protection to sensitive benthic habitat, including coral reef, sand flats and seagrass beds. These areas provide significant fish nursery, breeding and feeding habitat (Gascoyne Coast Habitat Protection Figure 1).

Further protection (see Gascoyne Coast Habitat Protection Figure 2) has been subsequently added to these highly-valued areas by:

- The proclamation of marine conservation reserves under the *Conservation and Land Management Act 1984* at Ningaloo Reef, Shark Bay and, most recently, the Murion Islands;
- The declaration of Fish Habitat Protection Areas under the *Fish Resources Management Act 1994* at Point Quobba and Miaboolya Beach; and
- section 43 closures under the FRMA to fishing at South Murion Island and surrounding the wreck of the '*Gudrum*' (Shark Bay).

The Australian Commonwealth Government is also considering nominating an area of the Ningaloo coast for consideration as 'World Heritage' listing in view of the significant environmental values of the coast and near-shore marine ecosystem. The boundary of this area will be determined through negotiation between the Commonwealth and State Governments.

As a consequence of World Heritage listing, there would be no change to existing management arrangements for this area. However the listing would require any future development proposal that has a significant impact on the World Heritage values of the area to be referred to the Commonwealth Government under the *Environment Protection and Biodiversity Conservation Act 1999.*

The Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. The DEWHA plans to complete a draft North West Marine Bioregional Plan, which will contain individual marine protected areas, in late 2009.

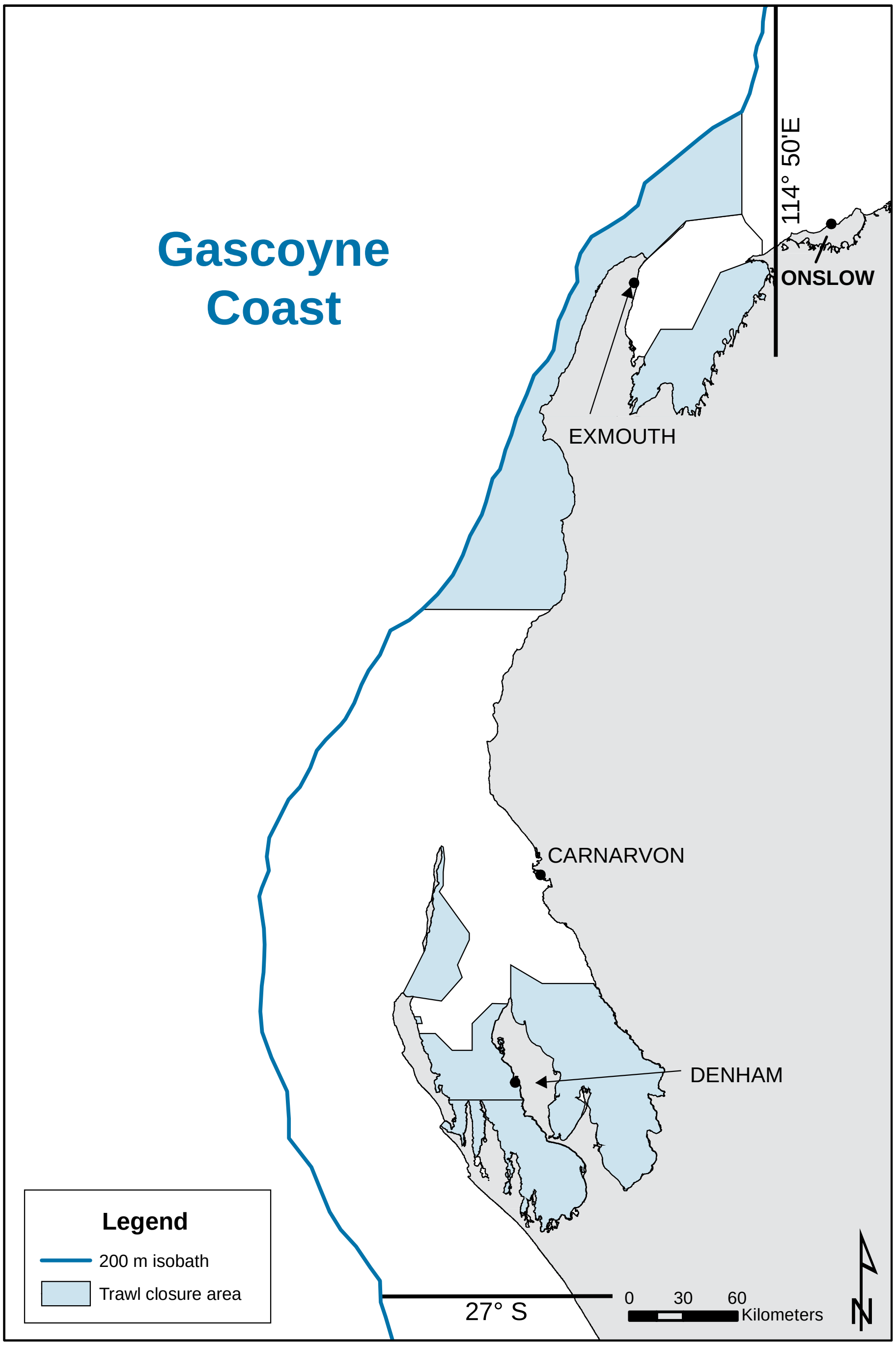
Specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the bioregion, to prevent the incidental entanglement of dugongs and turtles which inhabit the area. These controls have also provided protection for the large shark species which are a feature of this bioregion. More recently, bycatch reduction devices ('grids') installed in trawl nets have increased the protection for sharks, rays and 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 an Ecosystem-Based Fisheries Management (EBFM) framework. The West Coast and Gascoyne Coast bioregions have been selected to trial this process.

EBFM is a risk-based management approach, which recognizes the social, economic and environmental values of the region, and ecological links between exploited fish stocks and the broader marine ecosystem. EBFM will now guide fisheries management arrangements in the Gascoyne, to ensure the sustainable management of fish stocks in the future.

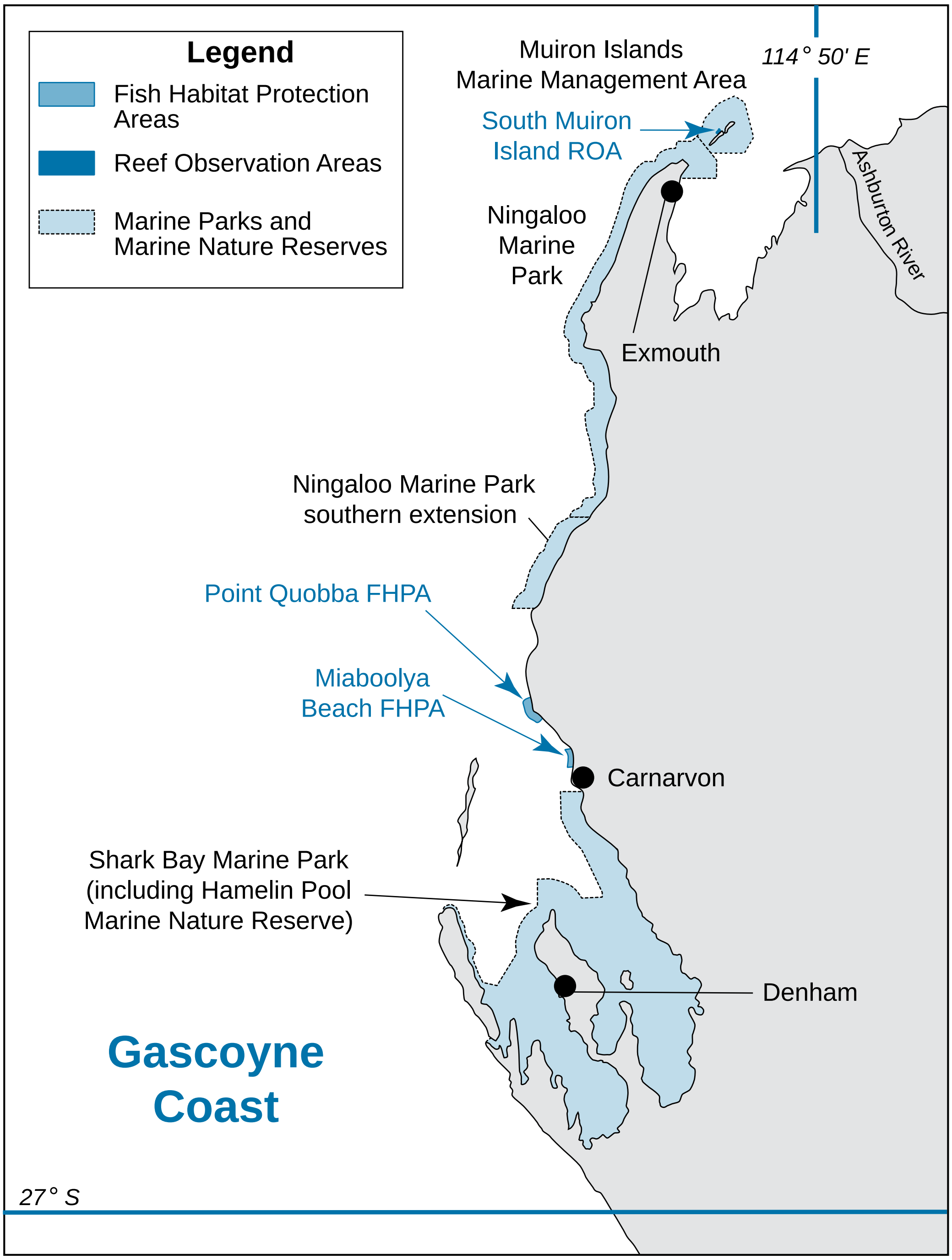
The Department of Fisheries also continues to provide advice to the Environmental Protection Authority on development proposals which, if implemented, have the potential to impact on the aquatic environment. These include a proposal by Straits Resources Yannarie Solar Salt to mine salt at Exmouth Gulf, which has been the subject of intense assessment in the past year.

The Department also continues to actively engage with natural resource management coordinating groups to promote sustainable use of the aquatic environment, and has 'introduced aquatic organism incursion' and 'fish kill incident response' programs in place to minimise risks to the marine environment through the introduction of exoctic aquatic organisms, or other incidents which have the potential to have an adverse effect.



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 J. Kennedy

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. The timing and spatial pattern 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. Non-fishing periods occur around the full moon, commonly known as moon closures. These moon closure periods are variable and can range from five to ten days and are set out in the season arrangements. King prawns are photosensitive, which makes them less active around the full moon and less catchable. Industry has voluntarily extended these closures to increase economic efficiency by shifting fishing effort away from these times of reduced catch rate.

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 fishing arrangements for the 2007 season opened on 19 March and closed on 23 October for a total of 170 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. In 2007 all boats towed quad gear.

Bycatch reduction devices (BRDs) are fully 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 Ecological 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 was 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 was completed in early 2008. A new FRDC-funded project focussing on minimising gear conflict and resource sharing issues in the Shark Bay prawn and scallop 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 2007): 1,250 tonnes

Landings

The total landings of major penaeids for the 2007 season were 1,250 t, comprising 771 t of king prawns, 478 t of tiger prawns and a minor amount of endeavour prawns (Shark Bay Prawn Figure 2). In addition, there were also 27 t of minor penaeids (coral prawns) landed. Total landings were below the target catch range (1,501 – 2,330 t); tiger prawn landings were within the target range for that species (400 – 700 t), but king prawn landings were below the acceptable catch range (1,100 – 1,600 tonnes).

Scallop landings by the prawn fleet in 2007 totalled 711 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 256 t of blue swimmer crab (*Portunus pelagicus*), 23 t of squid, 9 t of cuttlefish, <1 t of bugs (*Thenus orientalis*) .

Fishing effort/access level

There are twenty-seven licenses in the Shark Bay Prawn Managed Fishery, but as a result of changes in gear configuration only 18 boats operated in 2007, towing quad gear (4 x 5.5-fathom nets). This fleet rationalisation incorporated a reduction of headrope length from 432 fathoms to 396 fathoms.

Previous status reports have documented effort as nominal effort, for twin gear (27 boats towing two 8-fathom standard nets) effort. 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 is adjusted to standardised twin gear equivalent effort.

Total nominal effort recorded by the prawn fleet in 2007 was 25,715 hours. The adjusted effort was 35,980 hours, which is lower than the 2005 and 2006 season's adjusted effort. The effort in 2007 is the lowest recorded in 36 years (Shark Bay Prawn Figure 2).

At the commencement of the 2007 season, the prawns were small size, mainly in the area east of the Carnarvon – Peron line. The size composition of prawns determined the extent of area to be opened to optimise the take of large-size prawns and instead of a full opening on an arbitrary date as in past years. In 2007, two area openings within the Carnarvon/Peron area were based on surveys prior to each opening. A flexible harvesting strategy requiring real-time management is used to maximize king and tiger prawn size and market value, while still providing a sustainable approach to stock management.

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 21.5 kg/hr (equivalent to twin gear units) for king prawns observed in 2007 remains relatively high compared to past years, even though the total landings of king prawns were low. The 2007 tiger prawn catch rate of 13.3 kg/hr was higher compared to the catch rates (mean 12.0 kg/hr) during the 1970s and a significant increase compared to the low catch rates observed during the 1980s (mean 4.9 kg/hr).

The overall 2007 daily catch rates were maintained at relatively high levels for the season by maintaining a flexible strategy of extending moon closures when catch rates declined to a lower level. This strategy is designed to reduce the period of inefficient fishing.

Spawning stock and recruitment indices are derived from logbook and survey data, which are compared to the accepted spawning stock – recruitment relationship (SRR) for tiger prawns in Shark Bay. Research logbooks provide information on the daily catch (kg) of target species and effort (hours trawled) expended in specific fishing areas. Catch and effort can then be derived for each fishing area by each boat by species. 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 July and August for 2007. Two or three surveys may be undertaken each year, depending on the timing of the moon phases.

To maintain adequate breeding stock levels for tiger prawns, the tiger prawn spawning area (TPSA) is closed when the mean catch rate reaches the threshold level. Since the survey regime, to monitor catch rates of tiger prawns was established in 2001, the catch rate threshold has steadily increased from the initial level of 10 kg/hr to the present range of 18 to 22 kg/hr (based on twin gear, 8-fathom nets). The catch rate was adjusted for quad gear (four 5.5-fathom nets) to 27.5 kg/hr, with a range of 25 to 30 kg/hr.

King prawn breeding stock is also protected by this closure and their catch rates are also recorded during the surveys. From early August onwards, the Extended Nursery Area (ENA) is closed to protect smaller prawns (primarily king prawns) moving onto the trawl grounds from the nursery area. In addition, the Denham Sound opening is now later (July/August) in the year, which gives protection to these smaller prawns early in the season allowing a higher spawning biomass in this region.

Two standardised research surveys (to confirm commercial catch rates derived from logbook information) were carried out in the TPSA (Shark Bay Prawn Figure 1) in July and August to determine the catch rate of tiger prawns. The average catch rate of tiger prawns from the surveys was 22.4 kg/hr – below the target range for quad gear (25-30). When the TPSA was closed in early June, the survey catch rate in the area in July was 24.9 kg/hr only marginally below the threshold level. Therefore it was considered that the TPSA closure timing was appropriate for 2007 to provide protection of key spawning stock.

Fishery-independent survey data allows 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 multi-species nature of this fishery requires the levels of harvest for both king and tiger prawn stocks to be carefully monitored to 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 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.

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 trawl mesh, suggesting that the overall exploitation is low and that breeding stock levels will therefore be adequate. Due to the current low market prices for these minor species their retention is minimal.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2007, the breeding stock indicator for tiger prawns was met. The king prawns were below the catch range but this was because of reduced effort, targeting of larger-size prawns and a shift of effort away from king prawns by the majority of boats onto scallops and tiger prawns. Endeavour prawns were also below the catch range, but this is not a concern, as this species is not targeted in this fishery.

Bycatch species impact: Low

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 sub-tropical 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 the report completed in 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 two 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. The analysis indicates that trawled areas have similar biodiversity measures to the larger adjacent untrawled areas (even though abundances may vary), indicating that the objective is met. For provisioning, the objective has been met due to the lower and more targeted trawl effort and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period and the risk to these components is now considered to be low.

Protected species interaction: Low

Although protected species including whales, dolphins, dugongs, turtles and sea snakes are abundant in Shark Bay, only sea snakes are seen regularly in the trawl catches but only in certain areas, and these are mostly returned to the sea alive. The full implementation of bycatch reduction devices ('grids') in the fishery since 2002 has generally minimised the occasional capture of turtles in trawl nets. For 2007, grids were fitted in nets during the entire fishing season. For 2007 season, only two turtles were recorded as caught in nets and both were returned to the sea alive.

Performance measure for the fishery is for 90% of the turtles from non-BRD nets to be returned alive. In 2007, grids remained in nets for the whole season. The performance measure for returning 90% of turtles from non-BRD nets to the sea alive is no longer applicable, as all nets are fitted with grids for the entire fishing season. In 2007, two turtles were recorded as caught in nets and these were returned to the sea alive.

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 food chain 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 636 square nautical miles or ~13% 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.

Social Effects

During 2007 95 skippers and crew were employed in this fishery. 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 Coast bioregion, is a major contributor to regional employment.

Economic Effects

Estimated annual value (to fishers) for year 2007: $14.3 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time, and average ex-boat prices were as follows:

King prawns	$10.05/kg
Tiger prawns	$12.45/kg
Coral prawns	$2.00/kg

Fishery Governance

Current fishing (or effort) level: Acceptable

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 – 30 t. King prawn catches during 2007 were well below the target ranges set, while tiger prawn catches were within the target range. The endeavour prawn reported catches have declined markedly since the early 1990s.

Effort has also been directed to target larger king and tiger prawns and avoid areas of smaller prawns and where endeavour prawns are mainly taken. Therefore this latter species should no longer be included in the performance indicator for the fishery as this species is no longer a target species.

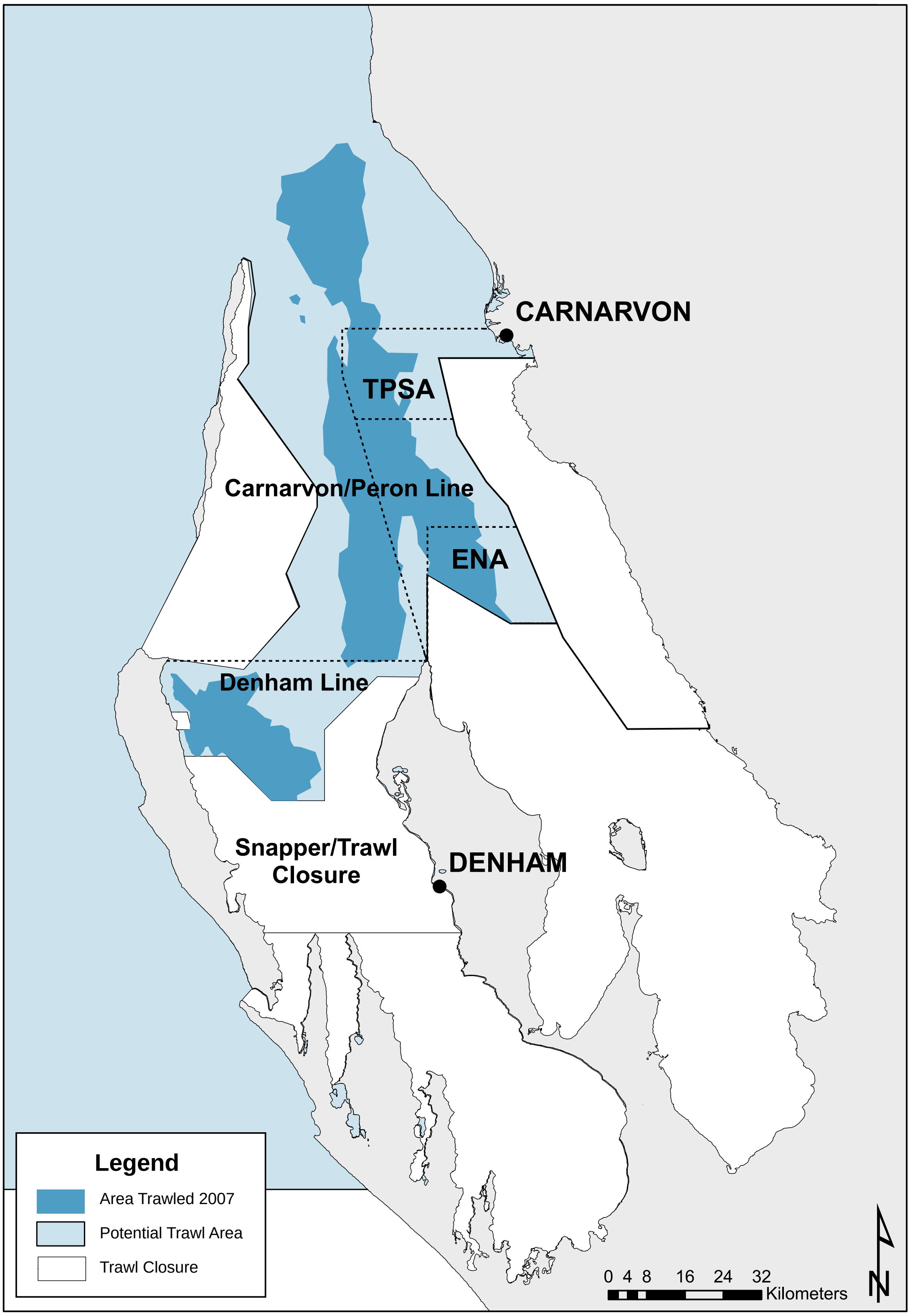
New management initiatives (2008)

The fleet restructure to reduce the number of boats actually fishing by towing larger nets per boat will continue in 2008.

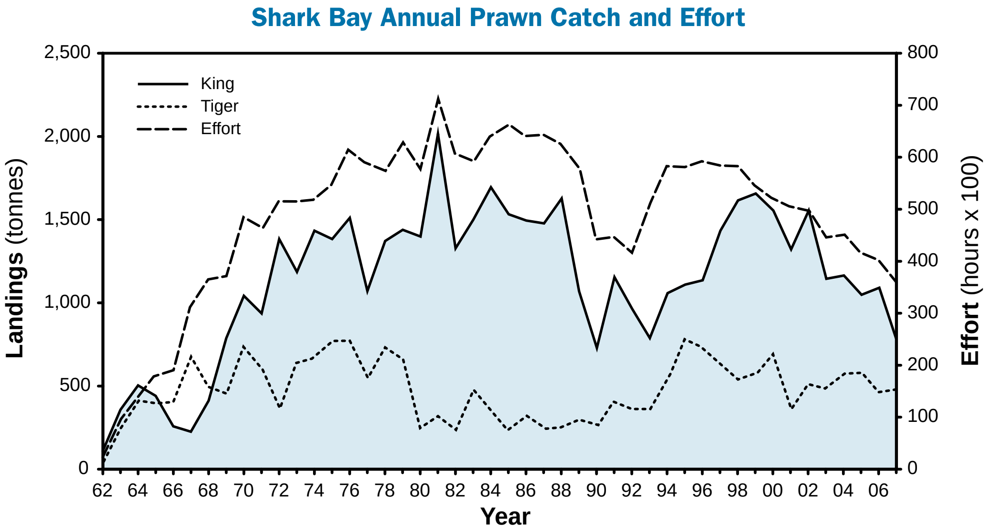
External Factors

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 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 1
Boundaries of the Shark Bay Prawn Managed Fishery and area trawled in 2007.



SHARK BAY PRAWN FIGURE 2

Shark Bay Prawn Managed Fishery annual landings and effort 1962 – 2007.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown

Management input from J. Kennedy

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 shown in Exmouth Gulf Figure 1.

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 provide a prediction of catch.

Management arrangements in recent seasons have provided for a fishing period of about 200 nights with a minimum of 28 non-fishing nights for moon closures (i.e. four nights each full moon). For the 2007 season, official opening and closing dates were formally set at 16 April and 24 November 2007 respectively, providing 197 nights for fishing. However, this is a flexible arrangement and the season actually commenced on 25 April, based on results from pre-season surveys, and closed at 0800 hrs on 16 November for a total of 161 nights 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 maintained at adequate levels and that the prospect of both recruitment 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 prescribe a mandatory closure of the tiger prawn spawning area (sometimes referred to as the 'TPSA') when the tiger prawn catch rate falls to 25 kg/hr (based upon 'quad gear' catch rate, 4 x 6-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 25 kg/hr to 19 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' (four 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 maximising economic efficiency but still maintaining overall catch in this fishery as well as sustainability.

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 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 was due to be reviewed in the 2007 season but has been postponed until 2008. Industry also installed 'hopper' in-water sorting systems in 2002, which provide an improved quality of prawns and reduce 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 logbooks, 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 was completed in 2007.

Retained Species

Commercial production (season 2007): 790 tonnes

Landings

The total landings of major penaeids for the 2007 season were 790 t, comprising 342 t of king prawns, 248 t of tiger prawns and 200 t of endeavour prawns. The total landings have reduced progressively since the high total landings in 2004 because of the decline in the tiger prawn landings, but remain within the target catch range.

The tiger prawn landings were low and marginally below their acceptable catch range of 250 – 550 t (Exmouth Gulf Prawn Figure 2) and below the catch prediction (260 – 390 t) based on survey indices. King prawn landings were also low and slightly below the target catch range of 350 – 500 t. The endeavour prawn landings were within the target catch range of 120 – 300 t.

Recorded landings of by-product included 39 t of coral prawns, 8 t of blue swimmer crab *(Portunus pelagicus)*, 10 t of squid, 2 t of bugs *(Thenus orientalis)* and <1 t of cuttlefish.

Fishing effort/access level

There are 16 Managed Fishery Licences in this fishery. In order to improve upon the economic efficiency achieved while maintaining sustainable catch levels, the number of boats has been reduced but these boats tow larger nets. 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, in twin gear configuration. 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 2007 the number of fishing boats that fished the season was reduced from 12 in 2006 to 9, with 1 boat towing 4.5-fathom nets, 4 boats towing 5.5-fathom nets and 4 boats towing 6-fathom nets (total of 202 fathoms of headrope length). The aim is to standardise the fleet and have all boats tow a maximum of 6-fathom nets with the total net allocation of 216 fathoms. The effort and catch rate information stated in this report is adjusted effort, which is standardised to 7.5-fathom twin gear.

Total nominal effort for the 2007 season was 16,278 hours. The adjusted nominal effort was 24,650 hours, which was 10 per cent lower than 2006 (27,511 hours adjusted). Using the mean trawl hours between 1989 and 1998 as a reference point for catch and effort (36,455 hours) the trawl hours for 2007 were 32 per cent lower. Of the nearly 200 nights allocated to fishing, the fleet fished 161 nights during the 2007. Although the number of days fished was slightly more than during the 2006 season (157 nights) the reduction in the number of boats from 12 to 9 was the major contributing factor for the reduced effort. The 2007 adjusted nominal fishing effort level was the lowest since 1969.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected catch next season (2008): 450 – 680 tonnes tiger prawns

The adjusted 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 ten-year reference point (1989 to 1998 inclusive) for each species. The adjusted catch rate, 13.9 kg/hr, for king prawns for 2007 is above the average catch rate of 11.7 kg/hr. The catch rate of 10.1 kg/hr for tiger prawns is at the average catch rate of 10.0 kg/hr. The endeavour prawn catch rate of 8.1 kg/hr was above the average catch rate of 5.6 kg/hr.

The tiger and king prawn stocks are also assessed each year using standardised 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 spawning stock and subsequent recruitment, which are assessed against the spawning stock – recruitment relationship.

The spawning stock survey catch rate average level (22.9 kg/hr) in 2006 was below the threshold of 25.0 kg/hr. Although the catch rate level was slightly lower than the target threshold, it is likely to not be critical due to the relatively conservative nature of the original threshold setting, but it is important to aim for the catch rate threshold due to variability in environmental conditions that also influence larval, juvenile and recruit survival.

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. As net headrope for each boat has increased, the threshold catch rate has been raised higher – from 19 to 25 kg/hr to adjust for the increase in headrope from 4.5 fathoms to 6 fathoms, quad gear configuration.

During 2007, tiger prawn catch rates were monitored from May to August and the tiger prawn grounds closed on 1 August. The August, September and October surveys showed a Catch Per Unit Effort (CPUE) of 21.3 kg/hr, 29.1 kg/hr and 26.9 kg/hr respectively, with an average CPUE of 25.2 kg/hr in the main spawning area. This was at the target threshold level. As the target threshold level was achieved during the spawning period, the tiger prawn spawning area was re-opened for fishing from November.

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 to November of the same year). For 2008, the projected tiger prawn catch range is 450 – 680 t under normal environmental conditions and average levels of fishing effort.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort. The extended breeding period and lower catchability of the species compared to tiger prawns also makes them more robust to over-fishing. The variability in the abundance of the king prawn stock has been assessed since 2002 by a pre-season recruitment survey. Further years of catch data will be required to assess the spawning stock – recruitment and catch prediction relationship for this king prawn stock.

There is no formal assessment for endeavour prawns because, given their lower value, they are not targeted to the same extent as tiger and king prawns. They are fished 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 2007, the spawning catch rate for tiger prawns was maintained at the threshold level, therefore the objective was met. Fishing took place after the key spawning period in order to fish the tiger prawn stock to the lower level of 19 kg/hr. King prawns were only marginally below the acceptable catch range. For the other species, the breeding stock indicators (catches within specified ranges) were all met. There were no reported landings of banana prawns.

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, all nine boats during 2007 used 'hoppers' (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality. Also, fishing effort in 2007 was the lowest in over 36 years, reducing trawl impacts.

The two 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 completed in 2007. Analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas (even though abundances may vary), indicating that the objective is met. For provisioning, the objective 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 fitted in all nets. No turtles were reported as being caught in nets during 2007.

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 has 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 2007 the performance measure was met as the total area trawled, at approximately 315 square nautical miles (~26%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2007 was 27 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 2007: $9.1 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	$12.00/kg
Tiger prawns	$13.00/kg
Endeavour prawns	$8.50/kg
Coral prawns	$3.50/kg

Fishery Governance

Target catch range: 771 – 1,276 tonnes

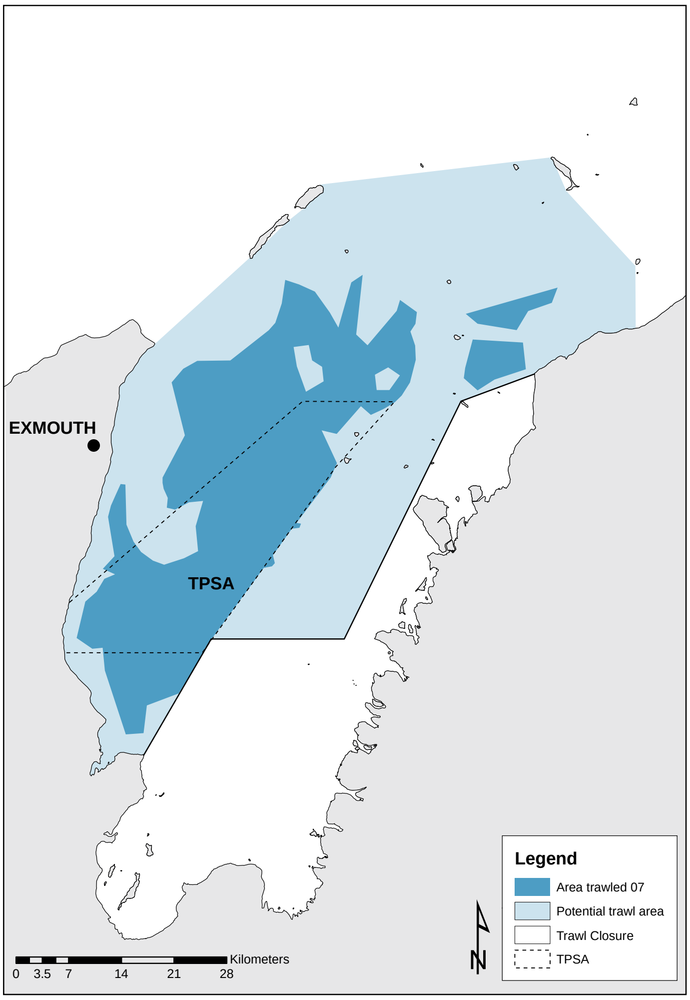
Current fishing level: Acceptable

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 both tiger and king prawns were not met for the 2007 season.

New management initiatives (2008): None

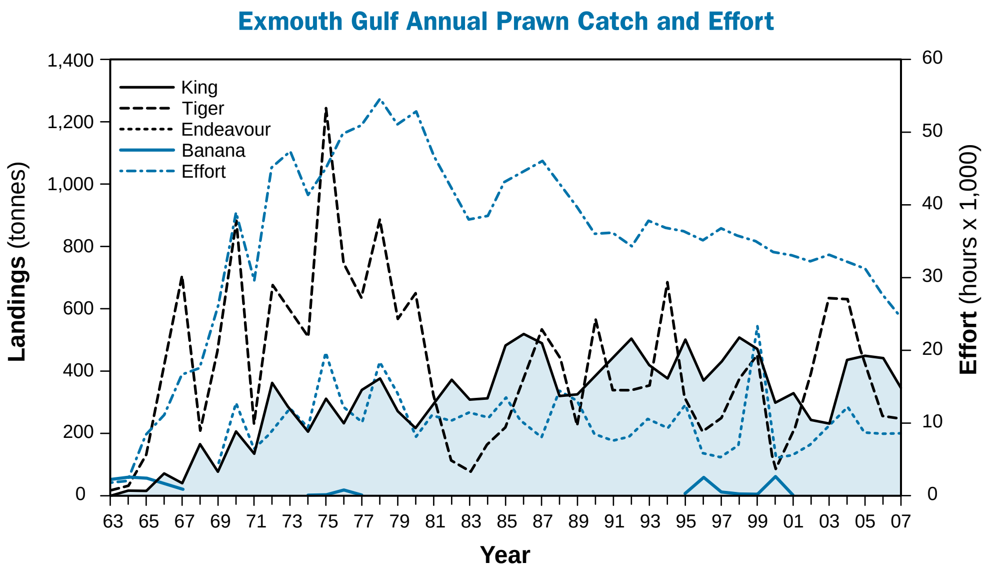
External Factors

Cyclones appear to have a significant effect on the productivity of Exmouth Gulf. Cyclone impacts can be either positive or negative. Early (December to February) cyclones can have a negative impact (high mortality) on small size prawns in the shallow nursery areas. There are other environmental factors that have not been fully investigated that can affect the spawning stock – recruitment relationship.



EXMOUTH GULF PRAWN FIGURE 1

Boundaries of the Exmouth Gulf Prawn Fishery and area trawled in 2007.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort, 1963 – 2007.

Shark Bay Scallop Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from J. Kennedy

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 boundaries of the fishery are outlined in 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. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats. 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.

For the 2007 season, a catch share arrangement was in place as part of a two-year trial with the share of 72% and 28% for the A and B Class boats respectively, to be averaged over two years. This catch share proportion was set using the average catch for these two fleets since 1982.

The 2007 scallop season commenced on 8 March in lower Denham Sound (Leads area) with all 14 Class A scallop boats (dedicated scallop boats) fishing. This was the third season an early opening has occurred, 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 rate limit for the scallop fleet to cease fishing.

On 11 March the dedicated scallop boats moved into the permitted trawl area in Denham Sound. This was the third season that fishing for scallops was restricted to daytime hours in Denham Sound. The northern part of Shark Bay (North West Peron area and the Red Cliff area north of 25°30.20´ S latitude) opened on 18 March for A and B class scallop boats. Fishing ceased for the A class scallop boats on 11 April and these boats left Shark Bay to fish in the Abrolhos Islands and Mid West Trawl Fishery.

The Department of Fisheries' Research Division carries out daily monitoring of the fleet for catch and effort to provide advice on when to close areas. This, together with the VMS, is a major element of the management strategy to control 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 logbook records and factory catch unloads provided by industry, and real-time monitoring of catch levels and catch shares. 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 was 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 was also 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 early 2008. This will include hydrographic modeling of scallop larval movement within Shark Bay.

Retained Species

Commercial production (season 2007): 2,273 tonnes whole weight

The total scallop landings for this fishery, for both A and B Class scallop boats, were 2,273 t whole weight, of which the A Class boats landed 1,562 t (68 % rather than achieving the 72%) and the B Class boats landed 711 t. This represents the highest catch in 12 years, but the total landings were below the predicted catch.

The November 2006 scallop survey provided a catch forecast of 5,445 t (catch range 4,360 – 6,530 t) for the entire Shark Bay scallop fishery for 2007. Catch projections are provided for two areas – northern Shark Bay and Denham Sound. The catch range predictions for each area were 4,460 t (catch range 3,570 – 5,350 t) and 985 t (catch range 790 – 1,180 t) respectively.

The total scallop landings from Denham Sound (673 t) were below the catch prediction range. Catch in Denham Sound was limited by the cessation of fishing by the A class boats at a higher level to ensure that enough catch remained for the B class fleet to take during the latter months of the fishing season, due to the catch share arrangement.

The total scallop landings from Red Cliff and North West Peron areas were 1,431 t – well below the catch prediction range.

During the November 2006 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 catch prediction was in excess of 250 tonnes whole weight after leaving 40 per cent stock for spawning. Therefore, fishing for scallops in 'the Leads' area in 2007 was permitted, which provided 169 t this season.

The overall catch may have been affected by the change in fishing pattern including daylight fishing in Denham Sound, cessation of fishing during the key spawning period, and the use of catch threshold limits to increase the residual biomass in the fishery.

Fishing effort/access level

The total effort recorded by the Class A boats in 2007 was 6,176 hours. The effort in 2007 compared to another recent good catch year (1,400 t whole weight in 2002) had an effort of 11,284 hours (83% above the 2007 effort). For the past three 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 (sunrise to sunset), in order to reduce interaction with prawn stocks. This continued for the 2006 and 2007 seasons. 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 1,500 kg whole weight per day fished (daylight fishing in Denham Sound) and 2,000 kg whole weight per 24-hour fishing in the northern part of the fishery. The use of a catch rate threshold is experimental for at least three years, from 2005 inclusive, to establish if this level of the remaining spawning stock provides adequate recruitment under normal environmental conditions.

Recreational component: **Nil**

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Projected catch next season (2008): **4,040 – 6,050 tonnes whole weight**

The status of the stock is determined from a pre-season survey of recruitment and residual stock carried out in November to December on the main fishing grounds in the northern part of Shark Bay 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.

Research has shown that scallops mature at about one-year of age and the key spawning period typically occurs from April to July inclusive. Fishing is therefore controlled to ensure that sufficient scallops remain through the key spawning period, which is the critical period for settlement and grow-out of future recruits.

The survey design and analysis of the data provides separate catch forecasts for the northern Shark Bay and Denham Sound areas, allowing separate opening dates to be determined for each area to optimise scallop catches each season. The 2006 November annual scallop survey showed acceptable scallop recruitment in both northern Shark bay and Denham Sound. Fishing ceased above the threshold limit in Denham Sound, at 600 meat kg/hr for the 2007 season. In addition, fishing for scallops ceased for a period of two 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.

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. Since 2006 the fishing season has been 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 2008 season is based on the 2007 survey results. The predicted catch forecast for the entire fishery is 5,050 t whole weight, with a range of 4,040 – 6,050 t whole weight. For the northern part of Shark Bay the catch prediction is 2,660 t, with a range of 2,130 – 3,190 t. The prediction in the Denham Sound area is 2,385 t, with a range of 1,910 – 2,860 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 2007.

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 2007, 18 per cent 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 2007 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 2007: $8.2million

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 $3.60/kg whole weight or $18.00/kg meat weight. Meat weight is 20 per cent of whole weight.

Fishery Governance

Target catch range: 1,250 – 3,000 tonnes whole weight

Current fishing levels: Acceptable

The target catch range is approximately 1,250 – 3,000 t whole weight, based on catches over the five-year period 1995 – 1999. This period excludes the high catches of the early 1990s (Shark Bay Scallop Figure 1), apparently created by an unprecedented four 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.

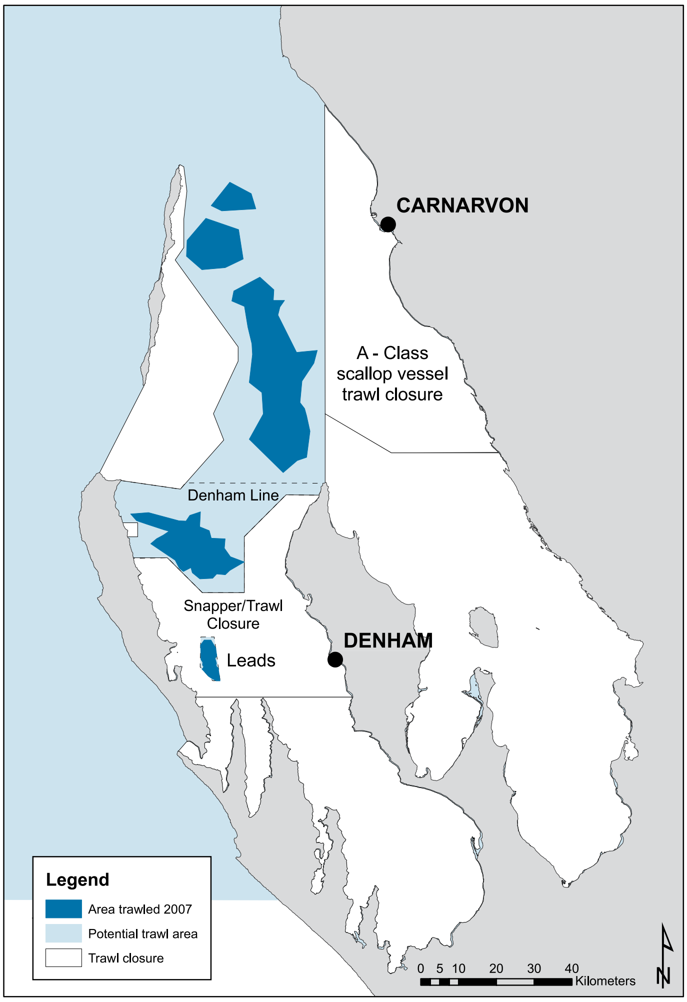
New management initiatives (2008)

None

External Factors

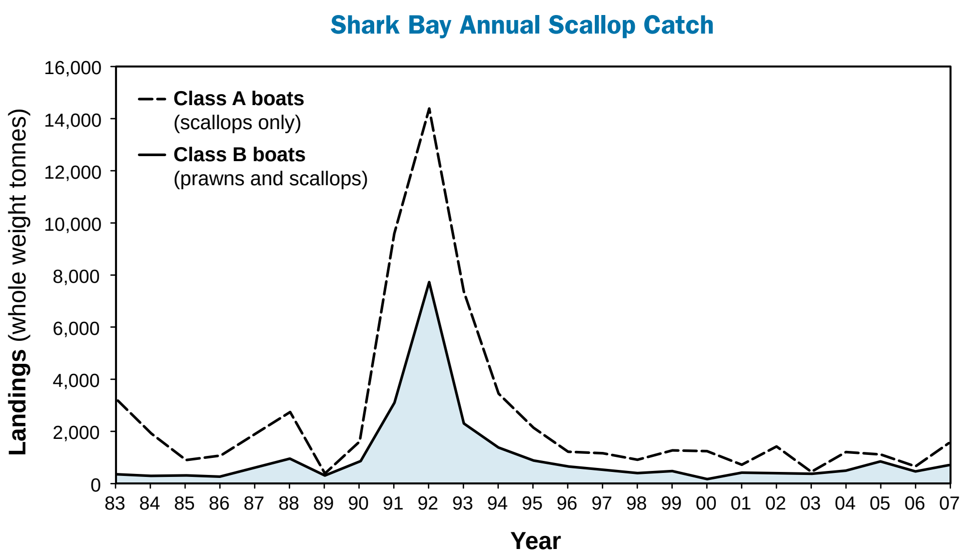
A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels corresponding to strong Leeuwin Current correlate with poor recruitment.

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 and areas that were actually trawled in 2007.



SHARK BAY SCALLOP FIGURE 2

Annual scallop landings by fleet for the Shark Bay Scallop Managed Fishery, 1983 – 2007.

Gascoyne Demersal Scalefish Fishery Status Report

G. Jackson and E. Lai
Management input from M. Stadler

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational fishing activities that target demersal scalefish in the continental shelf waters of the Gascoyne Coast bioregion (currently between 114° 50´ E and 27° S, Gascoyne Demersal Scalefish Fishery Figure 1). These include the activities of the Shark Bay Snapper Managed Fishery (SBSF), commercial 'open-access' wetline fishing and recreational line fishing from both licensed charter and private vessels.

Commercial line fishing in these waters is now almost entirely undertaken by SBSF licensed vessels that have historically targeted the oceanic stock of pink snapper (*Pagrus auratus*) in the 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). However, the exact relationship between pink snapper in continental shelf waters off Shark Bay and those elsewhere along the west coast remains to be determined (see section 'External Factors'). 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*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicus*) and trevallies (Carangidae). Commercial 'open-access' wetline vessels without SBSF-quota use similar line fishing gear and operate in waters outside of the SBSF management zone (see section 'Boundaries').

A total of nine commercial wetline vessels are permitted to fish for a period of five months per year north of the 'Point Maud-Tantabiddi Well' commercial fishing closure (see 'Boundaries'). All commercial line fishing vessels catch a similar variety of species as do a limited number of licensed charter vessels and large numbers of recreational vessels fishing out of Denham, Carnarvon and around the Ningaloo area (Coral Bay, Tantabiddi, Exmouth).

The focus of this report is three of the four key Gascoyne scalefish indicator species, i.e. pink snapper, goldband snapper and spangled emperor (see 'New Management Initiatives'). A fourth species, Spanish mackerel, is reported elsewhere in this document (see Mackerel 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
Prohibition on Fishing by Line From Fishing Boats (Pilbara Waters) Order 2006
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
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 most of the inner gulfs of Shark Bay. A limited number of commercial 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 (situation for the 2007 fishing season, prior to implementation of new arrangements for West Coast Demersal Scalefish Fishery in May 2008). No commercial fishing (WA state licensed vessels) 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 with the exception of Ningaloo and Shark Bay Marine Park sanctuary zones, marine nature reserves and conservation areas (Gascoyne Demersal Scalefish Fishery Figure 1).

Management arrangements

Commercial line fishing for pink snapper in the Gascoyne dates back to the early 1900s. The SBSF came under formal management in May 1987. Between then and 2000, pink snapper catches taken during the peak season (May to August) were subject to individual quotas, while gear controls applied in the off-peak season (September to April).

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 (value of each unit = 5,125 divided by total allowable commercial catch [TACC]).

In 2004, the TACC was reduced to 338,250 kg (from 563,750 kg), with the value of each unit set at 66 kg. In the same year, Shark Bay Scallop and Prawn Managed Fishery licensees volunteered not to take any pink snapper, effectively reducing the commercial quota further. This resulted in an 'effective' TACC of 313,000 kg in 2004, 2005 and 2006. In April 2007, the TACC was reduced to 297,250 kg and on 1 September 2007, further reduced to 276, 750kg (for the 2007/08 season) with the value of each unit reset at 54 kg (also see 'New Management Initiatives'). Currently there are no specific catch limits 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. This ESD report was used to meet the requirements of the Commonwealth's EPBC act. This identified that the fishery needed to report on the level of the oceanic pink snapper breeding stock annually (see boxed text for the annual assessment of performance of the fishery in relation to this requirement).

'Open-access' commercial wetline fishing outside of the SBSF is to come under formal management as an outcome of the 'Wetline Review' with the creation of a Gascoyne Demersal Scalefish Fishery and a Gascoyne Inshore Net Fishery scheduled for late 2009 (see Fisheries Management Paper No. 224 for further details).

Many of the commercial target species are subject to mimimum legal sizes (emperors, pink snapper, Spanish mackerel, red emperor, cods). The recreational fishery (including charter vessels) is principally managed using daily bag, possession, trip and size limits, coupled with prohibitions on the use of 'commercial' fishing gear (e.g. longlines).

Research summary

Research for this fishery includes annual analyses of the commercial and charter catch and effort data provided from monthly returns and from daily logbooks (charter) and quota returns (snapper only). Commercial catch and effort data reported here covers commercial line fishing in Gascoyne waters between 114° 50´ E and 27° S unless stated otherwise. Because most of the commercial catch of demersal species is taken by SBSF vessels, catches are reported for the SBSF quota-year – September 1 2006 to August 31 2007. These catches exclude mackerels, sharks and tunas (which are reported elsewhere). Recreational catches (estimated) and charter catches (reported) are those for the period January to December 2007.

A major survey of the boat-based recreational catch within the Gascoyne region was completed during the past year; the results from this survey will be available next year.

Pink snapper: Detailed research on the oceanic pink snapper stock and the associated SBSF was undertaken throughout the 1980s and early 1990s. An integrated stock assessment model has been used to assess the status of the oceanic snapper stock since 2003 using the age composition of SBSF catches and the commercial catch and effort data to provide the status report for the species.

A Western Australian Marine Science Institution project (4.4.2 Implications of stock structure, mobility and biology of species for spatial management approaches) is of relevance to this fishery. The study is investigating the spatial relationships between pink snapper populations throughout their distribution within WA waters (i.e. Shark Bay to the South Australian border). The study will use genetics, otolith chemistry and related techniques and will provide important information on the sources of recruitment for pink snapper in waters off Kalbarri and elsewhere down the west coast.

Goldband snapper: Biological information on goldband snapper is available from the nearby Kimberley region with some limited biological sampling having been undertaken in the Gascoyne region since 2005. More comprehensive research including a stock assessment is currently being undertaken as part of a Gascoyne Integrated Fisheries Management (IFM) research project; the results of which will be presented next year.

Spangled emperor: Preliminary biological information on several emperor species in north-west WA was generated in the early 1990s. Comprehensive research on spangled emperor commenced in March 2007 as part of the Gascoyne IFM research project. A more detailed status report for the species will be presented next year.

Retained Species

Commercial landings (season 2007):

Pink snapper 302 tonnes
Goldband snapper 107 tonnes
Spangled emperor 7 tonnes
Other emperors 29 tonnes
Other species 80 tonnes

The total commercial catch of pink snapper in the Gascoyne in 2007 was 302 t (334 t in 2006). Of this total, 286 t was taken by SBSF licensed vessels fishing within the SBSF management zone (TACC for 2007 season was 297 t). In addition, SBSF vessels also caught a total of 230 t of other species in 2007 including 106 t of goldband snapper, 16 t of red emperor and 6 t of spangled emperor (Gascoyne Demersal Scalefish Fishery Table 1). Wetline vessels without SBSF-quota fishing outside of SBSF waters caught approximately 16 t of pink snapper, 1 t of goldband snapper, around 0.5 t of spangled emperor and approximately 20 t of other various species.

While catches of emperor and cod species taken by commercial vessels in the Gascoyne have been relatively small and stable, catches of goldband snapper were observed to increase sharply from less than 10 t in 2001 before peaking at around 300 t in 2003 and then declining to around 100 t in 2006 and 2007 (Gascoyne Demersal Scalefish Fishery Figure 3).

Recreational catch:

Pink snapper 11%
Goldband snapper 7%

In 2007, the recreational catch of oceanic pink snapper landed at Denham was estimated at 8 t (12 t in 2006, 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 2007 was 22 t (18 t in 2006, 21 t in 2005, 25 t in 2004) (based on 83% return rate for 2007 returns at time of reporting, a total of 15 charter vessels reported pink snapper catches). Based on these data, the recreational catch of oceanic pink snapper was estimated at approximately 11% of the total catch in 2007 (the same as in 2006 and 2005). In the inner gulfs, pink snapper are almost entirely taken by recreational boats and are subject to separate management arrangements (see Inner Shark Bay Fishery).

The recreational catch of goldband snapper (mostly taken by charter boats) increased significantly to 8 t in 2007 (from 2 t in 2006, 3 t in 2005) (based on 83% return rate, a total of 7 charter vessels reported goldband catches). Based on these data, the recreational catch of goldband snapper was estimated at approximately 7% of the total Gascoyne catch in 2007 (this was 2% in 2006, 3% in 2005).

Data on recreational catches of spangled emperor are not available at this time. Detailed information obtained from the recently completed (March 2008) Gascoyne recreational fishing survey will be reported next year.

Fishing effort/access level

Commercial

Commercial line fishing between 23°34´ S and 26°30´ S is now entirely conducted by SBSF licensed vessels. Management arrangements introduced in 2004 to further protect the oceanic pink snapper stock resulted in a sharp decline in 'open-access' wetline effort across the Gascoyne. In 2007, SBSF vessels landed 92% of the total commercial catch of the key demersal species in the Gascoyne (includes pink snapper).

At the start of the 2007 season there were 46 licences in the SBSF. A total of 20 vessels actively participated in fishing in 2007 (there was 18 in 2006, 23 in 2005).

The effectiveness of fishing effort has varied markedly on a seasonal basis, historically peaking in June to July, when pink snapper gather in groups 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 to July. Fishing effort in the SBSF was 547 standard boat days in 2007 (518 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 2007, of the 83 fishing tour and 17 restricted fishing tour/eco-tour operators licensed to operate within the Gascoyne, only 40 licenses were active.

Stock Assessment

Assessment complete: Pink snapper: Yes; Goldband snapper: Not assessed; Spangled emperor: Not assessed

Breeding stock levels: Pink snapper: Inadequate but recovering

Pink snapper: Stock assessment modeling (using an age-structured model) which began in 2003 indicated that the spawning biomass of the oceanic stock was depleted. Subsequently, the assessment has been updated regularly, including the outcomes of an external review completed in July 2006.

The most recent update was completed in February 2007 that incorporated data from the 2006 commercial season. This estimated the spawning biomass to be only 27 – 28% of the unexploited level, which is below both the target reference level (40%) and threshold reference 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). Consequently, further reductions in the overall catch were implemented for the 2008/09 fishing seasons. The next assessment is scheduled for early 2009 that will be based on data from the 2007 and 2008 commercial fishing season.

Previous to the model, the breeding stock was assessed using the catch rate generated during the peak of spawning season (June-July), and this was used as the indicator for this fishery's *Environment Protection and Biodiversity Conservation Act 1999* assessment. The use of catch rates as an index of pink snapper abundance must be treated with caution due to the 'aggregating' (grouping to spawn) behaviour of the species during this 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 various reductions in quota.

The pink snapper catch per boat day in 2007 for SBSF licensed vessels for the peak months (June to July) was 523 kg snapper/boat day (614 kg snapper/boat day in 2006, 491 snapper/boat day in 2005 and 465 kg snapper/boat day in 2004, 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 to July) should not fall below 500 kg/standard boat day. Catch rates in 2006 increased significantly to 614 kg/standard boat day but fell in 2007 to 523 kg/standard boat day. However, this catch rate was still above 500 kg/standard boat day threshold.

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 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 relatively 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 2007 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 2007, 12 vessels fished for more than 10 days during the peak season (May to August) with average crew of 2.

Fishing and associated fish processing is a significant source 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 has been recently undertaken to assess levels of recreational fishing activity and human usage in the Ningaloo area as part of the Western Australian Marine Science Institution Node 3 Project.

Economic Effects

Estimated annual value (commercial fishers) for year 2007: $ 3.5 million

The overall value of the commercial component of the Gascoyne Demersal Scalefish Fishery (i.e. catch by SBSF and 'open-access' wetline vessels combined) was around $ 3.5 million in 2007 with $1.9 million from pink snapper and $1.6 million from all other scalefish species.

While an actual dollar value cannot be assigned to recreational catches in the Gascoyne at this stage, 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 (season 2007): 410 – 580 days

With the reduction in the pink snapper quota (initially by ~40% in 2004), the range in boat days required to take the landed catch (by SBSF vessels only) has been adjusted to 410 – 580 days. An estimated 547 boat days were required to take the landed catch (286 t) in 2007 which is near the upper end of the target range. Thus, the average Catch Per Unit Effort (CPUE) initially increased after the 40% quota reduction in 2004 to an estimated 614 kg/June – July boat day for the 2006 season, but has subsequently declined to 523 kg/June – July boat days for the 2007 season.

This is still above the Ecologically Sustainable Development (ESD) performance measure of 500 kg/standard boat day. However, given the issues raised in relation to pink snapper catch rates in this fishery (see 'Stock Assessment'), and the as-yet-to-be-determined effect of the most recent quota reductions on fisher's behaviour, the current ESD trigger (500 kg/standard boat day) and the acceptable range of days will be reviewed in the near future as part of the 5-year ESD-process review for the fishery.

New management initiatives (2007/08)

With the most recent stock assessment estimating that in 2006 the spawning biomass of the oceanic pink snapper stock was still below the 'threshold' (30%) levels, it was recognized that the spawning biomass would not reach the target level within the previously agreed timeframe (i.e. by 2014). Based on this assessment, and following a series of discussions with industry that took place between July 2006 and February 2007, the Minister of Fisheries approved a series of further TACC reductions for the 2006/07 and following two seasons (2007/08 and 2008/09). The arrangements will be reviewed prior to the start of 2009/10 season (i.e. in mid 2009).

Concerns around the sustainability of fishing for the more vulnerable deeper-water species (e.g. goldband snapper, ruby snapper, pearl perch) remain. Management arrangements within the proposed Gascoyne Demersal Scalefish Fishery aim to address this issue by limiting the total number of days that commercial operators can actually fish. Management arrangements for this fishery and the Gascoyne Inshore Net Fishery (to 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 being developed.

A Vessel Monitoring System (VMS) became operational in the SBSF in May 2008. In addition, daily/trip logbooks were introduced in February 2008, aimed at providing better resolution of catch and effort information for stock assessment purposes.

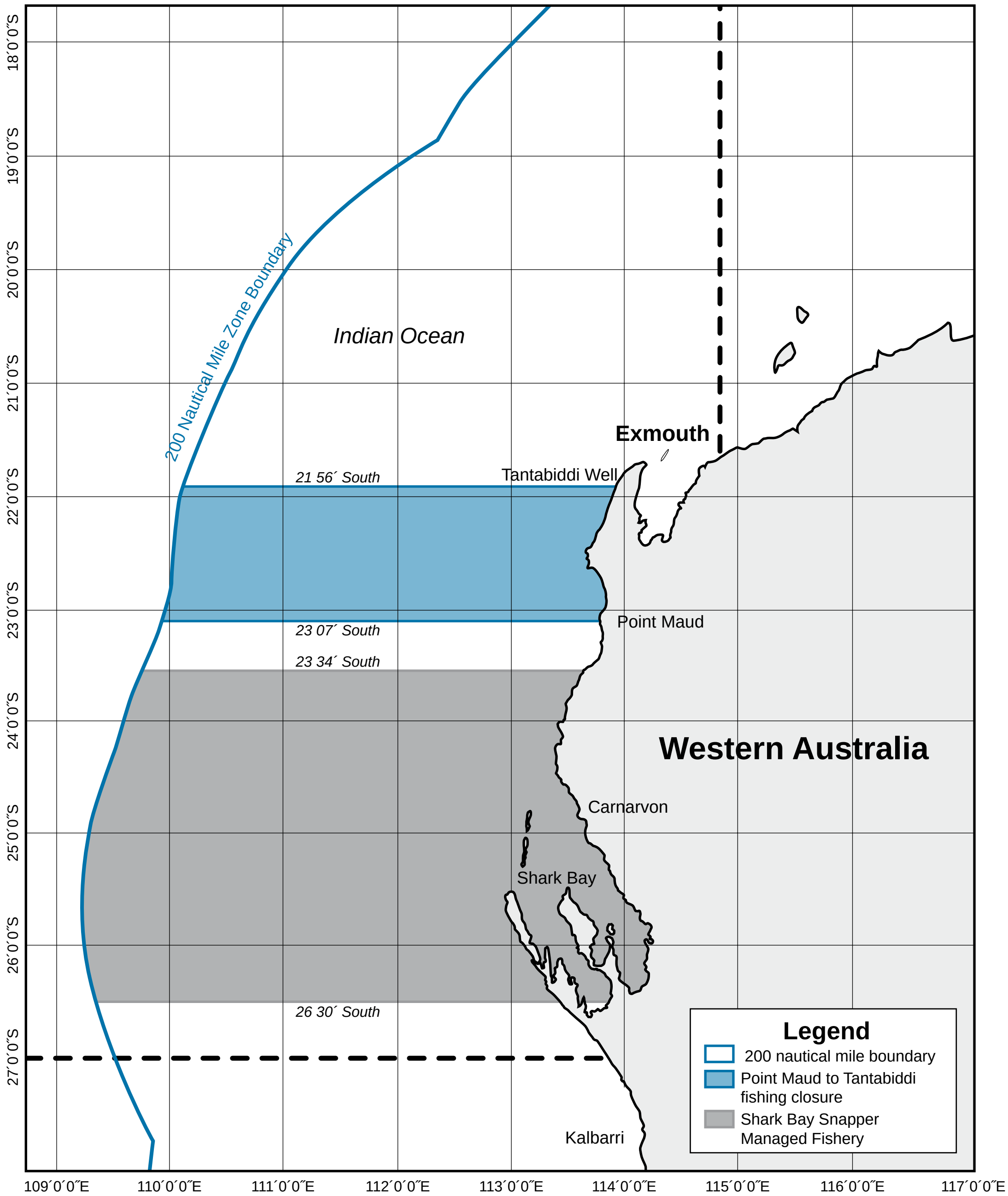
A management plan introduced for the West Coast Demersal Scalefish Fishery (adjacent to the southern boundary of the SBSF) and compulsory VMS introduced for these operators in May 2008 will significantly improve the integrity of management arrangements for both the West Coast and Gascoyne Coast bioregions.

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 (pink snapper, goldband snapper, spangled emperor, Spanish mackerel) by mid-2009.

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 2007, WDWTF licensed vessels reported nil landed catch of pink snapper. The quantity of pink snapper returned to the water is unknown.

Based on at-sea observations of SBSF operators and Department of Fisheries' (WA) Fisheries and Marine Officers who have reported seeing pink snapper on-board WDWTF vessels, this raises issues about the quality of the data provided to the Commonwealth in relation to catches of pink snapper.



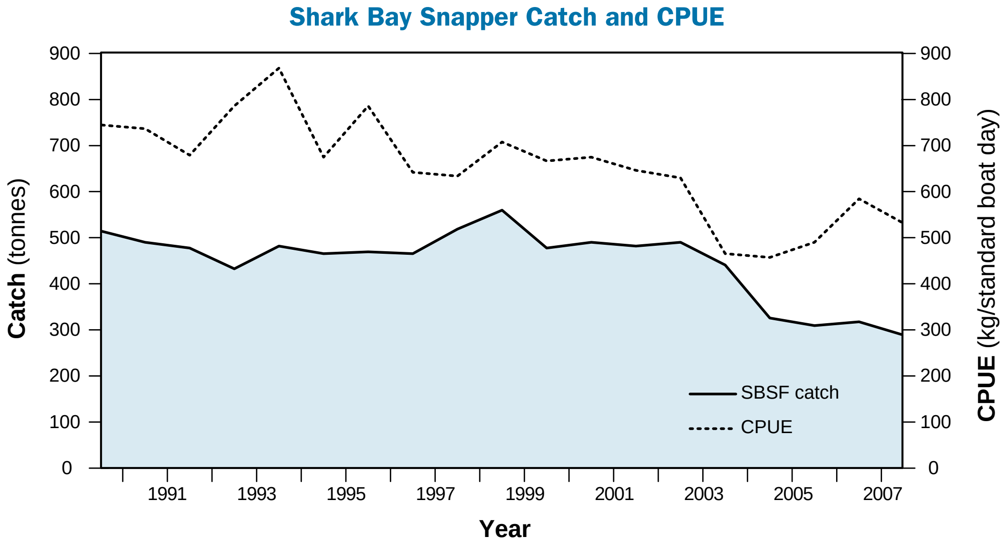
GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 1

Waters of Gascoyne Coast bioregion including Shark Bay Snapper Managed Fishery management zone and 'Point Maud to Tantabiddi Well' fishing closure. Hatched lines indicate boundaries of Gascoyne Coast bioregion.

GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

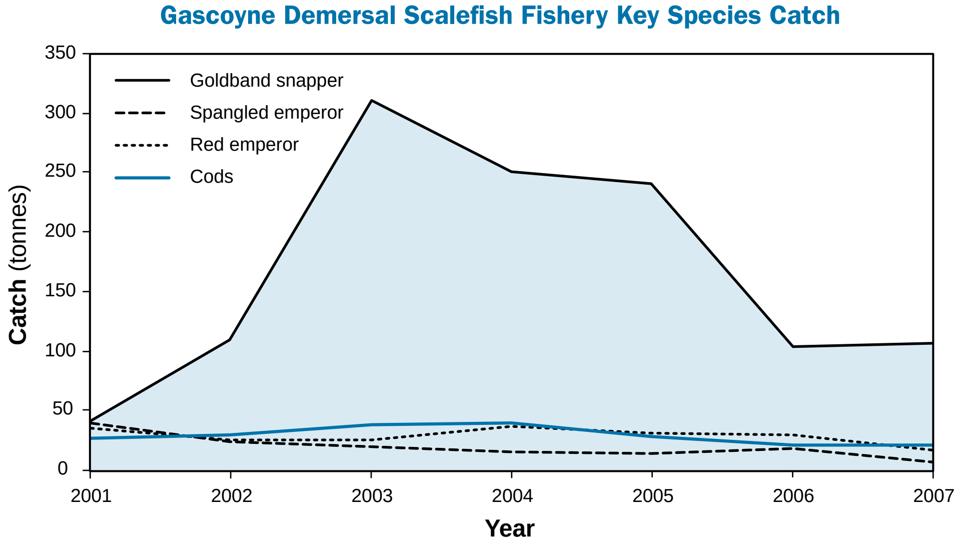
Catches of species other than pink snapper taken in the years 2001 – 2007 by SBSF licensed boats in the area between 114° 50´ E and 27° S. This list excludes mackerels and sharks (which are reported elsewhere in this volume, and tunas (which are reported to the Commonwealth Government).

Species	2001 (tonnes)	2002 (tonnes)	2003 (tonnes)	2004 (tonnes)	2005 (tonnes)	2006 (tonnes)	2007 (tonnes)
Goldband snapper	3.4	6.2	109.1	202.8	204.3	95.8	106.2
Red emperor	6.4	16.1	15.5	30.1	27.4	23.7	16.1
Spangled emperor	13.3	16.5	17.4	10.6	10.1	14.9	6.3
Other emperors	13.6	12.0	11.3	17.7	16.0	17.9	25.0
Cods	9.8	19.4	21.5	29.2	23.0	17.6	16.6
Other	46.8	56.1	55.8	56.2	50.9	52.4	59.9
Total	93.3	126.3	230.5	346.5	331.7	222.3	230.1



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Catch and catch per unit effort by year from 1989 to 2007 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 to July (peak season) is used as one index of abundance in the stock assessment model used for this stock.



GASCOYNE DEMERSAL SCALEFISH FISHERY 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 – 2007.

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 commercial and recreational fishing activities that target scalefish species within the waters of Denham Sound and the Eastern Gulf (Inner Shark Bay Fishery Figure 1) which 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 four main species/groups: whiting (*Sillago schomburgkii* and *S. analis*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and yellowfin bream (*Acanthopagrus latus*). Small quantities of other assorted species (e.g. garfish, trevallies, yellowtail perch) are also caught. One of the SBBSMNF fishers also holds one of the two authorisations that can trap blue swimmer crabs (*Portunus pelagicus*) in waters of Shark Bay south of Cape Inscription (see 'Gascoyne Coast Blue Swimmer Crab Fishery Status Report').

Most recreational fishing is boat-based (rod and line, handline) with some limited fishing from the shore (mostly rod and line, very limited netting for mullet). 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 significant numbers of blue swimmer crabs, mostly in the Eastern Gulf.

A limited number (currently around 5) of licensed charter vessels operate out of Denham and Monkey Mia.

Governing legislation/fishing authority

Commercial

Shark Bay Beach Seine and Mesh Net Management Plan 1992
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
Regional Recreational Fishing Advisory Committees (Denham, Carnarvon)
Direct consultation with local community on specific issues (e.g. Shark Bay Inner Gulf Pink Snapper Working Group)

Boundaries

The areas covered by this report are shown in Inner Shark Bay 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 high water mark of Kopke Point on the mainland to the high water 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 that require:

- 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 that have historically been the main recreational target species. Pink snapper inhabiting the inner gulfs comprise several reproductively-isolated populations. Management has recognised there are separate stocks in the Eastern Gulf, Denham Sound and the Freycinet Estuary since 2000 (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. The TACs each 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 2007 these TACs were set as follows:

- Eastern Gulf – 15 t (approximately 12 t recreational, 3 t commercial)
- Denham Sound – 15 t (approximately 12 t recreational, 3 t commercial)
- Freycinet Estuary – 5 t (approximately 1,400 fish – made up of 1,050 recreational, 350 commercial)

To manage the recreational pink snapper catch in each area, the fishing regulations in 2007 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)
- Freycinet Estuary only – limited number (1,050) of single-use 'management quota tags' available, with each 'tag' entitling the fisher to retain one 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, to allow breeding stocks to recover to and then be maintained at, or above, the target reference level (40% of the unexploited level).

Recreational catches of other 'Category One' species (e.g. black snapper, estuary cod, tuskfishes) in the Gascoyne Coast bioregion are managed using a combination of size, bag and possession limits. Additional protection is offered to estuary cod, baldchin grouper and tuskfish in the inner gulfs of Shark Bay via reduced bag limits compared to other state waters.

Research summary

Research to support the management of pink snapper in the inner gulfs has been undertaken by the Department of Fisheries since 1996/97. Scientific assessments of the status of the three pink snapper stocks have been provided each year since 1998. A review of the research 1997 – 2001 and 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 more recent recreational fishing surveys were used to determine management arrangements for pink snapper and other 'Category One' species for the period 2006 – 2008. Arrangements for pink snapper were again reviewed in July 2008.

A Fisheries Research and Development Corporation (FRDC)-funded project 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.

Murdoch University has undertaken a number of FRDC-funded research projects that have provided important biological information on other key target species including yellowfin bream (1999 – 2001), tuskfish (2000 – 2003) and whiting species (2001 – 2003, updating research initially carried out by the Department of Fisheries in the 1960s) in inner Shark Bay. Yellowfin bream, blackspot tuskfish and whiting inside Shark Bay are each managed as single unit stocks.

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.

Catches of the key species taken by licensed commercial and charter fishing vessels are estimated from data provided via compulsory monthly catch returns (these 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 commercial catch returns, coupled with the extensive scientific knowledge gained from previous research. Performance indicators based on catch and catch rates were determined for these four species by the Department of Fisheries in 2003 as part of drafting an ESD report for the SBBSMNF.

Retained Species

Commercial catches (season 2007):

Whiting: 101.5 tonnes
Mullet: 91.3 tonnes
Tailor: 22.7 tonnes
Yellowfin bream: 14.0 tonnes
Pink snapper: 2.0 tonnes

The total commercial catch (all species combined) taken by SBBSMNF licensed vessels in 2007 was 238 t, 9 t higher than in 2006. The total catch in 2007 comprised 101.5 t of whiting, 91.3 t of sea mullet, 22.7 t of tailor, 14.0 t of yellowfin bream and 8.5 t of other mixed scalefish species including 2.0 t of pink snapper (Inner Shark Bay Fishery Table 1, Figures 2 – 6). The catch of blue-lined emperor (black snapper) and blackspot tuskfish taken by the SBBSMNF is almost nil.

Recreational catch estimates:

Pink snapper: Eastern Gulf 4.3 tonnes
Denham Sound 3.8 tonnes
Freycinet 1.6 tonnes

Black snapper: 13.7 tonnes

Blackspot tuskfish: 2.6 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 Fishery Figure 7). In 2007, the recreational pink snapper catch was estimated to have increased slightly to 4.3 t in the Eastern Gulf, but decreased to 3.8 t in Denham Sound and to 1.6 t in the Freycinet Estuary. In all three areas, pink snapper catches were well within the TAC (Inner Shark Bay Fishery Table 4). These catches include 250 kg of pink snapper taken in the Eastern Gulf by licensed charter vessels in 2007 (nil catch taken in Denham Sound and Freycinet Estuary, based on 83% return rate for 2007 returns at the time of reporting).

Black snapper: Black snapper remain the most common species landed (in order of number kept) by recreational boats in inner Shark Bay. In 2007 the recreational catch of black snapper was estimated to have increased significantly to 13.7 t compared with 2006 (9.3 t) (Inner Shark Bay Fishery Table 2). A total of 120 kg of black snapper was taken by licensed charter vessels in the inner gulfs in 2007 (based on 83% return rate at the time of reporting).

Whiting: Whiting (mostly yellow-finned *Sillago schomburgkii*) are the next most common species landed (by number kept) by recreational boats after blue-lined emperor (black snapper) and western butterfish. In 2007 the recreational catch was estimated at 0.8 t (0.2 t in 2006) (Inner Shark Bay Fishery Table 2).

Tailor: Catches of tailor landed by recreational boats in 2007 were estimated at 0.9 t (0.8 t in 2006) (Inner Shark Bay Fishery Table 2).

Blackspot tuskfish: In 2007 the recreational catch of blackspot tuskfish was estimated at 2.6 t (2.3 t in 2006). Nil catch of this species was reported by licensed charter vessels in 2007.

Fishing effort/access level

Commercial

In 2007, of the 10 SBBSMNF licenses, 6 vessels were actively involved in fishing. Since 1990, total fishing effort has averaged 1,216 boat days per year, with a peak of 1,760 in 1991 and a low of 979 in 1995 (Inner Shark Bay Fishery Figure 2). In 2007, a total of 1,013 boat days of fishing effort were expended in the fishery. The fishery operates all-year-round with an average of 5.3 boats fishing per month. Fishing effort has been at historically-low levels during the last decade, in part due to a reduction in the number of active licensees.

Recreational

In 2007, boat-based recreational fishing effort was estimated to have declined overall to approximately 33,000 fisher days compared with 2006 (35,000 fisher days) and 2005 (38,000 fisher days) with the effort shared equally between both gulfs (Inner Shark Bay Recreational Fishery Table 3).

Stock Assessment

Assessment complete:

Whiting: Yes
Mullet: Yes
Tailor: Yes
Yellowfin bream:Yes
Pink snapper: Yes
Black snapper: Yes
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

Assessment of the four main SBBSMNF target species is based primarily on analysis of the commercial catch and effort data from statutory monthly returns. A target range of annual catch, and a

Catch Per Unit Effort (CPUE) trigger level have been determined for each species (Inner Shark Bay Fishery Table 1). In the event that catch is outside the acceptable range or the CPUE is below the trigger level, a review is initiated, and the results used to determine whether further management action is required.

The 2007 total catch (all species combined) at 238 t was within the target range of 235 – 335 t. The overall CPUE in 2007 was 235 kg/boat day (all species combined) – slightly above the average since 1990 (230 kg/boat day). The significant decrease in CPUE since the record high of 310 kg/boat day in 2004 was primarily due to a decline in the mullet catch rate.

Whiting: The 2007 whiting catch of 101.5 t was within the target range (93 – 127 t) and the CPUE of 100 kg/boat day was above the trigger level (75 kg/boat day). 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 suggest that the breeding stocks are being maintained at adequate levels.

Mullet: The 2007 mullet catch of 91.3 t was within the target range (77 – 144 t) after being below this range for the previous two years. The 2007 mullet CPUE of 90 kg/boat day had also increased from recent years and was above the required trigger (62 kg/boat day).

The consistent levels of catch of sea mullet over recent years suggest that the breeding stocks are also being maintained at adequate levels.

Tailor: The 2007 tailor catch was 22.7 t, which, although an increase from 20.7 t in 2006, was just below the target range (25 – 40 t) for the fourth consecutive year. The CPUE was 22.4 kg/boat day – 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 and 2004. This explanation is consistent with the observation that the CPUE has remained above the trigger level for all of the last 16 years except in 2005.

While some reduction in natural abundance cannot be discounted, it should be noted that for 8 of the 12 years between 1976 and 1987, the annual tailor catch was also below the more recently determined target range. A review of the tailor catch and the target range (given the self-imposed catch restrictions in place) will be undertaken by the Department of Fisheries prior to next years' *State of the Fisheries* status report. Breeding stock levels of tailor are unknown.

Yellowfin Bream: The 2007 yellowfin bream catch of 14.0 t was within the target range (7 – 15 t), and the CPUE of 14 kg/boat day was well above the minimum required trigger of 5 kg/boat day. Catches and catch rates were seen to increase sharply around 2002. It was established that the increased catches and catch rates were related to an increase in abundance, due to exceptionally strong recruitment from the 1999 year class. Both the catch and catch rate for this species are now returning to more historical levels.

The high catches and CPUE of yellowfin bream over recent years, due to strong natural recruitment, indicate that breeding stock levels are healthy. A review of the fishery and minimum legal size for yellowfin bream was undertaken by the Department of Fisheries in early 2008.

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 juveniles, have been conducted each year since 1996. Between 1998 and 2001 these data, combined with reported commercial catches (from the CAES database) and estimates of recreational catch (from boat ramp surveys), were used to determine the status of each inner gulf pink snapper stock. Since 2002, integrated stock assessment models have been used to assess the status of the three pink snapper stocks in relation to the management target (40% of the unexploited spawning biomass). These stock assessments are now updated every three years.

Based on the most recent stock assessments (July 2008), spawning biomass was estimated at approximately 45% and 42% of the unfished levels in the Eastern Gulf and Denham Sound, respectively, i.e. above the management target (40%) level in both areas. The spawning biomass in the Freycinet Estuary was estimated at only 25% of the unfished level, i.e. below the management threshold (30%) level. However, the breeding stock is rebuilding and it is estimated with a high probability (80%) that the management target (40%) level will be reached by 2012.

Black snapper: A preliminary yield-per-recruit model was developed, based on biological data for black snapper collected between 1999 and 2002. More recently, based on age-structure data collected in 2005, fishing mortality was estimated to currently be at the threshold level and will therefore be monitored by the Department of Fisheries into the future. 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

Bycatch is likely to be minimal in the commercial fishery because the seine netting carried out is a highly selective method used to target specific schools of fish. 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 non-target species and under-sized 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 were caught they can be 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 intertidal 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 suggests that the fishery would have no lasting effect on the habitat.

Social Effects

Currently around 18 fishers are employed in the SBBSMNF based on 6 managed fishery licenses actually operating each with a maximum crew of three. In 2007 there was a 5% increase of the number of crew days (2,233) expended in the fishery compared with 2006. 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 2007: $863,000

Commercial

The overall value of the Shark Bay Beach Seine and Mesh Net Managed Fishery in 2007 was estimated at $863,000 and includes catch values of $523,000 for whiting, $183,000 for sea mullet, $70,000 for yellowfin bream and $50,000 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 SBBSMNF catch 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 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 subsequently lead to management changes.

In 2007, the catch of tailor was below the acceptable catch range for the fourth consecutive year. However, the CPUE remains above the trigger level. Given the self-imposed restrictions on the catch for this species, the acceptable catch range will be reviewed. Catches of the other three key target species are considered to be at sustainable levels.

Catches of pink snapper taken by recreational boats and SBBSMNF vessels in 2007 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 Fishery Table 4).

Recreational catches of blackspot tuskfish in 2007 were around the same level as in 2006, while those of estuary cod had decreased significantly compared with 2007.

Current fishing (or effort) level: Acceptable

Commercial

Total fishing effort in SBBSMNF in 2007 declined by approximately 2% from 2006 levels.

Recreational

There was an estimated 6% reduction in overall recreational fishing effort (boat-fisher days) in 2007 compared with 2006.

New management initiatives (2007/08)

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.

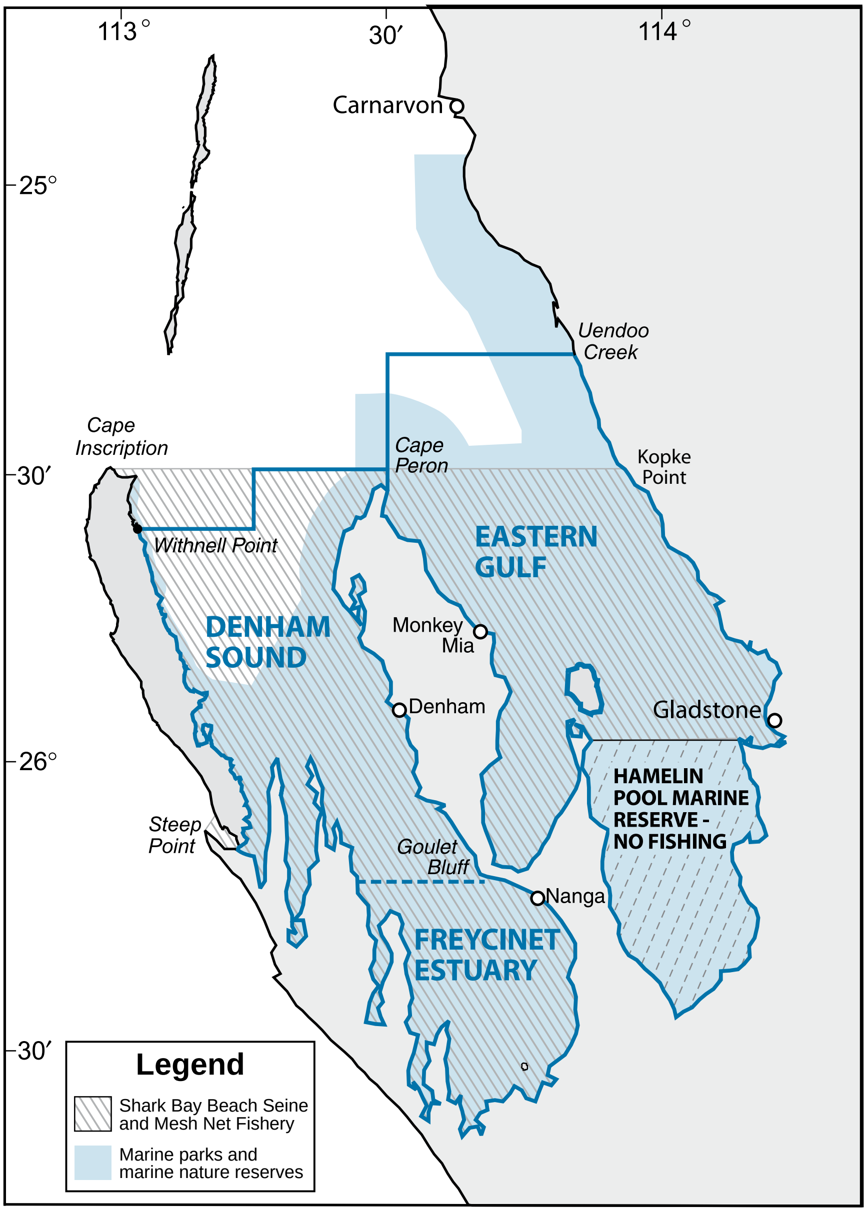
As an outcome of the ‘Wetline Review’, a management plan will be developed for the proposed Gascoyne Inshore Net Fishery that will incorporate the existing SBBSMNF, the Exmouth Gulf Beach Seine Fishery and commercial net fishing in the Carnarvon area as separate zones under the one overall management plan.

The state-wide minimum legal length for yellowfin bream (originally increased from 250 mm to 350 mm on 1 January 2006 following a Department of Fisheries review of recreational fishing in the Pilbara and Kimberley) decreased from 350 mm to 300 mm in May 2008, following a review of available biological and fishery information (an exemption to the 350 mm size limit had been effective since April 2006).

Integrated Fisheries Management (IFM) is scheduled for implementation in the Gascoyne in 2009 and will include consideration of the inner Shark Bay Fishery. Research is currently underway that will provide information on existing catch shares and stock assessments for the key indicator species (pink snapper, goldband snapper, spangled emperor and Spanish mackerel) by mid-2009.

External Factors

The inner Shark Bay environment is particularly stable as a result of its low-rainfall, arid environment. The abundances of some target species tend to be fairly stable, with the fishery production mostly determined by levels of fishing effort. However, other species including pink snapper, yellowfin bream and possibly tailor appear to be influenced by environmentally-driven variations in recruitment.



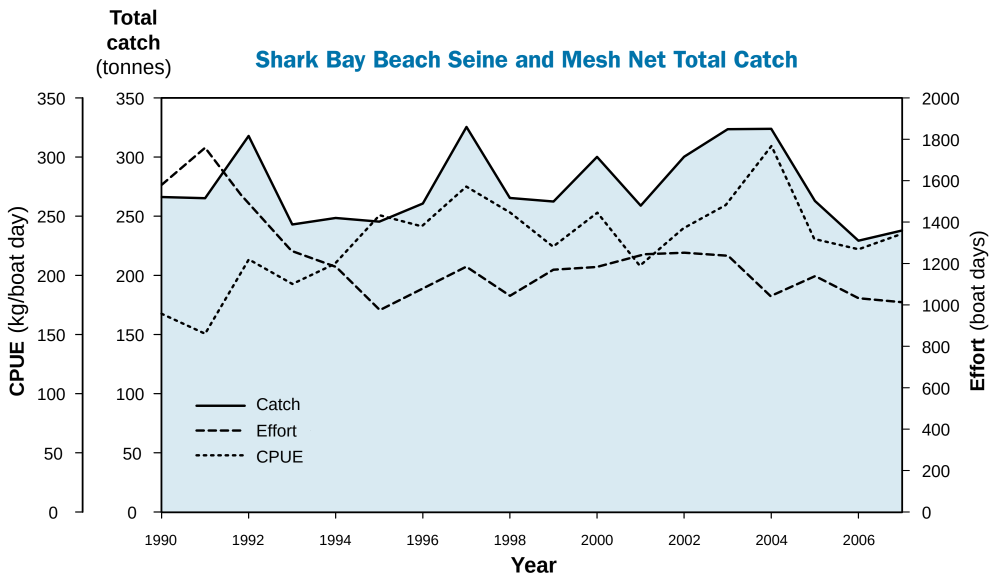
INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

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 FISHERY TABLE 1

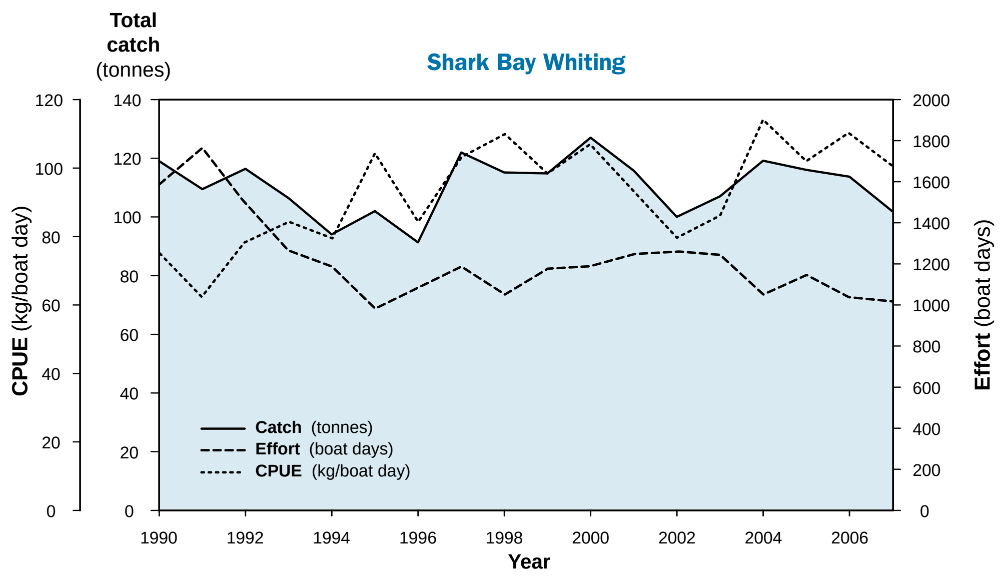
Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2000 – 2007.

Species	Trigger Level	2000	2001	2002	2003	2004	2005	2006	2007
Whiting	75	106	92	79	86	114	102	110	101
Mullet	62	107	93	80	120	137	74	60	91
Tailor	20	32	21	21	22	23	17	20	23
Bream	5	7.3	6.2	13	19	26	23	22	14



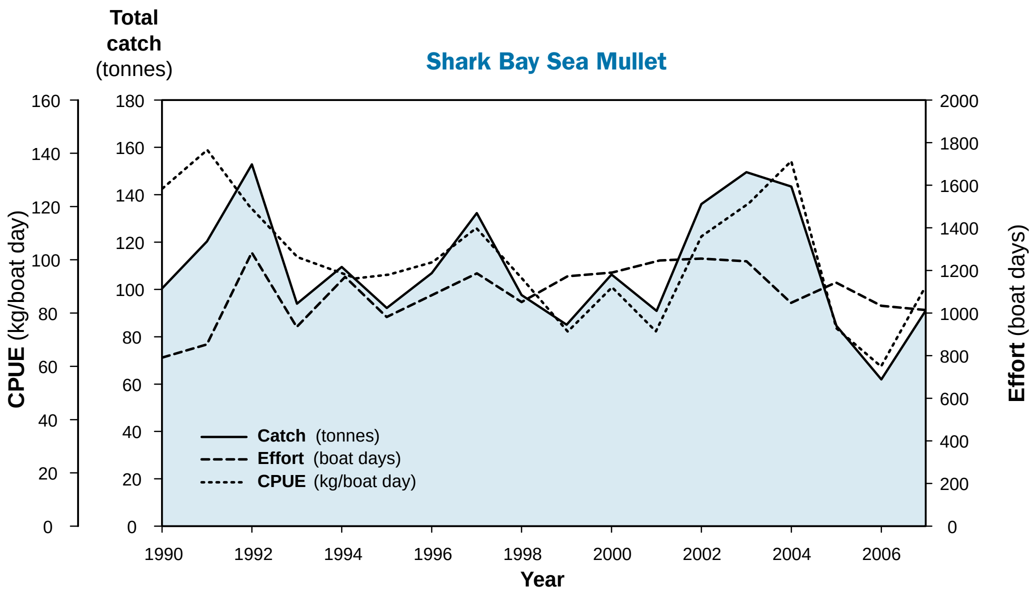
INNER SHARK BAY SCALEFISH FISHERY FIGURE 2

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 – 2007.



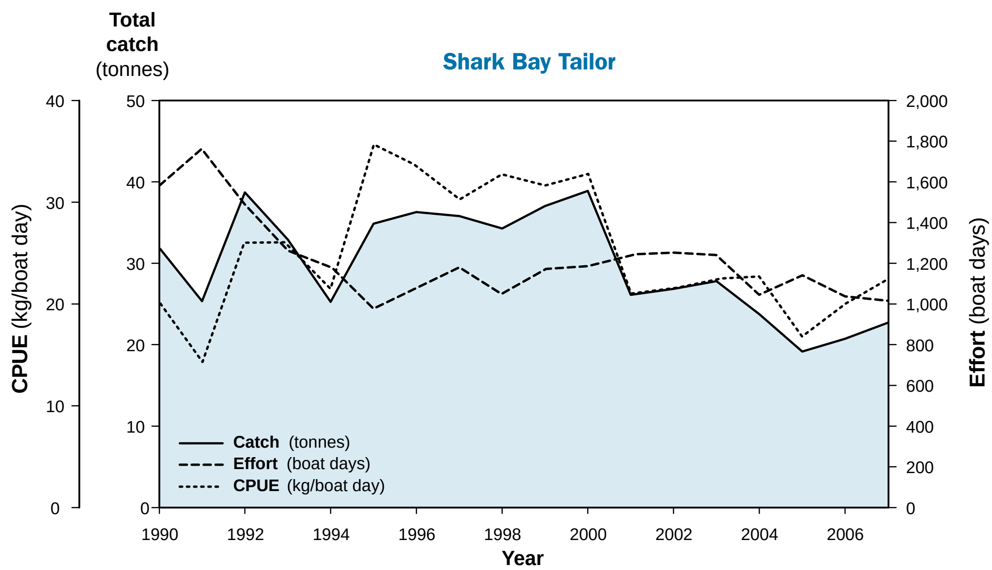
INNER SHARK BAY SCALEFISH FISHERY FIGURE 3

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 – 2007.



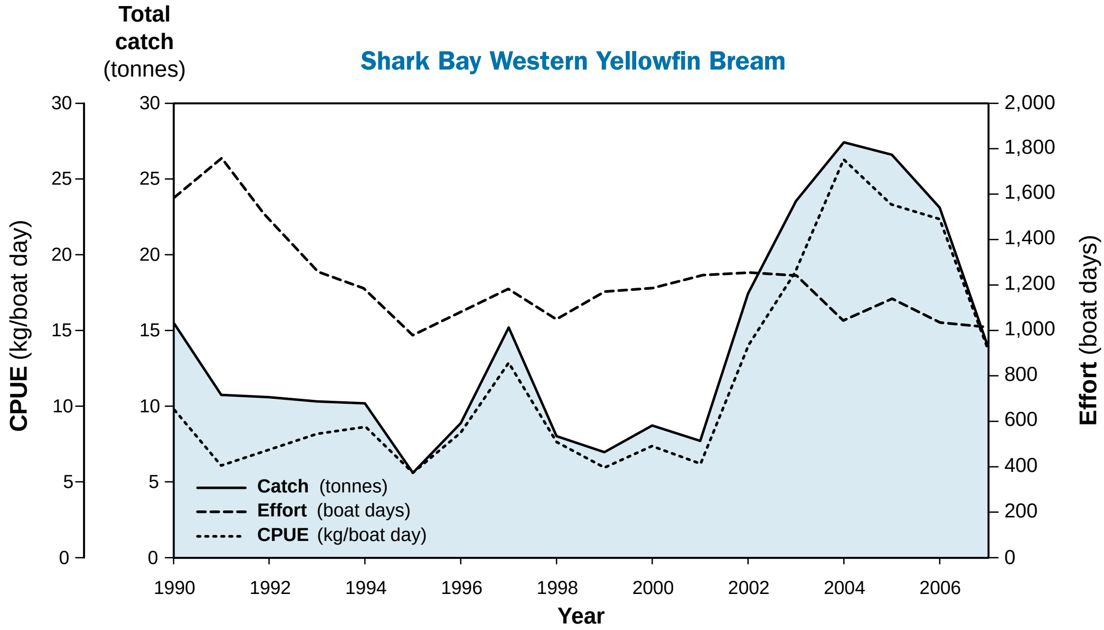
INNER SHARK BAY SCALEFISH FISHERY FIGURE 4

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 – 2007.



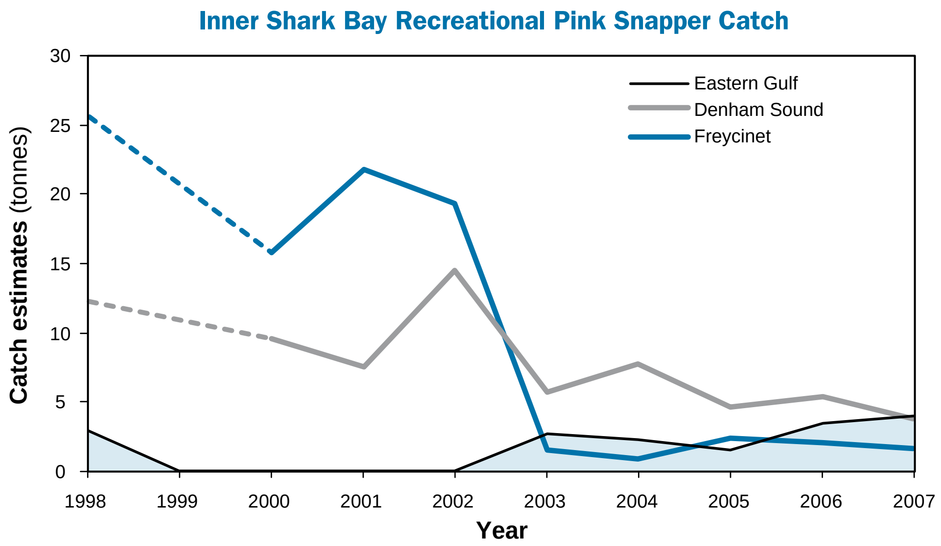
INNER SHARK BAY SCALEFISH FISHERY FIGURE 5

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 1990–2007.



INNER SHARK BAY SCALEFISH FISHERY 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 – 2007.



INNER SHARK BAY SCALEFISH FISHERY FIGURE 7

Estimated catches of pink snapper taken by recreational boats in the three fishing areas of inner Shark Bay, 1998-2007 (does not include charter vessel catches). The Eastern Gulf was closed to take of pink snapper from June 1998 to March 2003.

INNER SHARK BAY SCALEFISH FISHERY 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. Note: no survey was conducted in 1999.

Year	Pink snapper	Black snapper	Whiting	Tailor	Mullet	Blackspot tuskfish
1998	13,926 (88,020)	17,073				
2000	8,387 (53,493)	10,042 (18,272)	3,105 (61)	1,128 (72)	901 (19)	
2001	8,319 (87,655)	7,357 (15,470)	5,071 (203)	1,774 (128)	550 (0)	260 (4,667)
2002	9,130 (95,920)	11,286 (21,417)	9,043 (6,152)	2,123 (362)	755 (0)	1,160 (4,583)
2003	3,803 (84,622)	9,982 (20,548)	3,281 (730)	924 (27)	51 (0)	1,967 (4,703)
2004	4,418 (97,780)	13,376 (21,382)	9,979 (1,635)	265 (590)	49 (0)	1,552 (5,201)
2005	3,311 (62,068)	9,987 (25,218)	5,142 (514)	455 (38)	1,303 (0)	1,771 (5,205)
2006	3,904 (39,886)	7,542 (14,872)	3,064 (449)	1,285 (228)	475 (0)	955 (6,472)
2007	3,641 (38,872)	10,149 (17,328)	4,278 (774)	1,029 (580	62 (156)	849 (2,879)

INNER SHARK BAY SCALEFISH FISHERY 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.

	Eastern Gulf		Denham Sound		Freycinet			
Year	Effort	Catch	Effort	Catch	Effort	Catch	Total Effort	Total Catch
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
2007	18,400	4.0[4]	11,331	3.8	3,535[2,5]	1.6[2,5]	33,266	9

1. For 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 FISHERY TABLE 4

Catches (tonnes) of inner Shark Bay pink snapper taken by each sector in 2007 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	4.0	3.8	1.6
Charter Vessels	0.3	na	0
Commercial	0.2	1.8	0
Total Catch	**4.5**	**5.6**	**1.6**
TAC	15	15	5
Commercial share (%)	4	24	0
Recreational share (%)	96	76	100
Total Catch:TAC (%)	**30**	**37**	**32**

Gascoyne Coast Blue Swimmer Crab Fishery

D. Johnston and D. Harris
Management input from N. Harrison

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. However, the majority of the commercially and recreationally-fished stock, 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. Since its inception in 1998, the Shark Bay Crab (Interim) Managed Fishery has developed into the largest dedicated crab fishery in WA, with an annual catch of about 600 t. It is a limited-entry fishery with a total of 5 licences authorising fishing in the waters of Shark Bay north of Cape Peron. Two authorization holders are also secondarily permitted to operate up to 200 of these traps south of Cape Peron.

Two 200-trap exemptions were issued in 2002 to explore the commercial viability of crab stocks in Exmouth Gulf. The Exmouth Gulf Experimental Crab Fishery has been assessed as part of the Developing New Fisheries Review, with outcomes due in 2008/09.

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. Operators in both the Shark Bay Crab (Interim) Managed and Exmouth Gulf Experimental Crab Fisheries are only permitted to use ‘hourglass’ 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

Exemptions authorizing crab fishing activities in Shark Bay and 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, one Shark Bay beach seine fisher and one Cockburn Sound crab fisher 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. Both fishers are permitted to trap in the waters of Shark Bay south of Cape Peron, using up to 200 traps of their 300-trap Shark Bay Crab (Interim) Managed Fishery permits to fish these areas.

In 2002, two exemptions were issued to explore the sustainability and commercial viability of fishing 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. Following a submission received in 2005 to fish the coastline northeast of Locker Point around the Ashburton River, the north and eastern boundaries of the Exmouth Gulf exemptions were extended to 115°E longitude. The Exmouth Gulf fishery now abuts 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 area, 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, while females become sexually mature below 100 mm carapace width.

The legal minimum size of 135 mm carapace width 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 determined that performance should be reported annually against measures relating to the breeding stock of crabs. As an outcome of the assessment, performance measures are required to be reported annually to the Commonwealth’s Department of Environment, Water, Heritage and the Arts.

Recreational fishing for blue swimmer crabs in WA 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 carapace width applies in the waters of the Gascoyne Coast bioregion, 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 2006/07): 745 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2006/07 was 947 t (West Coast Blue Swimmer Crab Figure 1) – a 6% increase on the 896 t taken in 2005/06. Total landings for the Gascoyne Coast bioregion during 2006/07 was 745 t, which accounted for 79% of the state catch (of blue swimmer crabs).

The annual blue swimmer crab catch from the Shark Bay Crab (Interim) Managed Fishery for the 2006/07 fishing season was 581 t, making it the highest catch on record. It represented a marginal increase on the 559 t landed in 2005/06 and 560 t landed the preceding year, which was the previous highest catch (Gascoyne Coast Blue Swimmer Crab Figure 2).

During the same period, landings from the Shark Bay trawl fleet also increased, jumping 40% to 142 t from the 102 t reported the previous year. Shark Bay trawlers tend to retain more crabs as a by-product of their fishing operations in years when their target prawn and scallop catches are lower. Market factors can also influence the quantity of crabs retained by the trawl fleet, with more crabs taken when demand from processors is high and the beach price is up.

A total of 21 t of blue swimmer crabs was landed by the two exemption holders in the Exmouth Gulf Experimental Crab Fishery and the trawl fleet in Exmouth Gulf during 2006/07 – up 30% on the previous year's catch of 16 t (Gascoyne Coast Blue Swimmer Crab Figure 1).

Recreational catch: (approximately 1% of total catch)

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.

A small amount of recreational crabbing also occurs in Exmouth Gulf.

Fishing effort/access level

Effort in the Shark Bay Crab (Interim) Managed Fishery decreased marginally during 2006/07, as operators gained a better understanding of stock dynamics throughout the year and looked to maximize profitability by capitalizing on peak catch periods. The 5 dedicated Shark Bay crab trap fishers reported 328,500 trap lifts over 1,097 fishing days (Gascoyne Coast Blue Swimmer Crab Figure 2) – down from 363,300 trap lifts over 1,215 fishing days the previous year.

The two exemption holders in the Exmouth Gulf Experimental Crab Fishery increased their fishing effort during 2006/07 as they continued to explore the commercial viability of blue swimmer crab stocks in the Gulf. Most of the effort was focused on exploring previously unfished areas along the north-east coast of Exmouth Gulf. The fishers reported a total of 111 fishing days in 2006/07, representing a significant increase in effort on the 41 days spent fishing for crabs the previous year.

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Adequate

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 breeding stock.

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 carapace width) and significantly reduced the catch of crabs < 120 mm carapace width, 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 that can be used to assess fishery performance from year-to-year. Following the establishment of the Carnarvon Experimental Crab Trap Fishery in 1998, blue swimmer crab trap catches in Shark Bay increased almost five-fold over the next 5 years (Gascoyne Coast Blue Swimmer Crab Figure 1).

This increase in catch was achieved with only a corresponding three-fold increase in effort. Consequently, there was a significant increase in catch per unit effort during this initial period of development, reflecting the more efficient fishing of blue swimmer stocks in Shark Bay as the commercial operators' knowledge of stock dynamics increased over time and improvements were made to fishing gear and vessels. Catch and effort have now stabilized to a degree, with mean annual CPUE since 2000/01 ranging between 1.4 and 1.8 kg/trap lift.

The mean catch rate for the Shark Bay Crab (Interim) Managed Fishery during 2006/07 was 1.77 kg/trap lift (Gascoyne Coast Blue Swimmer Crab Figure 2). This represents a 14% increase on the 2005/06 catch rate of 1.54 kg/trap lift, and is the highest catch rate on record.

An increase in exploratory fishing by the dedicated crab fishers in Exmouth Gulf was responsible for a halving of the catch rate of blue swimmer crabs for the 2006/07 season – down to 0.52 kg/trap lift from 1.1 kg/trap lift the previous year. Fishers were more intent on surveying large tracts of potential fishery rather than consolidating catches by returning to areas of higher catch. This exploration also served to reinforce the logistical problems associated with fishing the remote areas of the north-east coastline of the Gulf which appear to support the more commercially-viable quantities of blue swimmer crabs.

The minimum legal size at first capture (127mm carapace width for recreational fishers; 135mm carapace width for commercial fishers) for crab fisheries in the Gascoyne Coast Bioregion is set well above the size at first maturity (85 – 115 mm carapace width) of the resident stocks. Consequently, 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 Coast bioregion are further supported by the influence of the warmer waters that occur at these latitudes compared with the colder waters of the lower west coast. This 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 be maintained. The breeding stock is reported as adult crab abundance (catch per unit effort). The Catch Per Unit Effort (CPUE) in the Shark Bay fishery for 2006/07 was 1.77 kg/trap lift – well above the Environment Protection and Biodiversity Conservation Act 1999 performance measure of 1.0 kg/trap lift. This level of breeding stock has proven adequate to support recruitment to the fishery to date.

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 that retain crabs as a by-product is dealt with in those sections of this report 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 sea bottom occurring during trap retrieval. Sand and associated biota does 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 macro-benthos.

Although seagrasses are occasionally uprooted and 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 2006/07, 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 been created in Carnarvon through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers) for year 2006/07 — $4.3 million

The value of commercial blue swimmer crab fishing across the State for the 2006/07 season was estimated to be $4.3 million – up slightly on the $4 million generated in 2005/06.

Blue swimmer crab landings from the Gascoyne Coast bioregion during 2005/06 were worth $3.4 million – an increase of 20% on the $2.8 million generated during 2005/06 and comparable with the 2004/05 value of $3 million. This increase was largely due to the increase in numbers of blue swimmer crabs retained by the Shark Bay trawl fleet.

Beach prices for blue swimmer crabs caught using traps remained between $4/kg and $6/kg live weight in the major fisheries, with the average price for the year around $4.50/kg. Crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps. 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, but surplus stock from Shark Bay filled 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

A review of these blue swimmer crab fisheries is being undertaken and target catch ranges will be set.

Current fishing (or effort) level: Acceptable

Following several years of rapid expansion as the fishery developed, current catch and effort in the Shark Bay Crab (Interim) Managed Fishery suggests that fishing effort may have stabilized. The catch rate will be monitored closely, along with the trend in catch and effort.

With only slight changes in effort from the Exmouth Gulf trawl fleet and a moderate amount of exploratory fishing by the two dedicated crab fishers, the current level of effort in Exmouth Gulf is considered acceptable.

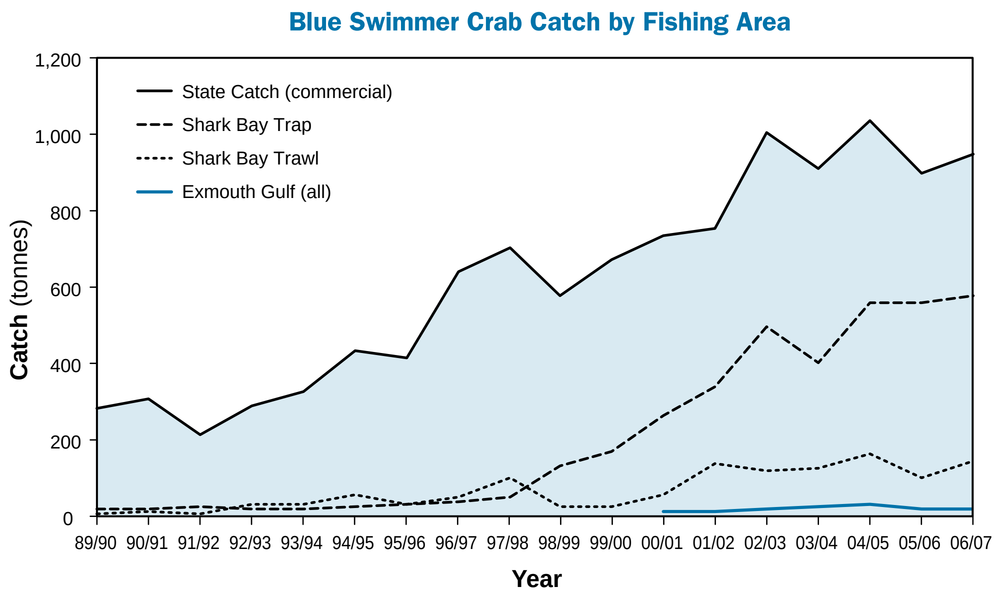
New management initiatives (2007/08)

The Shark Bay Crab Interim Management Plan ceases on 31 August 2010 and a review of the fishery will be required in 2009 in order to provide advice to the Minister regarding the future of the fishery. The issue of better integrating the activities of the two fishers in the southern part of Shark Bay (south of Cape Peron) with the interim managed fishery will need to be considered as part of that review.

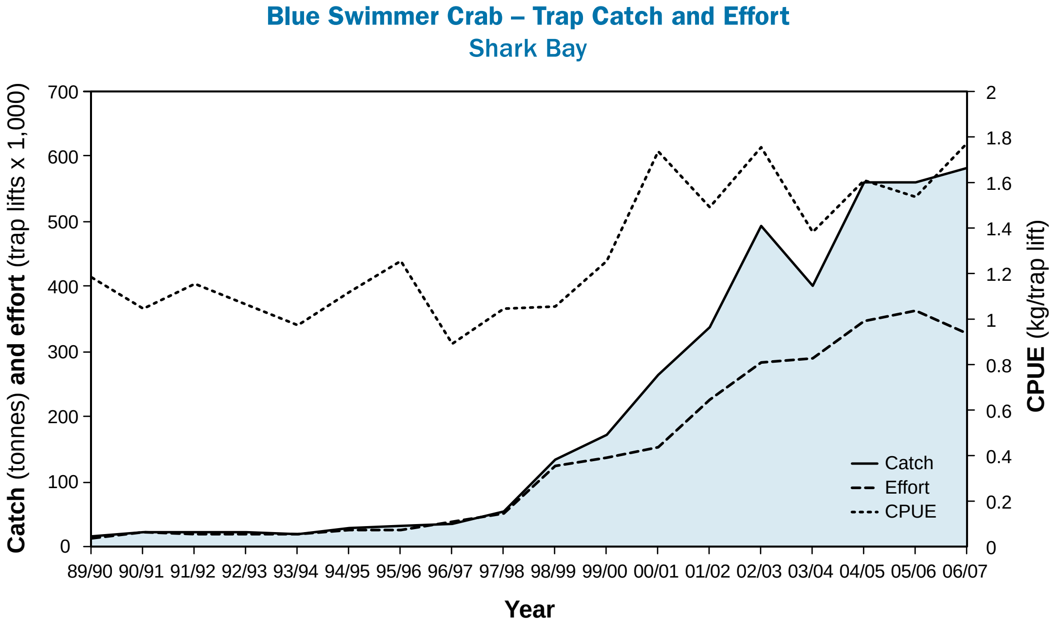
The Exmouth Gulf Experimental Crab Trap Fishery was formally reviewed in mid-2007 as part of the 'Developing New Fisheries' process. The Department is considering the review and intends to make clear recommendations in 2008/09 regarding the future viability of a fishery in this region.

External Factors

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



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 2006/07.



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 using traps.

AQUACULTURE

Regional Research and Development Overview

The main focus of the Department of Fisheries in the Gascoyne continues to be on the regulation of the regional pearling industry, based on species such as the blacklip oyster *Pinctada margaritifera*, which complements the major state industry built on silverlip pearls (*Pinctada maxima*).

Major research activities during 2007/08 included health monitoring by the Department's Fish Health Unit of pearl oysters and marine finfish (see Appendix 5).

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 2008.

Environmental authorizations have been issued for a land-based prawn farm south of Exmouth, enabling the proponent to start construction.

An exemption has been issued to a proponent to undertake research and development on the aquaculture of tropical rock lobster species.

COMPLIANCE AND COMMUNITY EDUCATION

Compliance and community education services 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 2006/07 the three district offices supported a total of 9 FMOs who delivered services to several client groups including commercial and recreational fisheries, marine reserves, pearling and aquaculture operations and fish-habitat protection areas.

The Gascoyne Coast bioregion covers approximately 2,700 km of the Western Australian coastline – some 13% of the State's coast. The various coastal landscapes represent some of the most remote, isolated, pristine and dangerous marine and terrestrial environments in WA.

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. They have also promoted and supported the introduction of the Recreational Skippers Ticket.

A further significant aspect of their work is the provision of compliance services to the State's marine reserves. The Gascoyne Coast bioregion has two of WA's most iconic and largest marine reserves – Ningaloo Marine Reserve (and the associated Commonwealth marine park) and Shark Bay Marine Reserve (and the associated World Heritage Area). These two marine reserves occupy just over 70% of the Gascoyne Coast bioregion. In partnership with the Department of Environment and Conservation (DEC), FMOs monitor and deliver compliance and education programs covering some 30 sanctuary zones and marine managed areas and other protected areas.

FMOs undertake regular land, air and sea patrols, programmed using a compliance model that is supported by a risk assessment process and associated operational planning framework. Throughout the bioregion FMOs employ specially-equipped four-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.

FMOs at Denham make extensive use of the 10-meter patrol vessel *John Brockman* to conduct compliance activities throughout Shark Bay. FMOs in Exmouth use the 8-metre patrol vessel *Gnulli* and a 7.3-metre rigid inflatable boat, *FD47* to conduct at-sea inspections in Exmouth Gulf and within the Ningaloo Marine Reserve and park.

Large patrol vessels (greater than 20 metres in length) also 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 in 2006/07. FMOs also conduct aerial surveillance, dive inspections, at-sea and on-land catch, license, gear and marine safety inspections, and attend community events as well as school education programs.

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 pivotal part of the management process, as does the inspection of catch landed ashore in accordance with the CDRs.

Recreational snapper tags in the Freycinet Estuary area remains another method for managing pink snapper recovery in this 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 large part, attributable to the efforts of the Department’s staff in the Gascoyne Coast bioregion and to the officers of the Denham district in particular. The Department was nominated for a Premier’s Award under the ‘Lifestyle and Environment’ Category and was successful in winning this award. Whilst this award is recognition for the achievements made so far, there is still work to be done in recovering this fish stock to safe levels of sustainability.

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 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.

FMOs 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’s 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 can program their inspection regimes and apply their investigation methods more efficiently by using the facilities provided by VMS. The expansion of the VMS into more fisheries, such as those for snapper and mackerel, will ensure that a higher and more effective rate of compliance is achieved.

Activities during 2006/07

During 2006/07 FMOs delivered a total of 3,553 hours of ‘in-field’ compliance activity (Gascoyne Coast Bioregion Table 1 – which excludes Gascoyne pearling compliance activities which are reported in the North Coast Bioregion), representing a significant decrease on the previous financial year (Gascoyne Coast Compliance Patrol Hours Figure 1).

The total budgeted hours for compliance were not delivered by FMOs in the region during 2006/07. This was due to significant staff shortages for extended periods of time. The effects of a stable work group had resulted in a better working relationship between fishers and FMOs, especially commercial fishers, however that previous effort might have been diminished because of the ongoing issue of staff shortages. 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 make use of a risk assessment and intelligence analysis-driven model to compliance planning and prioritization. All the existing Operational Compliance Plans (OCP) were reviewed and updated using this model. This continues to be the model for delivering compliance across the Department of Fisheries by providing the most effective and efficient method for a planned and measurable approach to compliance delivery. The OCPs deliver agreed outcomes and provide an accountable and realistic process for budget creation and the actual services that are to be delivered.

OCPs are operating in the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery, Shark Bay Crab Fishery, Gascoyne Aquaculture and Pearling Fishery and are used in the management of the Ningaloo Marine Reserve, Shark Bay Marine Reserve and the Commonwealth’s Ningaloo Marine Park. A more targeted, effective and relevant compliance service, in terms of both cost and activities, has been 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 and intelligence-led operations. 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 lower again in 2006/07 and compliance overall is assessed as being at an acceptable level, confirming the positive approach of the commercial fishing industry in complying with regulations and playing their part to ensure the sustainability of their fisheries. A total of 5 infringement warnings and 3 infringement notices were issued and 11 prosecutions were instigated from a total of 511 field contacts with commercial fishers. Field contacts were lower because of the previously highlighted staff shortages.

The monitoring of marine reserve activities with respect to recreational fisheries has divided the recreational fishing program from a stand-alone fishery into two distinct fisheries – one with a marine reserve focus. FMOs increased their compliance activities in relation to both Ningaloo Marine Reserve and Shark Bay Marine Reserve in line with the increased importance and focus of government on marine reserves across the State.

The number of infringement warnings (87) and infringement notices issued (56) and prosecutions instigated (2) from a total of 9,513 recreational fishing field contacts reflects the increased importance placed on recreational fishing and marine reserves in general across the Gascoyne. Recreational contacts were approximately 20% lower in 2007/08 because of staff shortages, especially in the Ningaloo Marine Reserve.

Two FMOs from the 'Mobile 1' patrol unit were active in the Gascoyne. 'Mobile 1' provides a dedicated mobile recreational fishing patrol, using specialized remote-area-equipped vehicles and surveillance equipment. 'Mobile 1' patrols operated mainly in the Denham and Carnarvon districts this year, working in a coordinated approach with district officers 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.

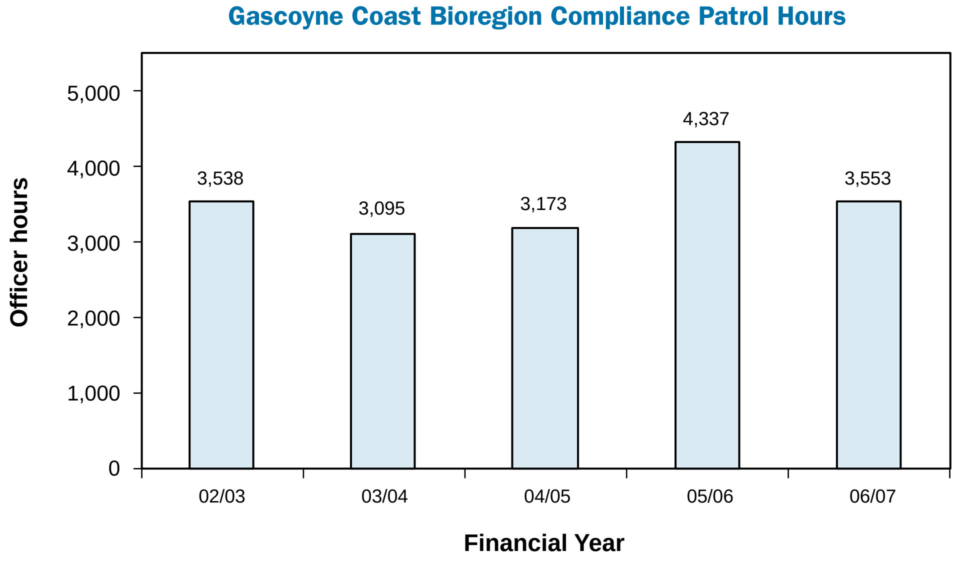
During 2006/07, FMOs contributed significantly to the marine safety compliance program within the Gascoyne Coast bioregion and across the state. FMOs conducted 958 safety checks on recreational vessels – a decrease on the previous year, but in line with the lower number of recreational contacts made. 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 in conjunction with their routine fisheries activities.

The bioregion's Volunteer Fisheries Liaison Officer (VFLO) program continued to find it difficult to attract volunteers during 2006/07. As in previous years, with a population base of less than 12,000 people in the Gascoyne, all organizations find it hard to attract people to the large number of volunteer organizations that exist within the region. Solutions to this problem remain elusive, but work continues on developing viable ways of making the program work.

Initiatives in 2007/08

For 2007/08, a number of initiatives across the Gascoyne Coast bioregion have been planned – these include:

- Expanding marine reserve services to the Muiron Islands Marine Management Area.
- Finalizing the tender and implementing the construction of the replacement patrol vessel for the *PV John Brockman*.
- Recruiting and retaining staff, especially FMOs, to stabilize the operations of the workgroup.
- Continuing research and development into telescope/video surveillance equipment specific to fisheries requirements.
- Continuing research and development into the 'downloading' of navigational track data for evidentiary purposes.
- Expanding the joint patrolling regime between the Department of Fisheries and the Department of Environment and Conservation in both Ningaloo and Shark Bay marine reserves.
- Carrying out an expanded patrolling regime in the Commonwealth's Ningaloo Marine Reserve, in conjunction with DEWHA.
- Expanding the VMS into the mackerel and snapper fisheries.
- Educating the trawl industry about risk assessment and Operational Compliance Planning (OCP) processes.



GASCOYNE COAST COMPLIANCE FIGURE 1

'On Patrol' Officer Hours showing the level of compliance patrol activity delivered to the Gascoyne Coast bioregion over the previous 5 years. The 2006/07 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, etc.

GASCOYNE COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the Gascoyne Coast bioregion during the 2006/07 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	3,553 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries and Marine Officers	511
District Office contacts	1,654
Infringement warnings	5
Infringement notices	3
Prosecutions	11
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries and Marine Officers	9,513
District Office contacts	4,463
Infringement warnings	87
Infringement notices	56
Prosecutions	2
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1,445
District Office contacts	4,019
Fishwatch reports**	12

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The 'Other' 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 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 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, Broome. Photo: Eloise Dortch

NORTH COAST BIOREGION

ABOUT THE BIOREGION

The oceanography of the North Coast bioregion has 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 eastward 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 metres along the Kimberley section of the coast down to around 2 metres 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 finfish 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.

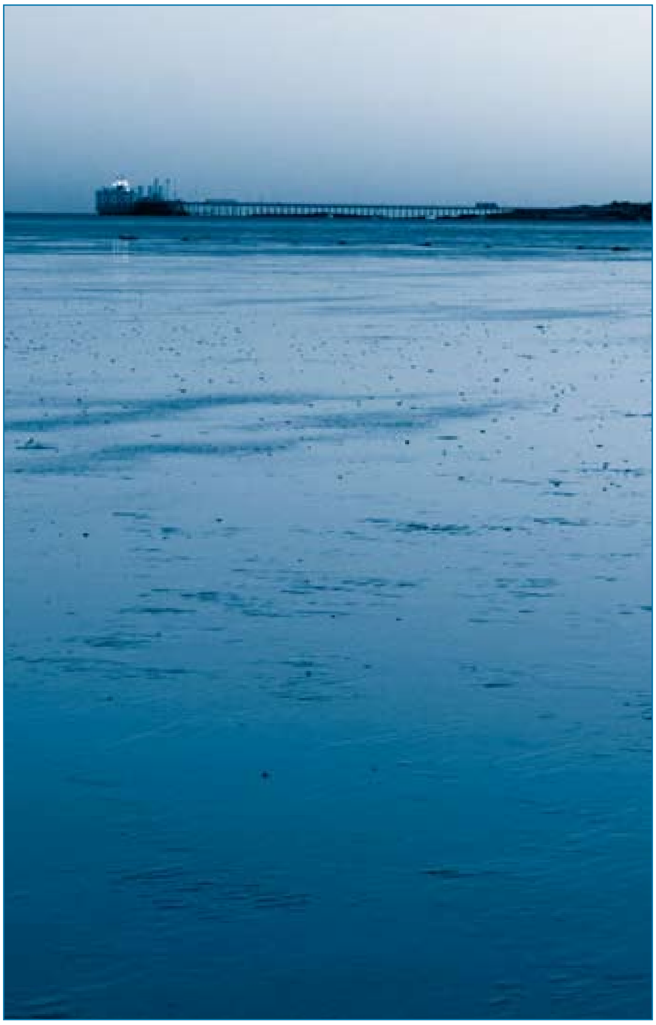
Creek systems, mangroves and rivers, and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide 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 and Biosecurity 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.

For many years, some of the Indonesian boats arrested for fishing illegally off the north coast have been impounded in Willie Creek north of Broome. The creek was surveyed for invasive bivalves and barnacles, but none were found.



Roebuck Bay, Broome. Photo: Eloise Dortch

ENVIRONMENTAL MANAGEMENT

Regional Overview (North Coast)

Marine habitats within the North Coast bioregion of Western Australia are experiencing pressure through a range of activities including; increasing recreational fishing at popular tourist destinations, and increased resource development activity and illegal foreign fishing.

The Department of Fisheries continues to engage with the Environmental Protection Authority through the environmental impact assessment process by providing advice on individual development proposals, which, if implemented, could potentially have an adverse impact on the marine environment. These include new (and upgraded) port developments in the Pilbara region, as well as offshore and near-shore oil and gas extraction projects in the Kimberley and Pilbara region. Major developments recently assessed in which the Department has played a key role include the Gorgon Gas Development at Barrow Island, seismic exploration activity at Scott Reef, and the proposed Kimberley Gas Hub assessment process, being coordinated by the Northern Development Taskforce.

The increase in international shipping movement and dredging activity associated with resource development in the Northern Coast bioregion is considered to present a high risk to the marine environment because of the potential for the introduction of non-indigenous marine organisms (including animals, plants, pathogens and diseases) into WA's coastal environment. The Department of Fisheries 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 biosecurity risks associated with increased shipping in the Pilbara and Kimberley regions. Within WA, this will be achieved through the *Biosecurity and Agriculture Management Act 2007* and associated regulations and subsidiary legislation that are currently being developed.

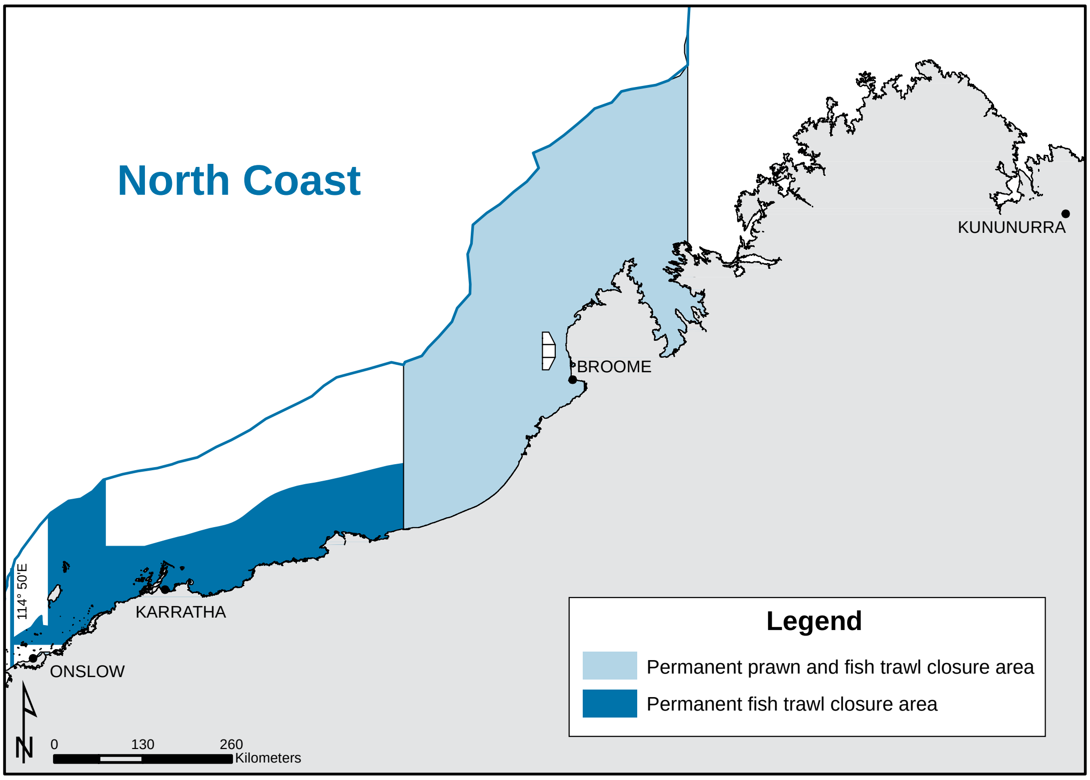
Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Habitat Protection Figure 1). However, trawling is still permitted in a number of locations (see specific commercial trawl fishery reports elsewhere in this 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 North Coast 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) (see North Coast Habitat Protection Figure 2).

The Department of Fisheries is actively participating in a new marine conservation reserve planning process in the Pilbara Eighty-Mile Beach area, coordinated by the Department of Environment and Conservation. The Department of Fisheries continues to work closely with the Rangelands Natural Resource Management Coordinating Group to develop strategies to minimize environmental effects in the marine environment.

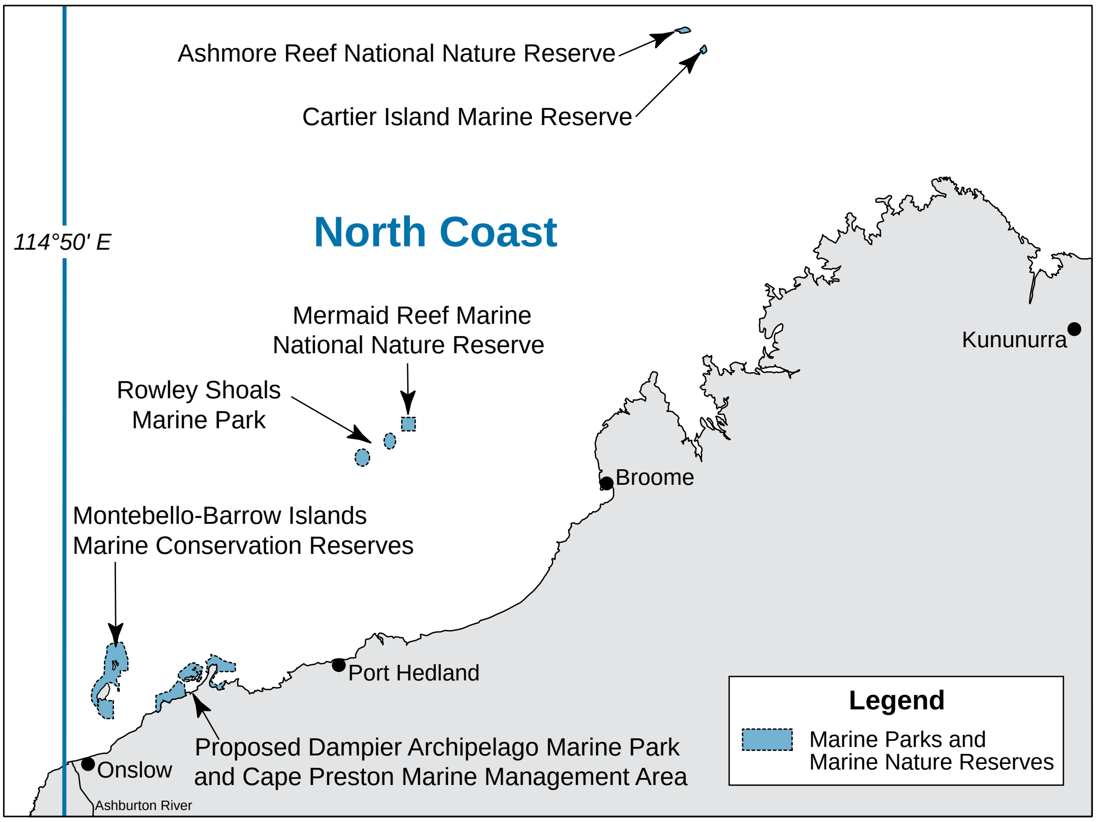
The Australian Government's Department of Environment, Water, Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with a view to completing a draft North West Marine Bioregional Plan in late 2009, 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. The Department of Fisheries also has 'introduced aquatic organism incursion' and 'fish kill incident' response programs in place.



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 J. Kennedy

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 divided into three 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 (Onslow Prawn Figure 1).

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. 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 metres in length, operating twin- or quad-rigged otter trawls to a maximum headrope length of 16 fathoms (29.27 m).

One boat was exempted to fish with larger nets – four 5-fathom nets instead of the permitted four 4-fathom nets because of the marginal economic conditions. This required the amalgamation of net allocations from two boats onto one boat, resulting in a reduction of net headrope length from 32 fathoms to 20 fathoms. The other boats that were licensed to fish this season chose not to undertake fishing operations during 2007. The Mangrove Island area voluntarily remained closed for the season. The Mangrove Island area is opened and closed by industry in consultation with the Department of Fisheries' Research Division.

Annual meetings are held with licence holders to consider the status of the stocks and recommend changes to the opening and closing dates that operate within the season. These are designed to protect smaller prawns and allow 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	17 April – 26 October
Area 2	17 April – 26 October
Area 3	17 April – 26 October
Fortescue SMFG	10 May – 1 September
Ashburton SMFG	8 June – 1 August
Weld Island SFMG	10 May – 1 September
Mangrove Island SFMG	10 May – 26 October

Moon closures were again implemented this season on a voluntary basis. The moon closure period was three days around each full moon during the fishing season across all areas.

The Department of Fisheries' vessel monitoring system (VMS) monitors 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 information from daily logbooks. Since 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 officially opened.

A Fisheries Research and Development Corporation (FRDC)-funded project examining the biodiversity of bycatch species in trawled and untrawled areas of Shark Bay, Exmouth Gulf and Onslow Area 1 was completed in 2007.

Retained Species

Commercial production (season 2007): 4 tonnes

Landings

A research survey was undertaken prior to the season commencing. The survey information showed very low abundance of tiger and banana prawns indicating a poor season for 2007.

The total landings of major penaeids for the 2007 season were 4 t, including < 1 tonne of king prawns, < 2 t of tiger prawns, < 1 tonnes of endeavour prawns and < 1 tonne of banana prawns. This season's catch was extremely low and below the target range for this fishery (60 – 180 t). Generally, tiger prawns dominate the landings, but since 2003 the tiger prawn catches have declined to the lowest recorded level. This lower level in 2007 mirrored a similar decline observed in the adjacent Exmouth Gulf fishery. The king prawn landings were below average and below the target catch range for the species. Landings include less than 1 tonne of coral prawns.

Recorded landings of by-product species included 1 tonne of bugs (*Thenus orientalis*). The low landing of by-product is a direct result of low effort, due to low prawn abundance.

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 endorsements:

Class A Areas 1, 2 and 3 (four boats)

Class B Areas 2 and 3 (three boats)

Class C Area 2 (12 Exmouth Gulf boats)

Class D Area 3 (12 Nickol Bay boats)

Because of high running costs and potential low returns, only one boat fished in the Onslow Prawn Managed Fishery during the 2007 season – compared to 8 and 3 boats in 2005 and 2006 respectively. During 2007, a total of 53 boat days (equivalent to 66 boat days for four 4-fathom nets) were fished. This was a significant decline in fishing effort compared to 214 boat days in 2006 and this is reflected in the total landings.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

The management strategies established for the Exmouth Gulf fishery were translated to the Onslow fishery in 2004, including protection of inshore seagrass habitats, undertaking surveys to minimize the take of small size of prawns early in the season and providing protection of some spawning stock during the key spawning period in spring (August to November). Therefore, the low catches during this season are not due to overfishing in previous seasons. The key factor affecting recruitment is environmental conditions.

The banana prawn season total catch was low, but was expected because of the low local summer rainfall (December to March). Generally there is a positive correlation between early seasonal rainfall and the catch of banana prawns. The total rainfall for the 2006/07 summer period was 20.2 mm. Banana prawn catches were negligible, therefore industry maintained a voluntary closure of the Ashburton SMFG for the season.

The 2007 season king prawn catch (1.0 t) was extremely low compared to the annual mean catch (32.8 t). All fisheries along the coast from Broome to Exmouth Gulf recorded lower-than-average king prawn catches this year.

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. While the low recruitment in 2007 appears to have been driven by environmental conditions, this can result in a low spawning stock, despite low fishing effort.

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 levels from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for calculating acceptable catch ranges. These 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 2007 the breeding stock indicators (catches within specified ranges) for tiger and banana prawns were not met. 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 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.

Protected species interaction: **Low**

The Onslow Prawn Managed 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') and fish escape devices (FEDs) are now fully implemented in the fishery, minimising the capture of large animals including turtles. No turtles were reported as caught in nets in the logbooks 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. Within the extensive licensed fishing zone, relatively few discrete areas offshore from size management fish grounds ('SMFGs') are fished. In 2007 the area fished was less than 2% 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 2007 was 6 people, including skippers and crew, with up to 6 people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for year 2007: N/R

Fishery Governance

Target catch range: 60 – 180 tonnes

Current fishing level: Acceptable

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

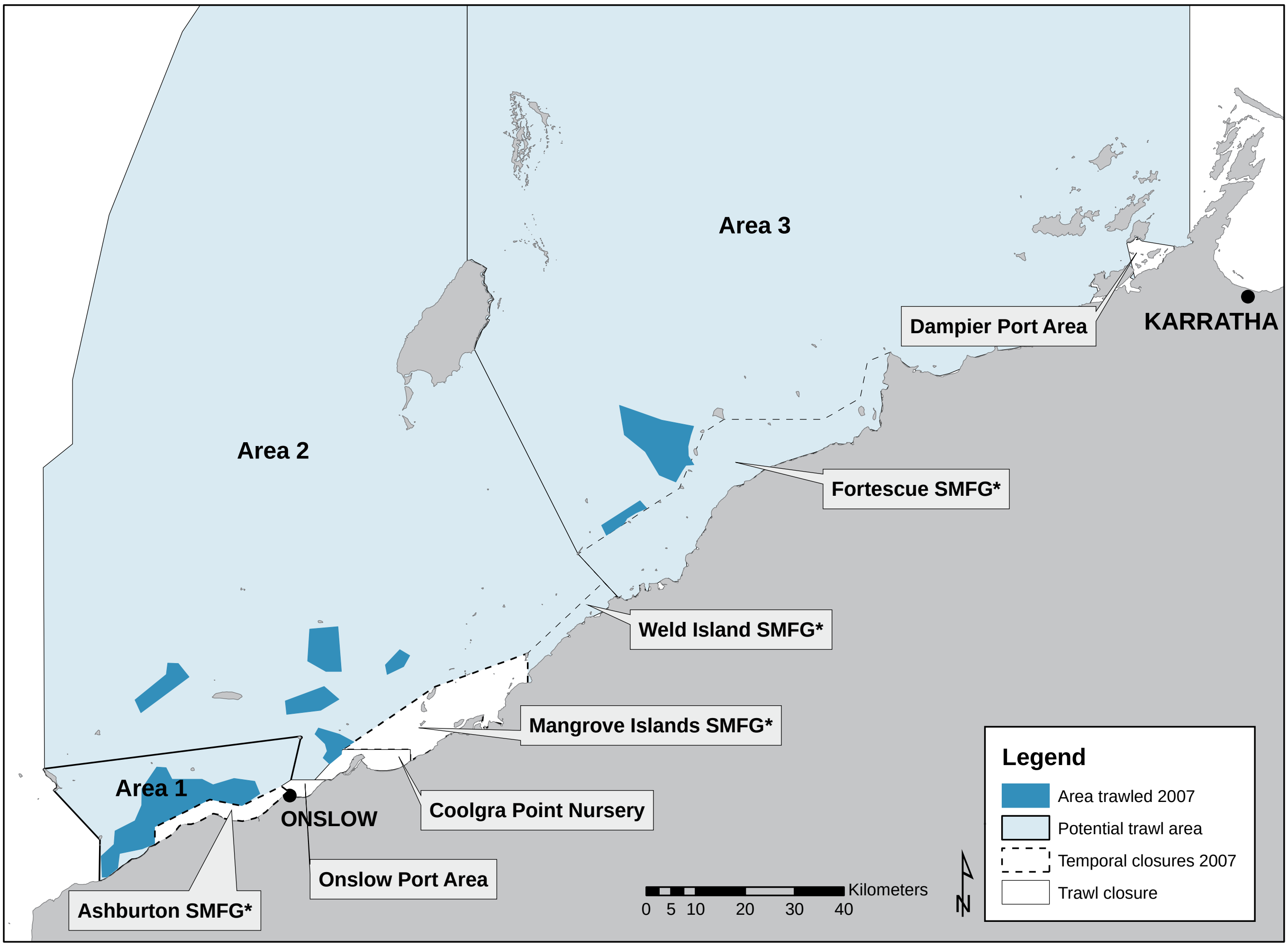
The overall acceptable range for all species combined is different from the aggregate of the individual species ranges shown above. This is because the environmental circumstances that benefit banana prawns generally result in decreased catches of the other species, as occurred in 1997 and 2000. The overall catch for the fishery in 2007 was below the target range, but still acceptable.

New management initiatives (2008): None

External Factors

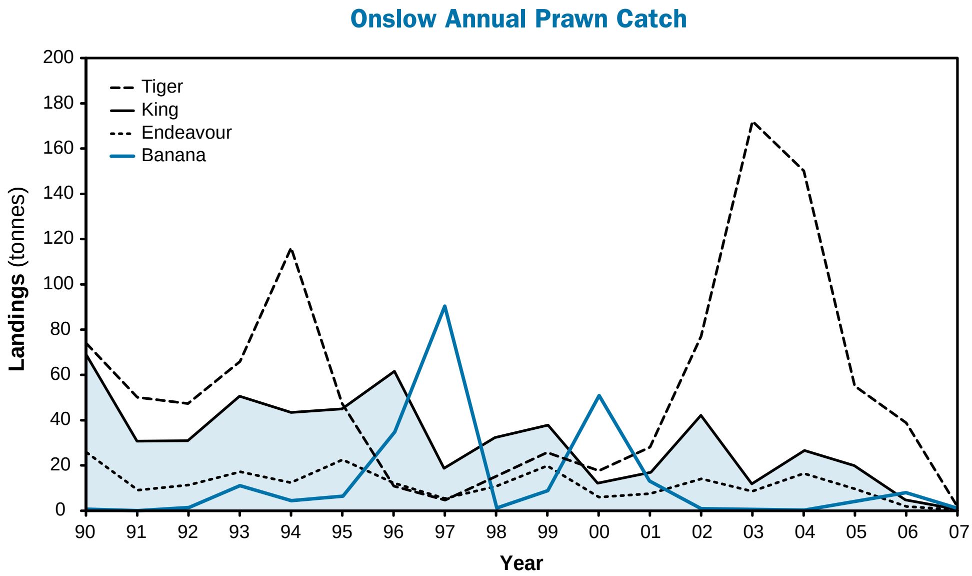
The catches taken are from a number of separate size management fish grounds and can be highly variable from year to year. This is particularly the case for the rainfall-dependent banana prawn, taken predominantly off the mouth of the Ashburton River.

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 trawl closures and size management fish grounds and area trawled in 2007



ONSLOW PRAWN FIGURE 2

Annual landings for the Onslow Prawn Managed Fishery, 1990 – 2007.

Nickol Bay Prawn Managed Fishery Status Report

M. Kangas, E. Sporer and S. Brown

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 trawl.

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 NBPF are based on limited entry, seasonal and area closures, gear controls including bycatch reduction devices (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) monitors the activities of all boats.

Arrangements for the 2007 season specified that the major fishing areas would be open during the following periods:

Season opened 12 March and closed 18 November 2007. Specific area openings for the size management fish grounds (SMFG) were:

Nickol Bay	19 May – 31 August
Extended Nickol Bay SMFG	19 May – 18 November
Depuch SMFG	19 May – 31 August
De Grey SMFG	19 May – 18 November

The management system involves a total allowable effort arrangement where all boats have an equal allocation of headrope length. The fleet is composed of trawlers up to 23 metres in length, which operate twin or quad-rigged (four nets) 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 return data provided by industry, information from boat skippers, and rainfall records. Three of the five boats that operated during

2007 also provided detailed daily logbooks. 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.

Retained Species

Commercial landings (season 2007): 44 tonnes

The total landings of major penaeids for the 2007 season were 44.4 t, comprising 44.3 t of banana prawns, <0.1 t of king prawns, and no recorded landings of tiger or endeavour prawns. The recorded landings of banana prawns in 2007 were low and below the projected catch range (120 to 180 t). Indications are that other factors as well as rainfall may influence banana prawn catches. The king and tiger prawn landings were below the target ranges for these species. Recorded byproduct landings for 2007 were 0.4 t of squid, 0.1 t of bugs (*Thenus orientalis*) and 0.1 t of blue swimmer crabs.

In this fishery the first two weeks are daytime fishing only, which then reverts to 24 hour fishing. The main reason for this is to target tiger prawns (and king prawns to a lesser extent) and continue to catch banana prawns opportunistically, mainly in the Nickol Bay SMFG. As only five boats fished this season and not all boats remained fishing for long, little effort was expended to take tiger prawns.

Recreational catch: Nil

Fishing effort/access level

There were 14 boats licensed to trawl for prawns in Nickol Bay during 2007, with only five boats fishing during the season for an aggregated total of 159 boat days fished this season, recording a very low level of effort.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

Projected catch next season (2008): Banana prawns 110 – 210 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 also 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. For king prawns the analysis of catch and effort data 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.

The catch projection for banana prawns for 2008, based on the moderate summer rainfall level of 238 mm during the 2007/08 summer period, is between 110 t and 210 t (Nickol Bay Prawn Figure 3).

The main performance measures for the Nickol Bay fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2007 the breeding stock indicators (catches within specified ranges, as set out in the 'Fishery Governance' section) for banana prawns were met but were near the lower end of the range. The king and tiger prawns were below the acceptable catch range. This is likely to be a result of the very low effort and very limited targeting of these species this year. The endeavour prawns are not a target species due to low value and abundance in this fishery and since 1995 the endeavour prawn catch cannot be used as a performance measure.

Non-Retained Species

Bycatch species impact: Low

The Nickol Bay prawn fishery operates predominantly by specifically targeting schools of banana prawns. This results in relatively low effort and minimal bycatch compared with other trawl fisheries. In 2007, less than 2% of the total Nickol Bay prawn fishery area was fished.

Protected species interaction: Negligible

The Nickol Bay prawn fishery 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 on 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 for the year 2007 was 15 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2007: $0.3 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 2007 were as follows:

King prawns	$10.05/kg
Tiger prawns	$13.00/kg
Endeavour prawns	$7.50/kg
Banana prawns	$7.50/kg
Coral prawns	$3.50/kg

Fishery Governance

Target catch range: 90 – 300 tonnes

Current fishing level: Acceptable

Historical catch ranges from periods where it is known that recruitment was not affected by fishing effort have been used as the basis for acceptable catch ranges for these species. These historical catch ranges are used as an indicator of breeding stock adequacy. 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

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 only three occasions over the past 35 years.

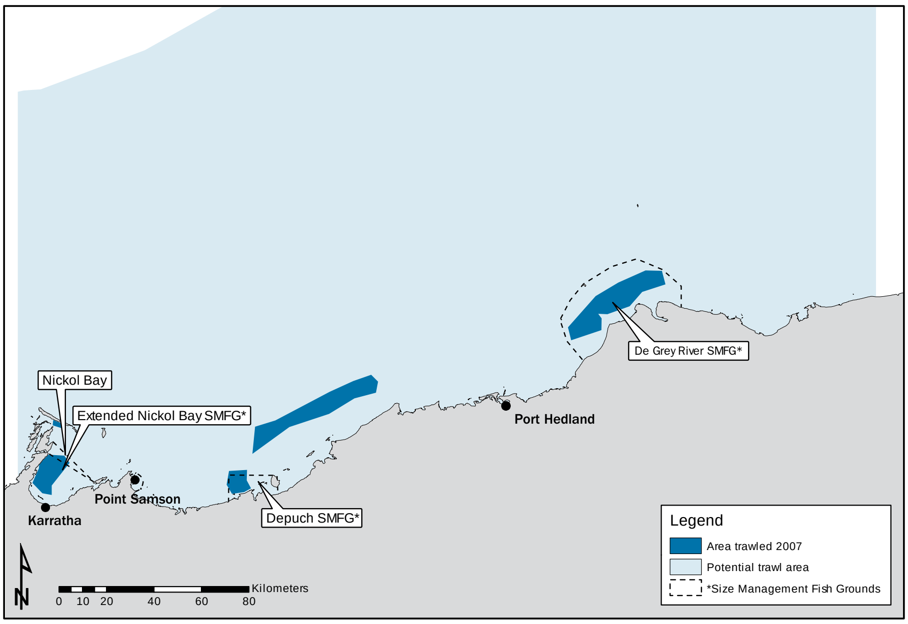
The king prawn total landings were extremely low and below the target catch range. It is notable that there was a marked decline in the total landings of king prawns for the last three years. Whether this is due to reduced stock levels or due to minimal targeting of kings prawns is being investigated. King prawns have also been at low abundance levels in other northern prawn fisheries (Broome, Onslow and Exmouth Gulf) during 2007.

New management initiatives (2008)

Prawn logbooks are to be mandatory and filled-out by fishers for the purpose of providing the Department of Fisheries' Research Division with more detailed catch, effort, fishing location and prawn size data, together with relevant comments regarding the fishery. This will allow the Research Division to improve their stock assessment of this fishery and provide data that may assist with recommendations to the management arrangements each year.

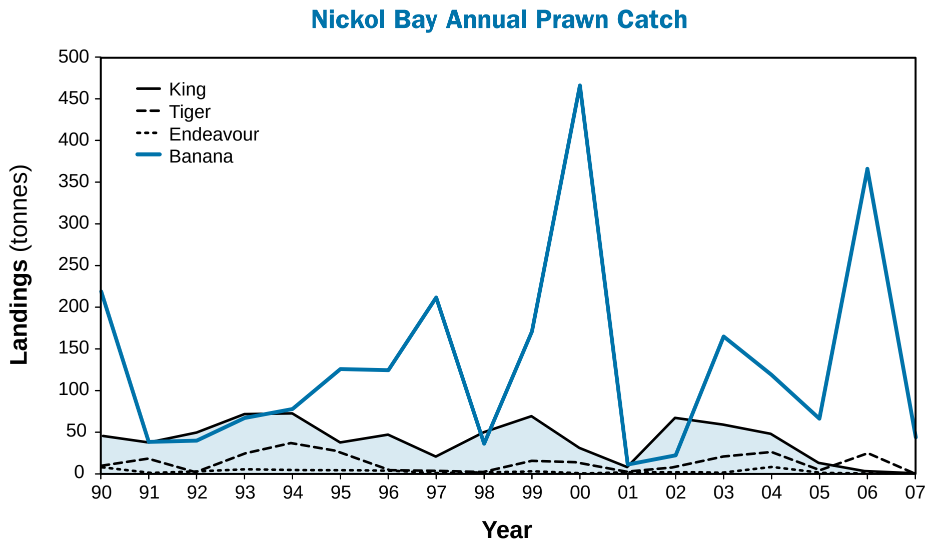
External Factors

Due to high costs of fishing and low prawn prices, some boats in the fishery are choosing not to fish in years of relatively low banana prawn catches.



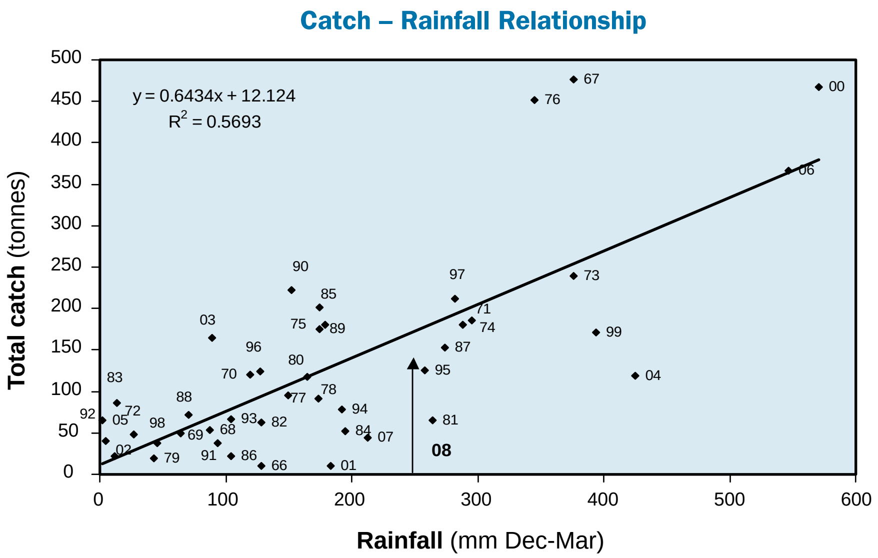
NICKOL BAY PRAWN FIGURE 1

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2007.



NICKOL BAY PRAWN FIGURE 2

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990 – 2007.



NICKOL BAY PRAWN FIGURE 3

Relationship between banana prawn landings and rainfall between December and March for the years 1966 – 2007, with rainfall level for 2008 indicated.

Broome Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from J. Kennedy

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.

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

Meetings between the Department of Fisheries and industry

Boundaries

The boundaries of this fishery are shown in Broome Prawn Figure 1.

Management arrangements

Management controls for the Broome Prawn Managed Fishery are based on limited entry, seasonal closures and gear controls including bycatch reduction devices (grids). The open period generally coincides with the seasonal closures for the Commonwealth's Northern Prawn Fishery and the Kimberley Prawn Managed Fishery. In 2007, the season opened on 8 June and closed on 24 August.

The vessel monitoring system monitors the activities of all boats.

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 logbooks completed by all boats. These data are used for stock assessment and monitoring which is discussed with industry at annual review meetings. The fishing period included three new moon phases, thus optimising the best catching periods for king prawns for the time available in this fishery. A Delury depletion analysis is usually completed which assists in the assessment of the king prawn stocks within this region.

Retained Species

Commercial production (season 2007): 72 tonnes

Landings

The total landings for the 2007 season were 72 t, comprising 33 t of king prawns and 39 t of coral prawns (Broome Prawn Figure 2). King prawn landings for 2007 were below the target range, while the landings of coral prawns were within the target range. Only 1 tonne of squid was recorded as landed in 2007.

Fishing effort/access level

There are five managed fishing licenses in this fishery, but only four boats operated during the 2007 season. The fishing arrangements provided 77 nights fishing, however only 39 nights were fished. Fishing ceased by 18 July because of low catch rates of king prawns. Nominal effort recorded in the daily research logbooks for the fleet was 1,309 hours – low compared to the average effort (3,082) for the years 1997 to 2004 inclusive. The low effort in the last two years is a reflection of the economic downturn in prawn fisheries, low prawn prices and high fuel cost, with licensees focusing on fishing to economic levels.

Recreational component: Nil

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

As the actual fishing area is relatively small and confined, a relatively short period of time is fished annually. For the 2007 season, a Delury depletion analysis was not carried out because of the short fishing period. 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.

A 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. Normally this species has not been fully retained due to low prices, therefore, catches do not reflect actual abundance.

Generally, fishing is continuous during the Broome Prawn Managed Fishery season but with high and low prawn catchability periods influenced by the lunar phase. In 2007 the mean catch rate of king prawns was 25.1 kg/hr which is close to the average (25.2 kg/hr) observed for this fishery during 1997 to 2004. Although the catch rate appears relatively high, economic factors in 2007 continue to bias the final catch rates in this fishery. Thus the relatively high CPUE in 2007 was generated by boats leaving the fishery at a relatively high catch rate rather than fish to the previous lower (now uneconomical) levels because of high fuel costs. Also, the distance needed to travel to and from this fishery is now a significant cost consideration as to whether boats operate in this fishery.

The Delury analysis was not carried out for the king prawn stock in 2007. However the CPUE at the end of the season was at the level considered sufficient for sustainability.

For coral prawns, the annual catch in 2007 was within the target catch range and the catch rate of 30.2 kg/hr was higher than the average (23.2 kg/hr) between 1997 and 2004. The cessation of fishing at a relatively high catch rate for king prawns also maintained higher catch rates of coral prawns. There is a low risk of overfishing this stock, due to its low catchability and the relatively small fishing area compared to its widespread distribution.

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the target prawn species. In 2007 the breeding stock indicators for king prawns were met, as the catch rate for the king prawn was left at an acceptable level. Coral prawns were within their target catch range. The low effort and the restricted size of the area fished limit the 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 2007, 42% of the gazetted fishing area was fished, which represents less than 1% of the total Broome Prawn Managed Fishery area. Over the last four years the area trawled has declined in line with the catches each year. The introduction of fish escapement devices within all the nets towed by each vessel in 2007 should have reduced this risk even further.

Protected species interaction: Negligible

The fishery operates in relatively deep water, and 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 2007.

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 (this common name is due to the prawn's 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 mud or sand, which is unlikely to be adversely impacted by trawling.

Social Effects

The estimated employment generated by the fishery for the year 2007 was 16 skippers and crew over the three-month season. These boats also operated in other prawn fisheries further north.

Economic Effects

Estimated annual value (to fishers) for year 2007: $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 2007 were as follows:

King prawns	$10.05/kg
Coral prawns	$3.50/kg

Fishery Governance

Target catch range: 55 – 260 tonnes

Current fishing level: Acceptable

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 seven-year range (1996 – 2002) since catches were first recorded. The 33 t of king prawns was just below the acceptable catch range. It should be noted that the mean catch rate of king prawns over the relatively short fishing period for this fishery was at the mean level for this species and the exploitation rate was low. The 39 t of coral prawns taken were within the target range. In both cases, the low landings are due in part to low effort levels resulting from market forces (fuel costs and low prices, even though 82% of the prawns caught were an acceptable commercial size).

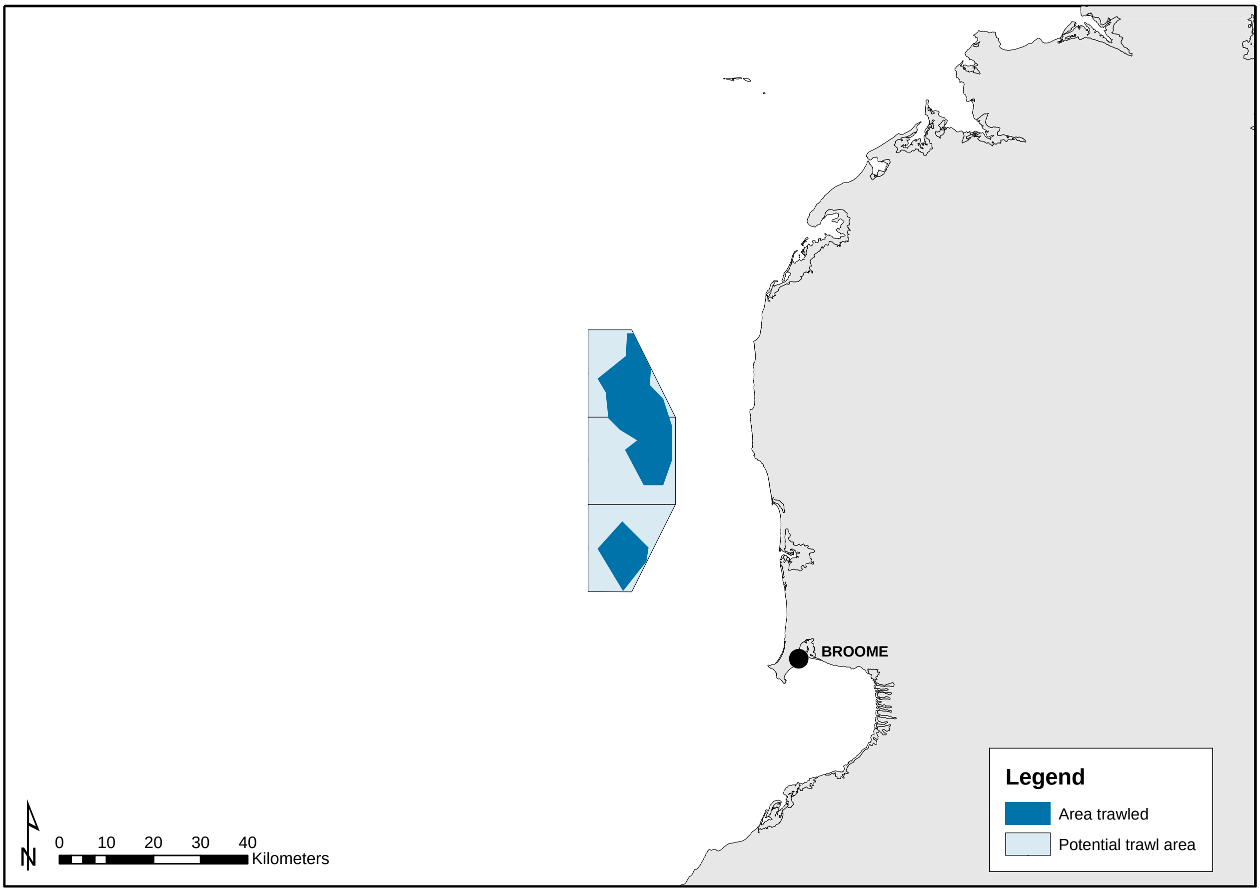
Other factors influencing catches are that the timing of the season is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in high abundances in the permitted fishing area.

New management initiatives (2008)

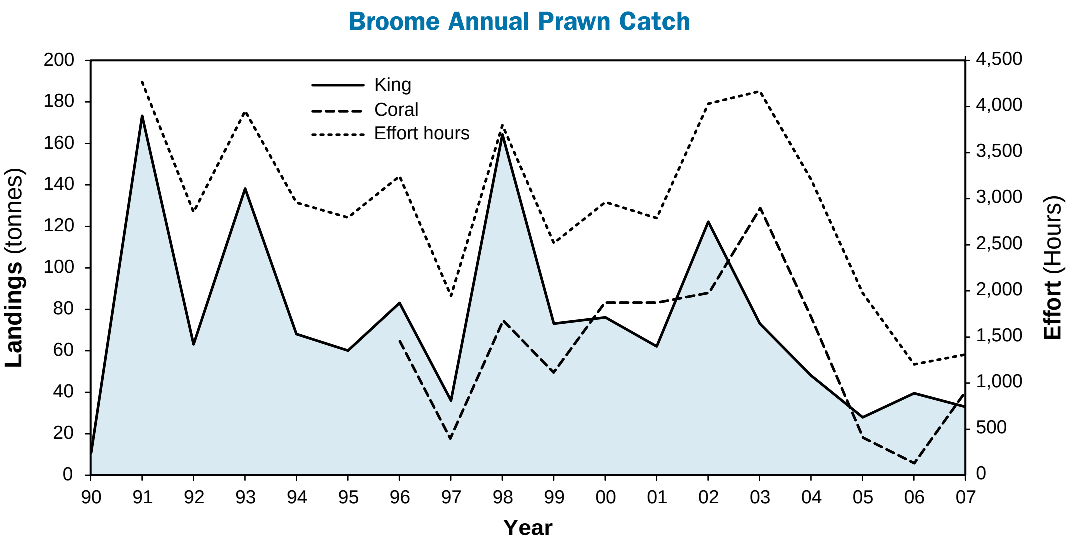
None.

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.



BROOME PRAWN FIGURE 1
Boundaries of the Broome Prawn Managed Fishery and trawled area in 2007



BROOME PRAWN FIGURE 2
Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2007

Kimberley Prawn Managed Fishery Status Report

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

Fishery Description

The Kimberley Prawn Managed Fishery (KPF) operates off the north of the state 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'*. It 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 Commonwealth Northern Prawn Fishery (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. The KPF in recent years has had two fishing periods – April to May (with an effort cap of 600 days) and the second period from August to early December (with an effort cap of 900 days).

In 2007 the KPF opened on 3 August, with a final season closure on 15 November. This was implemented with an aim to harvest larger prawns. All fishing activities are monitored by the Department of Fisheries' vessel monitoring system (VMS).

In addition, inshore closures to protect small prawns were implemented for the whole season (compared to only the first half in earlier years) after industry consultation for Collier Bay, Brunswick Bay-York Sound, Admiralty Gulf and Napier Broome Bay.

The fishery currently has a five-year Ecologically Sustainable Development (ESD) accreditation from the Commonwealth Department of Environment, Water, Heritage and the Arts. A comprehensive ESD 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 WA fishers' monthly returns, and by research logbooks collected by the Australian Fisheries Management Authority for NPF boats licensed to operate in the Kimberley fishery. Twelve boats provided comprehensive daily research logbooks, which provide higher resolution spatial catch, prawn grade and effort information. Research assessments are given to annual meetings of boat operators and provide the basis for recommending changes to management arrangements each year.

Retained Species

Commercial production (season 2007): **271 tonnes**

Landings

The total recorded landings for the 2007 season were 271 t, comprising 236 t of banana prawns, 23 t of tiger prawns, 12 t of endeavour prawns and <1 t of king prawns.

The banana prawn catch was within the projected catch range (200 to 300 t) calculated using the relationship between summer rainfall and catches. Banana, tiger and endeavour prawn catches were all within their target catch ranges.

As only the second part of the season was fished, the majority of the catch was landed during August (68% of the total catch). In previous years, between 40 and 90% of the catch was taken in April to May. In 2007 this catch was transferred into August, September and October and total catches were similar to those seen in the last two years under similar environmental conditions.

By fishing in the second half of the year, it was also evident that the prawns caught were a grade larger on average than in April and May, with the majority of the catch being U15 and U20 compared to 15/25 and 20/30 grade in 2006. This has economic benefits to industry, with reduced overall effort and larger prawn size.

Recorded by-product species for 2007 were 7 t of bugs (*Thenus orientalis*), and less than 1 t of squid and cuttlefish.

Recreational component: **Nil**

Fishing effort/access level

Although a total of 137 managed fishery licences have access to the KPF, 20 different boats operated in the fishery during 2007. The total number of days recorded as fished (logbooks and CAES) was 521 boat days – well under the 900 days allocated for the second half and a third of the total days (1,500) previously allocated to fish. The effort derived from logbooks is actual days fishing, rather than days including search time or time spent in the fishery as reported by VMS.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Projected catch next season (2008): **Banana prawns 210 – 330 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) provides 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 2008 was 241 mm at Derby and 221 mm at Kalumburu so the rainfall – catch relationship predicts that banana prawn catches for 2008 should be in the range of 210 – 330 tonnes. However, it should be noted that, due to the changes in harvesting patterns, fishing occurred only in the second out of the season, this rainfall catch relationship may need to be adjusted in the future.

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. In addition, inshore closures implemented in 2007 provide added protection to smaller prawns increasing the spawning biomass.

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 2007, the breeding stock indicators (catches within specified ranges) for banana, tiger and endeavour prawns were met.

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 some untargeted trawling may also occur. Overall, the fishery is likely to have a low impact on bycatch species. The lower overall effort in the fishery, due to only the second part of the season being open, reduces overall impacts.

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: Negligible

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, with the area trawled being 2% of the licensed area in 2007. Owing to the unusual nature of the environment, characterised by extreme (10m) 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 2007 was 80 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2007: $2.2 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 2007 were as follows:

Banana prawns	$7.50/kg
Tiger prawns	$13.00/kg
King prawns	$10.05/kg
Endeavour prawns	$7.50/kg

Fishery Governance

Target catch range: 240 – 500 tonnes

Current fishing level: Acceptable

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 (2008)

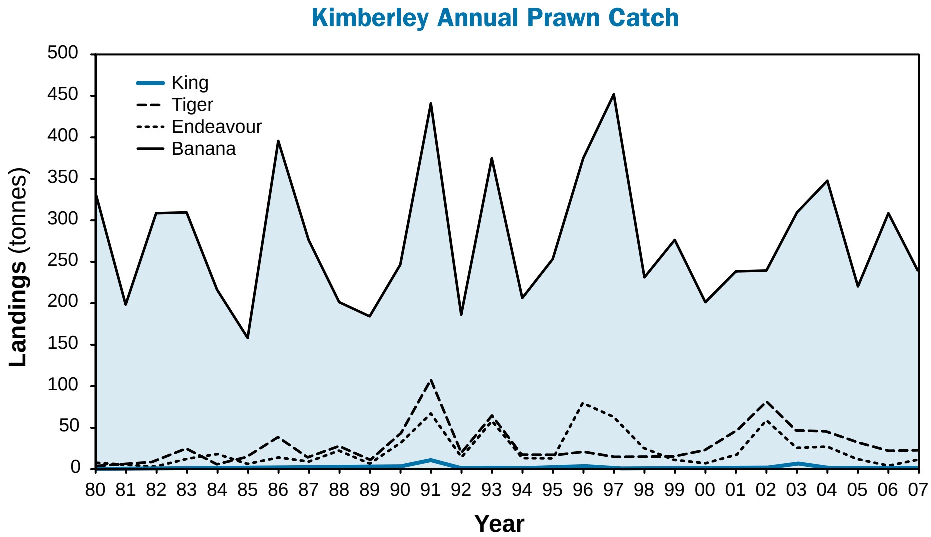
The introduction of inshore closures for the whole season will be continued in 2008 for economic benefits and to protect the capture of small prawns and to protect spawning stocks during the latter part of the season. It is planned to continue only opening the fishery for the second part of the season for a further 3 to 5 years to investigate the value of the strategy.

Mandatory prawn logbooks will need to be filled out by those fishers who fish for the majority or all of the season to provide the Department of Fisheries' Research Division with catch, effort, fish location and prawn size data, together with relevant comments regarding the fishery so that assessments can be improved and provide the basis for future recommendations to management arrangements.

A review of the management arrangements for the KPF will commence during 2008 to address key issues including de-linking the fishery from the NPF and addressing latent effort.

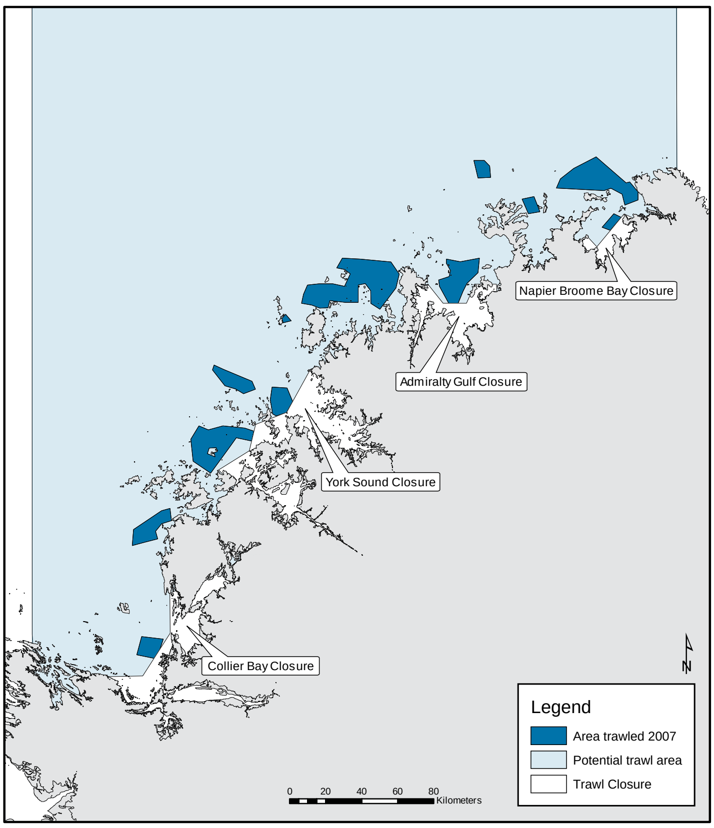
External Factors

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 and overall effort is now potentially reduced due to the shorter fishing season.



KIMBERLEY PRAWN FIGURE 1

Annual landings for the Kimberley Prawn Managed Fishery, 1980 – 2007.



KIMBERLEY PRAWN FIGURE 2

Areas fished in the Kimberley Prawn Managed Fishery in 2007 and the inshore trawl closures implemented.

Kimberley Gillnet and Barramundi Managed Fishery Status Report

S.J. Newman, C. Skepper, G. Mitsopoulos and R. McAuley
Management input from R. Green

Fishery Description

The Kimberley Gillnet and Barramundi Managed Fishery (KGBF) extends from the Western Australia/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*), king threadfin (*Polydactylus macrochir*) and blue threadfin (*Eleutheronema tetradactylum*). Lesser quantities of elasmobranchs (sharks and rays), black jewfish (*Protonibea diacanthus*) and tripletail (*Lobotes surinamensis)* are also landed. The composition includes 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 no longer be retained.

There are five principal fishing areas within the north coast (Pilbara/Kimberley) bioregion: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River), Broome coast (Roebuck Bay), and Pilbara coast (extending to the Ashburton River). Only four 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).

Governing legislation/fishing authority

Commercial:

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence Exemption holders

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

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 three 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 Western Australia 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 seven licences, but only six licences were active during 2007. In 2007, there were also two Exemption holders authorised to commercially fish with gillnets along the Eighty Mile Beach area (herein referred to as 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 KGBF (west of Cunningham Point, 123º08.23´ E 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. There are also limits on the length of net and mesh sizes to be used in the fishery.

Following the development in 2000 of the initial '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 17°27´ S and the lower Ord River upstream of Adolphus Island.

In March 2007, representatives from the commercial, recreational and charter fishing sectors agreed to the *Accord for the Future Management of Barramundi and Threadfin 2007 – 2012*. The new accord includes a number of recommendations for improved fisheries management arrangements for the various sectors that take barramundi and threadfin. The Department of Fisheries plans to develop a community awareness and education package to facilitate the release of the outcomes of the accord process, in order to support the recommended legislative changes for the improved management of these stocks.

Research summary

A study of the biological characteristics required for fisheries management for both the threadfin salmon species has recently been completed (Pember *et al.* 2005). These data will be used to provide a detailed stock assessment of threadfin salmon in the KGBF and Pilbara when resources become available.

WEST COAST BIOREGION
GASCOYNE COAST BIOREGION
NORTH COAST BIOREGION
SOUTH COAST BIOREGION
NORTHERN INLAND BIOREGION
SOUTHERN INLAND BIOREGION
STATE-WIDE
REFERENCES AND APPENDICES

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 CAES database. This status report is compiled annually and provided to industry and regional management.

Retained Species

Commercial landings (season 2007): **All species 108.8 tonnes**
Barramundi 25.6 tonnes
Threadfin salmon 77.7 tonnes

Each of the five 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 four sectors within the managed fishery.

The total reported catch of all species in the KGBF in 2007 was 109 t (Kimberley Gillnet Figure 2). Recent annual catches of the major target species by the KGBF are reported in Kimberley Gillnet Table 2. The total landings of barramundi from all four prescribed fishing areas within the KGBF were 25.6 t for 2007 (Kimberley Gillnet Figure 3). This decline is a result of reduced catches in the Cambridge Gulf and Kimberley Coast areas of the fishery due to reduced effort levels in these sectors of the fishery.

The 2007 landings of threadfin salmon in the KGBF were 77.7 t (Kimberley Gillnet Table 2, Kimberley Gillnet Figure 4). Catches of threadfin salmon from the KGBF in 2007 are similar to those reported from 2004 to 2006, however they are lower than the near record high catch of 94 t reported in 2003. In addition, the reported catch of 25.4 t of threadfin salmon in the Pilbara coast fishing sector in 2007 is substantially lower than the 2004 level of catch, while being similar to the 2005 level of catch.

The two 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 2007 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 2007 was estimated to be approximately 7.9 t of barramundi and 1.0 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^{-1}). During 2007, the total effective effort across the four prescribed fishing areas was 900.1 km gn hr. This level of effort is similar to that reported in 2006 (861.1 km gn-hr^{-1}) but is lower than that reported in the fishery in 2005 (1,071.6 km gn-hr^{-1}) and 2004 (1,811 km gn-hr^{-1}; Kimberley Gillnet Figure 2).

Stock Assessment

Assessment complete: **Barramundi – Yes**
Threadfin salmon – Yes

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 before rising again from 2004 to 2006. The catch rate of barramundi in 2007 is lower than that reported in 2006 but within the ranges seen in the last 5 to 10 years (Kimberley Gillnet Figure 3). .

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.

Historically, the catch rate of threadfin salmon was 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 2007 is the highest reported over the last 20 years. This may be evidence of increased efficiency in targeting these fish.

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.

Where practicable, sharks and rays are released alive. However, there is some mortality of sharks and rays associated with gillnet capture. 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 2007, six vessels fished in the KGBF with an average crew level of approximately 3 people, indicating that at least 18 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 2007: — $653,000

The KGBF landed a total of 109 t of fish in 2007, for a catch value of approximately $653,000 (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 25.4 t of fish in 2007 for a catch value of around $140,000 (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 five 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 2007 is at the lower end of 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 within the range reported for the last 5 years. The breeding stock levels of barramundi are considered adequate and therefore the current fishing and effort levels are acceptable.

New management initiatives (2007/08)

A new barramundi and threadfin salmon accord was finalised in March 2007 and applies to the recreational and commercial take of barramundi and threadfin salmon throughout the Pilbara and Kimberley regions. The accord agreement is set for 5 years (2007-2012) and is a form of integrated fisheries management for these species and follows consultation between commercial, recreational and charter stakeholders. The Department of Fisheries plans to develop a community education and awareness package detailing the outcomes of the accord, to support legislative changes recommended under the accord process.

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 utilising the large Kimberley river systems as nursery areas are expected to be reasonably resilient to fishing pressure. However, the impact of increasing exploitation from the charter and tourism sectors, as well as the gas and mining development sectors, on barramundi stocks needs to be investigated.

Furthermore, the smaller, isolated stocks along the arid Pilbara coastline are likely to experience highly variable recruitment due to environmental fluctuations (e.g. amount of rainfall). These stocks are subject to relatively uncontrolled levels of fishing pressure from recreational fishers (driven in the main by population growth resulting from gas and mining developments), and are likely to need more specific management arrangements in the future.

KIMBERLEY GILLNET TABLE 1

The reported catch (t) of the major commercial species from each of the principal fishing areas in the north coast bioregion in 2007.

Catch Category	Principal Fishing Area				
	Cambridge Gulf	Kimberley Coast	King Sound	Broome Coast	Pilbara Coast
Barramundi	0.3	13.5	5.2	6.7	0.0
Threadfin salmon	0.0	4.0	1.1	72.6	25.4
TOTAL	**0.3**	**19.6**	**6.5**	**82.4**	**25.4**

KIMBERLEY GILLNET TABLE 2

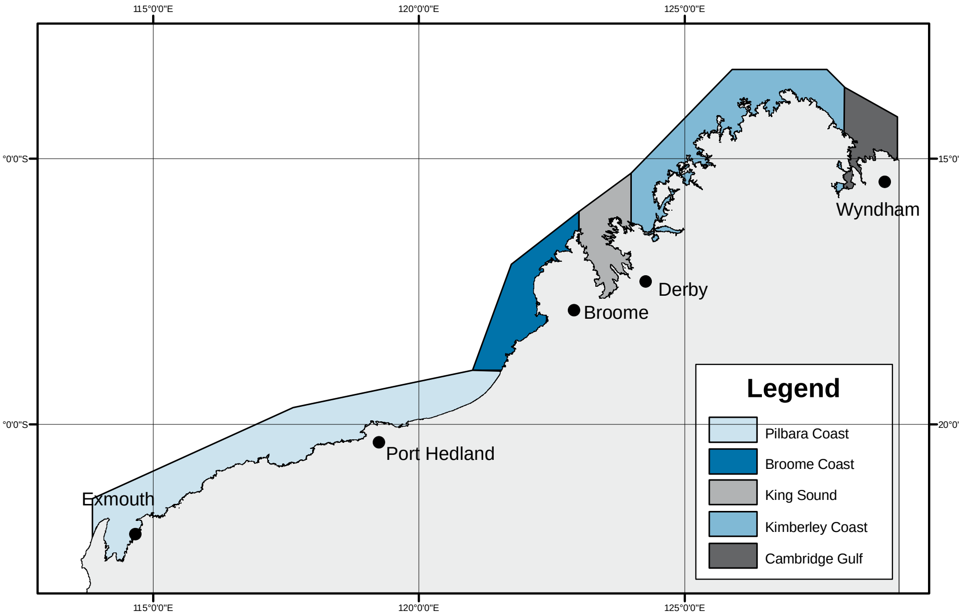
Recent annual catches of the major target species by the KGBF.

Species	Kimberley Gillnet Annual Catch (tonnes)									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Barramundi	33.5	41.2	42.9	38.8	39.5	45.0	53.5	35.6	36.3	25.6
Threadfin salmon	81.3	109.8	66.7	50.9	76.4	94.1	75.8	70.6	67.7	77.7
TOTAL	**123.2**	**160.4**	**120.7**	**100.5**	**124.4**	**148.0**	**136.1**	**117.8**	**109.9**	**108.8**

KIMBERLEY GILLNET TABLE 3

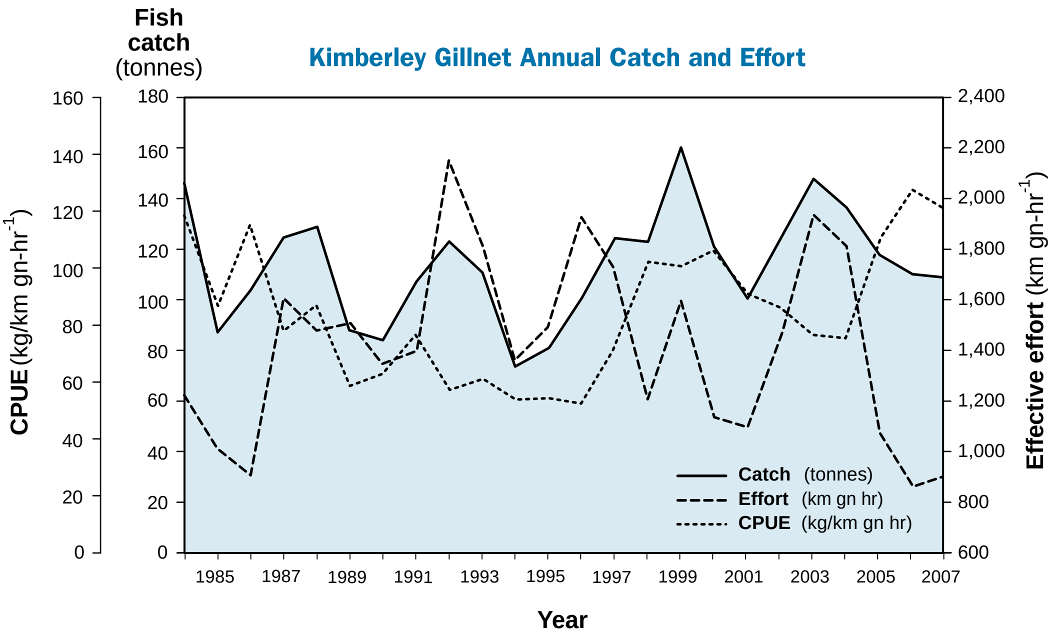
Summary of the reported catch (t) in the KGBF in 2007 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin salmon	77.7	71.4
Barramundi	25.6	23.6
Tripletail	3.4	3.1
Queenfish	1.0	1.0
Black jewfish	0.5	0.4
Sharks and rays	0.4	0.3
Other fish	0.2	0.2
TOTAL	**110.0**	**100.0**



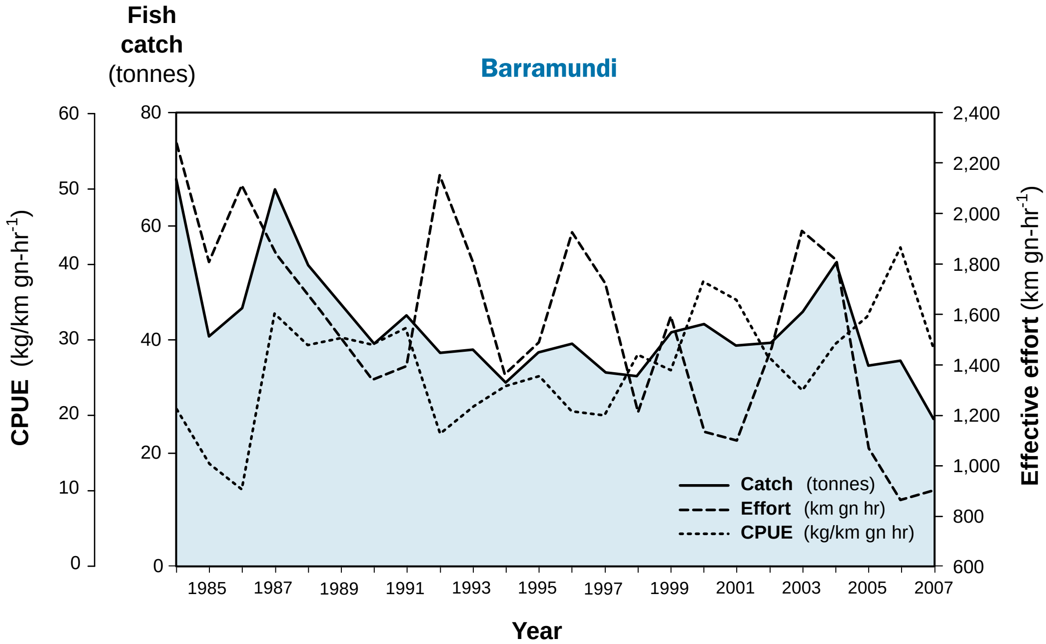
KIMBERLEY GILLNET FIGURE 1

Location of the principal fishing areas for barramundi and threadfin in the north coast (Pilbara/Kimberley) bioregion. Four 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.



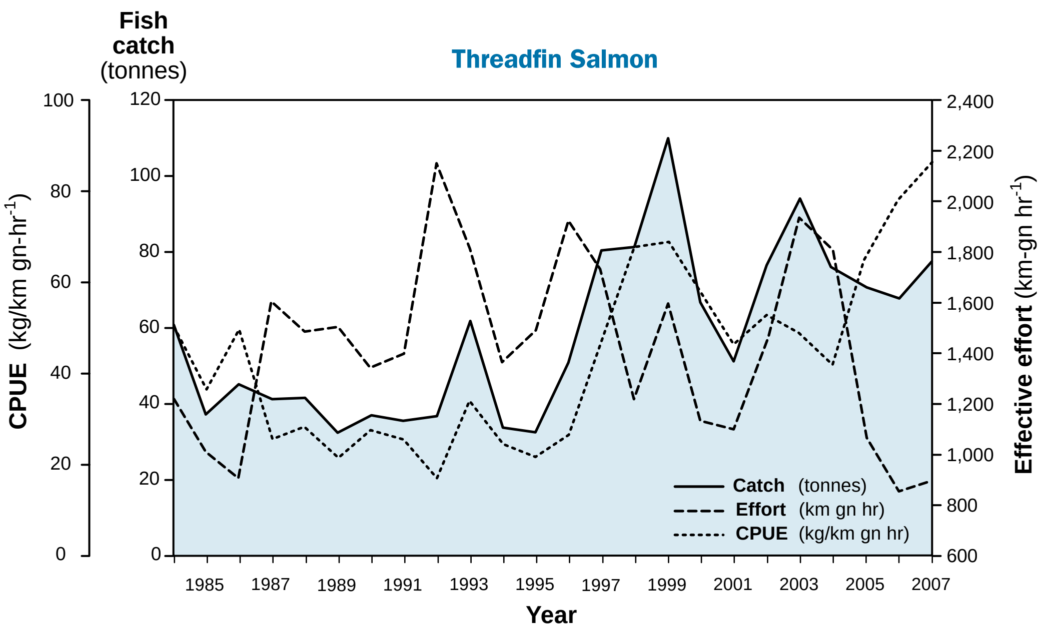
KIMBERLEY GILLNET FIGURE 2

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 2007.



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 2007.



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 2007.

Northern Demersal Scalefish Managed Fishery Status Report

S.J. Newman, C. Skepper, G. Mitsopoulos and B. Rome
Management input from R. Green

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 (cods) dominate the landed catch in this fishery.

Governing legislation/fishing authority

Commercial

Closed Waters Fish Trapping (Kimberley Coastline) Notice 1991
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
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 two fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2) (see Northern Demersal Scalefish Figure 1). Under a voluntary industry agreement, the offshore sector (Area 2) has been further divided into 3 zones – A, B and C. Zone B comprises the area of historical fishing activity and exploitation, while Zone A is an inshore developmental area and Zone C is an offshore deep-slope developmental area representing waters deeper than 200 m. Little is known of the demersal scalefish resources of the deep-slope waters of Zone C.

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, to the 30 m bathymetric contour. This closure was put in place to reduce the potential for conflict between commercial fishers and recreational fishers.

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 (TAC). The annual effort quota is determined by dividing the notional target TAC by the average catch rates per vessel per day within the fishery. The effort quota is then allocated equitably among license holders through units of entitlement on Managed Fishery Licenses.

The offshore area (Area 2) of the NDSF has separate allocations for each Zone (Zone A, Zone B and Zone C). An Exemption provides additional effort in Zone C (50 standard fishing days per licence), in order to encourage fishers to explore the lesser-fished offshore waters of the NDSF.

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 2007, the notional TAC for Zone B was 800 t of demersal scalefish and the total effort allocation was 1,144 standard fishing days.

The areas that encompass Zone A and Zone C are likely to be lower in productivity compared with Zone B, and thus the notional exploratory TAC set for Zone A and Zone C will need to be revised if substantial catches of either goldband snapper or red emperor are forthcoming. In 2007, the notional TAC for Zone A and Zone C 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 system. This allows the effort quota to be operated by a lesser number of vessels. For example, during 2007, 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 Department of Fisheries’ vessel monitoring system (VMS), is converted to standard fishing days.

A comprehensive Ecologically Sustainable Development (ESD) assessment of this fishery has determined that performance should be reported annually against measures relating to breeding stocks of the two indicator species – red emperor and goldband snapper – and the cod/grouper complex (a suite of more than 10 species), as reflected by their catch levels.

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 two key species, red emperor and goldband snapper. Ongoing monitoring of this fishery is being undertaken using both CAES data and 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. An FRDC-funded research project commenced in late 2006, which aims to examine the relative catching efficiency of traps in the NDSF and to investigate resource availability and contribute to the stock assessment process in the NDSF.

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 zone 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 2007): 908 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 Figure 2). Following 1996, catch levels decreased and were relatively stable in the period from 1998 to 2003; the catch of demersal scalefish in the NDSF began to increase in 2004. The total catch of demersal scalefish in the NDSF in 2007 was higher than that reported in 2006 due to an increased level of catch and effort from Zone A of the fishery (Northern Demersal Scalefish Table 1).

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), cods (Serranidae) and emperors (Lethrinidae) comprising the remainder of the catch. The catch of the major target and secondary target species over the last six years is provided in Northern Demersal Scalefish Table 1.

The species composition of the landed catch in 2007 is similar to that reported in 2006. There was an increase in the landed catch of red emperor – up from 166 t in 2006 to 176 t in 2007 (Northern Demersal Scalefish Figure 3), goldband snapper up from 336 t in 2006 to 393 t in 2007 (Northern Demersal Scalefish Figure 4), and a small decrease in the cods/groupers catch, down from 129 t in 2006 to 121 t in 2007 (Northern Demersal Scalefish Figure 5). The composition of the cod/grouper catch complex is dominated by one species – the Rankin cod (*Epinephelus multinotatus*). The catch of Rankin cod from 2004 to 2007 is similar to that reported in the fishery in the early 1990s. The catch of the major species by zone in the NDSF is described in Northern Demersal Scalefish Table 2.

The 2007 catch of goldband snapper was just above the current acceptable level (see 'Fishery Governance' section). The 2007 level of catch of red emperor and the cod/grouper complex were close to the upper bounds of the acceptable levels.

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 is now changing, with charter vessels moving into the offshore waters of the NDSF but the reported charter vessel catch of demersal scalefish in the offshore waters of the NDSF (depth > 30 m) in 2007 was still estimated to be less than 1% of the commercial catch. 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. However, the increasing number of vessels associated with oil and gas developments in the Kimberley region has the capacity to significantly increase the level of recreational catch directed towards species in inshore and offshore waters of the NDSF.

Fishing effort/access level

The seven fish trap vessels that fished in the NDSF in 2007 reported using between 20 and 48 fish traps per day. No line fishing was undertaken in the NDSF in 2007. The history of effort allocation in the NDSF since the introduction of the individually transferable effort management system in 1998 is detailed in Northern Demersal Scalefish Table 3.

The effort allocated in Zone B in 2007 was 104 fishing boat days per licence, or a total of 1,144 standard fishing days (i.e. using 20 traps) (Northern Demersal Scalefish Table 3). The number of standard fishing days recorded using VMS data was 1,077, indicating that only 67 standard fishing days remained unutilised in the fishery at the end of the season. The removal of latent and unutilised effort in Zone B in 2007 has meant that the allocated effort has virtually been fully utilised.

The effort allocated in Zone A in 2007 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 recorded using VMS data was 158, indicating that 458 standard fishing days remained unutilised in Zone A at the end of the season. Zone A is a developmental area and there is considerable scope for industry to operate in this area, with a large amount of unutilised effort available.

No fishing effort was expended in Zone C in 2007.

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 Catch Per Unit Effort (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 2007. Prior to 1998, the handline and dropline CPUE was low and variable.

The average Zone B trap CPUE during 2007 was 770.8 kg per standard trap fishing day (20 traps x 38.54 kg/trap/day). This annual average trap CPUE in Zone B of the fishery in 2007 has increased from that reported in 2006 (705.9 kg/std day).

During 2007, Zone B catch rates for the indicator species were 153 kg/std day for red emperor, 339 kg/std day for goldband snapper, and 104 kg/std day for cods. In the case of both goldband snapper and red emperor, the catch rates in 2007 were higher than those recorded in 2006, whereas the catch rate for cods was lower.

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 2008 fishing season is outlined in the ‘Target catch range’ section below.

The 2007 trap catch rates for the two main target species are marginally higher than those reported in 2006, with the cods/groupers catch rate decreasing from the 2006 level. The levels of catch of red emperor, goldband snapper and cods either exceeded or were close to the trigger point of a 20% increase in catch above the average of the past four years, despite the same level of effort to that allocated in 2006. These increases in catch levels need to be assessed to determine if there has been any change in species composition and/or increased exploitation of any particular species. A stock assessment review of the key target species in the NDSF will be undertaken in 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 two 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.

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 2007, the catches of goldband snapper exceeded the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2007 level of catch of red emperor and the cod/grouper complex were close to their performance indicators. Given the increased catch rates, the abundance of these species has probably been maintained at higher catch levels, thus all three species/groups were 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 for all indicator species/groups. This is currently in progress.

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 stellaris*, 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. Recent video observations indicate that the potato cod (*Epinephelus tukula*), a totally protected species, is present in high numbers at discrete locations within the fishery. The potato cod rarely enters traps due to its large size and girth, which limits its capacity to pass through the entrance funnel into the traps.

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 to those targeted have been observed on video to be able to exit traps if left undisturbed.

Social Effects

Seven vessels fished in the 2007 fishing season with an average crew level of over 3 people per vessel, indicating that at least 23 people were directly employed in the NDSF.

Economic Effects

Estimated annual value (to fishers) for year 2007: $5.2 million

The NDSF principally targets the higher-value species such as goldband snapper and red emperor. The fishery landed a total of 908 t of demersal scalefish in 2007, for a catch value of approximately $5.2 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

Since the introduction of management controls (1998 – 2007), the fleet has only achieved its 800 t notional TAC in Zone B in two years (2005 and 2007). A stock assessment review of the fishery is in progress and these results will be finalized during 2008. For the 2008 calendar year, the total allowable effort in Zone B of the fishery was maintained 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 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 four years. Thus in 2007, across the fishery (all zones) the acceptable level of catch (average + 20%) for red emperor was less than 186 t, for goldband snapper less than 382 t, and for the cods/groupers less than 125 t. The goldband snapper performance measure was exceeded in 2007, with the other two being close to 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: Acceptable

The reduction in the effort allocated in 2006 and 2007 translated into a level of catch equivalent to the notional TAC with very little unutilised effort. The updated acceptable catch ranges will be generated following the review of the stock assessments.

New management initiatives (2007/08)

There is a need to incorporate the voluntary industry agreed zoning and effort allocation arrangements of Area 2 of the NDSF into the management plan.

External Factors

The impacts of environmental variation on the fishery are not considered to be large, as the target species are long-lived. There are no data to indicate significant variation in recruitment amongst years for either of the two 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. In addition, offshore developments in the energy/gas industry may involve exclusion zones, thus potentially limiting fisher access to some areas of the fishery. Increasing development of the Kimberley region is also likely to see a marked increase in the recreational effort and this may impact on stock sustainability.

NORTHERN DEMERSAL SCALEFISH TABLE 1

Recent total annual catches of major target and by-product species or species groups across all zones in the NDSF.

Species	NDSF annual catch (tonnes)					
	2002	2003	2004	2005	2006	2007
Goldband snapper (*Pristipomoides* spp.)	152	226	283	429	336	393
Red emperor (*Lutjanus sebae*)	101	118	144	192	166	176
Scarlet perch (*Lutjanus malabaricus*)	61	48	68	92	79	96
Spangled emperor (*Lethrinus nebulosus*)	35	39	33	21	28	14
Cod/grouper (Serranidae)	49	74	103	110	129	121
Other species	36	47	59	78	63	108
Total demersal scalefish catch	**434**	**552**	**690**	**922**	**801**	**908**

NORTHERN DEMERSAL SCALEFISH TABLE 2

Catches of major target and by-product species or species groups by zone in the NDSF in 2006 and 2007.

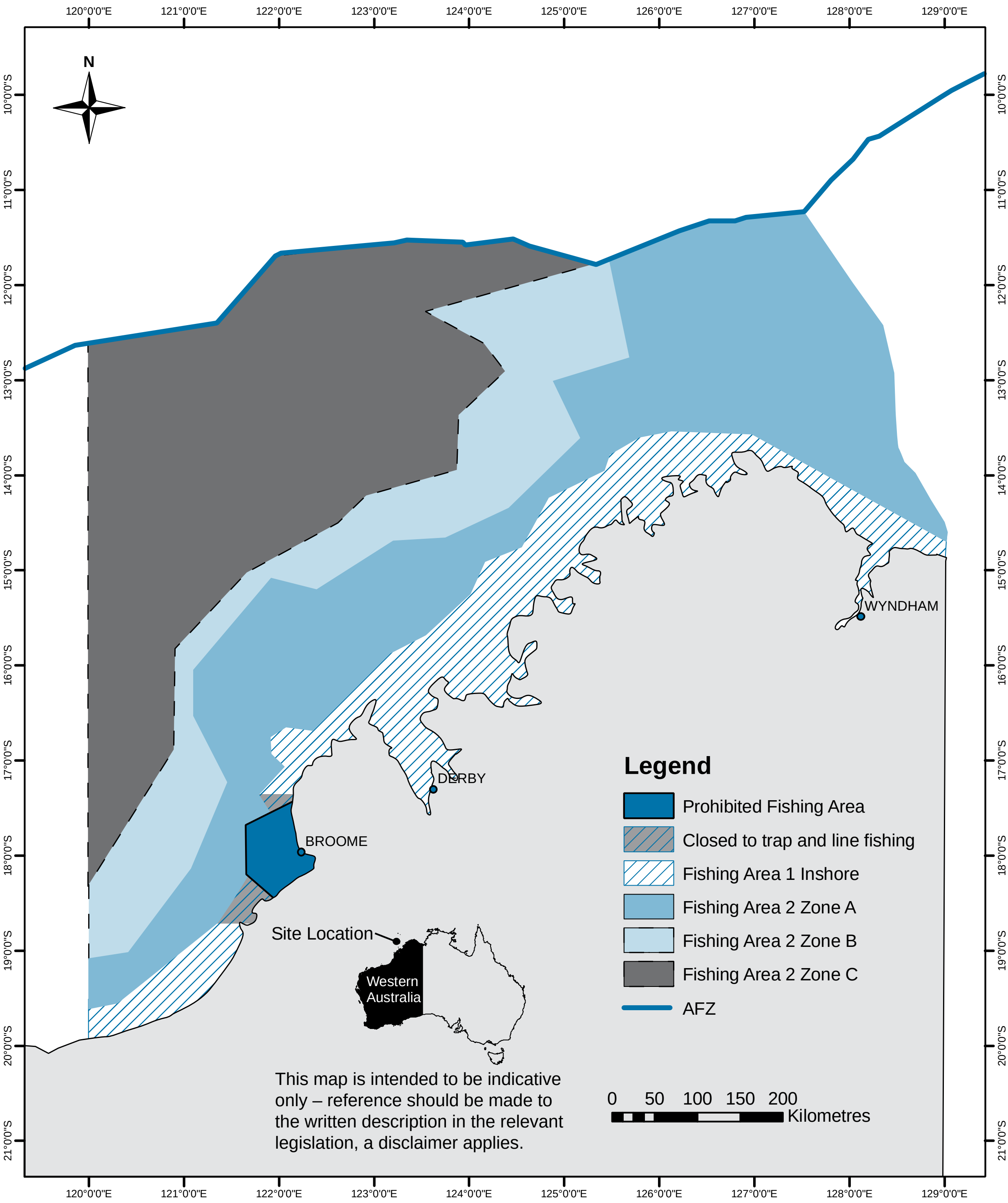
Species	NDSF annual catch (tonnes)					
	2006			2007		
	Zone A	Zone B	Zone C	Zone A	Zone B	Zone C
Goldband snapper (*Pristipomoides* spp.)	12.2	324.2		20.2	373.0	
Red emperor (*Lutjanus sebae*)	20.9	144.9		19.6	156.9	
Scarlet perch (*Lutjanus malabaricus*)	8.0	70.7		7.2	89.0	
Spangled emperor (*Lethrinus nebulosus*)	0.9	27.1		0.4	14.1	
Rankin cod (*Epinephelus multinotatus*)	5.6	34.6		8.2	32.3	
Other Cods/groupers (Serranidae)	7.2	81.3		7.7	73.1	
Other species	4.8	58.2		27.7	78.3	
Total demersal scalefish catch	**60**	**741**		**91**	**817**	

NORTHERN DEMERSAL SCALEFISH TABLE 3

Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

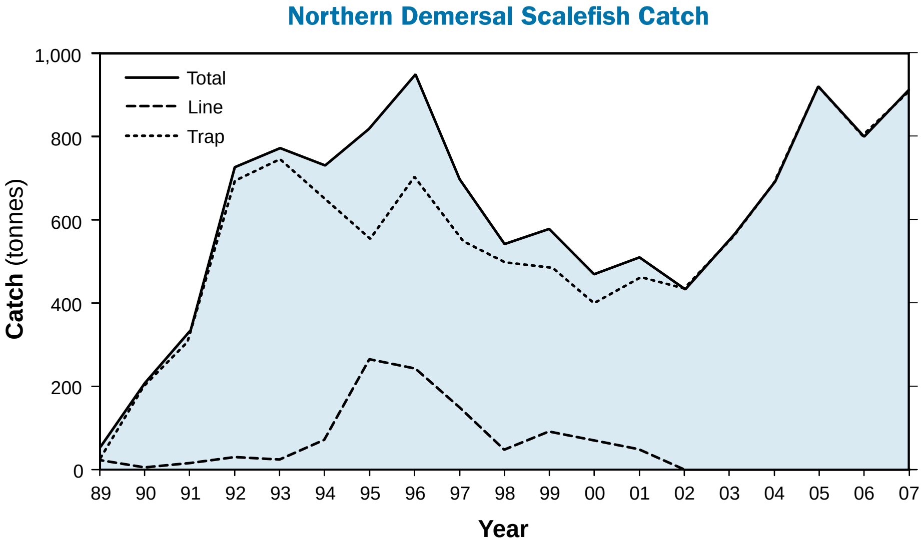
Year	Total allowable effort (days)	Line catch (t)	Line catch (days)	Trap catch (t)	Trap effort (days)	Total (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	0	0	434	900	434
2003	1,760	0	0	552	1,060	552
2004	1,760	0	0	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 standard fishing days, Zone B = 1,066 standard fishing days)						
2007	**1,144**	**0**	**0**	**908**	**1,235**	**908**

(Estimated Catch: Zone A = 91 t, Zone B = 817 t: Estimated Effort: Zone A = 158 standard fishing days, Zone B = 1,077 standard fishing days)



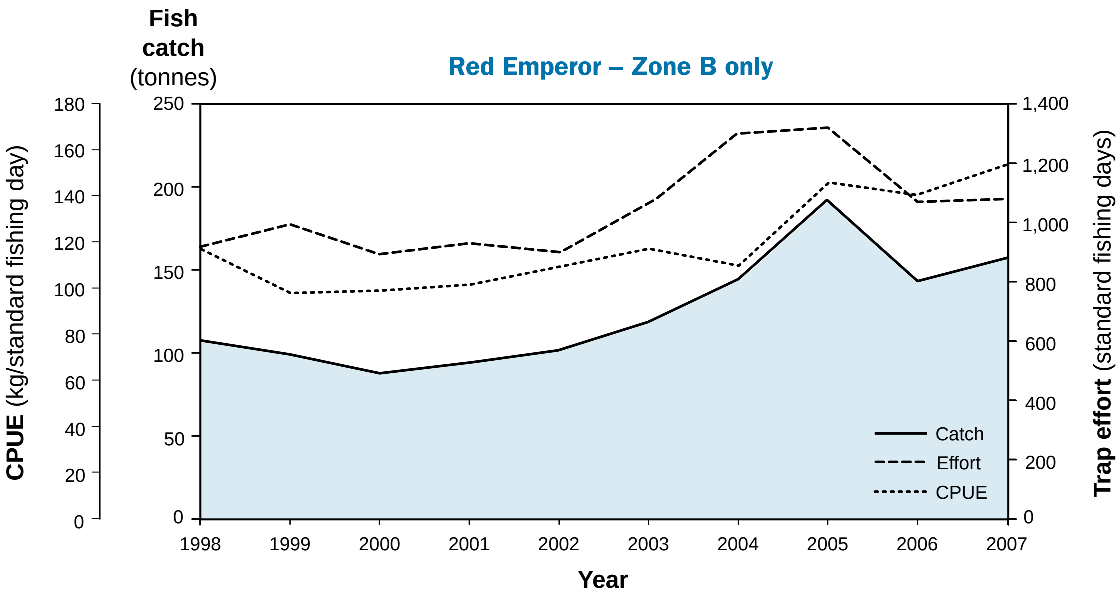
NORTHERN DEMERSAL SCALEFISH FIGURE 1

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



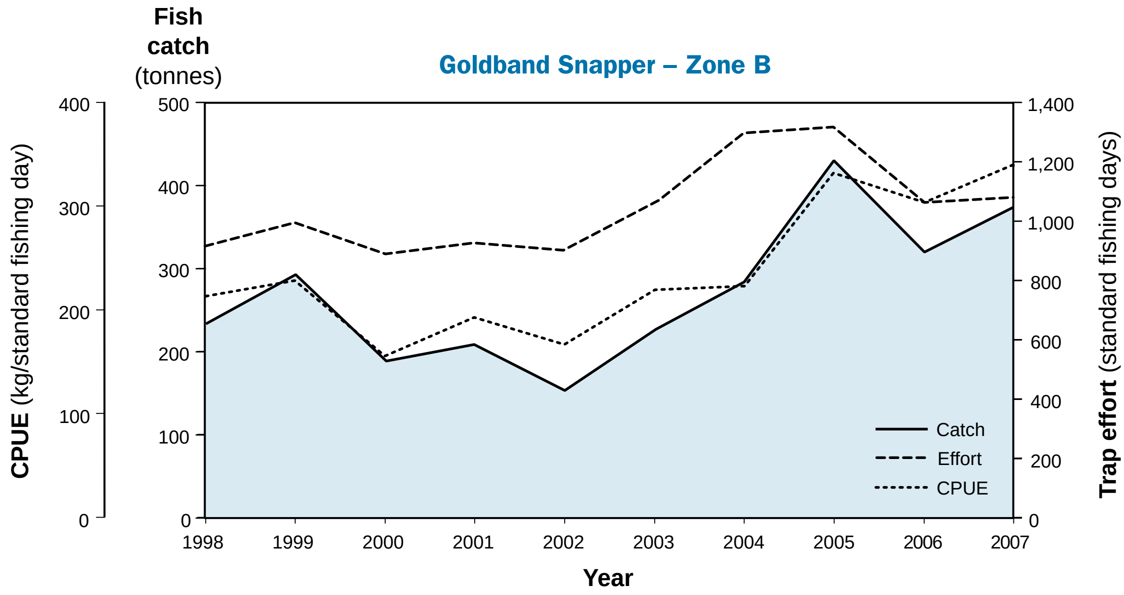
NORTHERN DEMERSAL SCALEFISH FIGURE 2

Catch levels of demersal finfish in the NDSF by line and trap, 1989 – 2007.



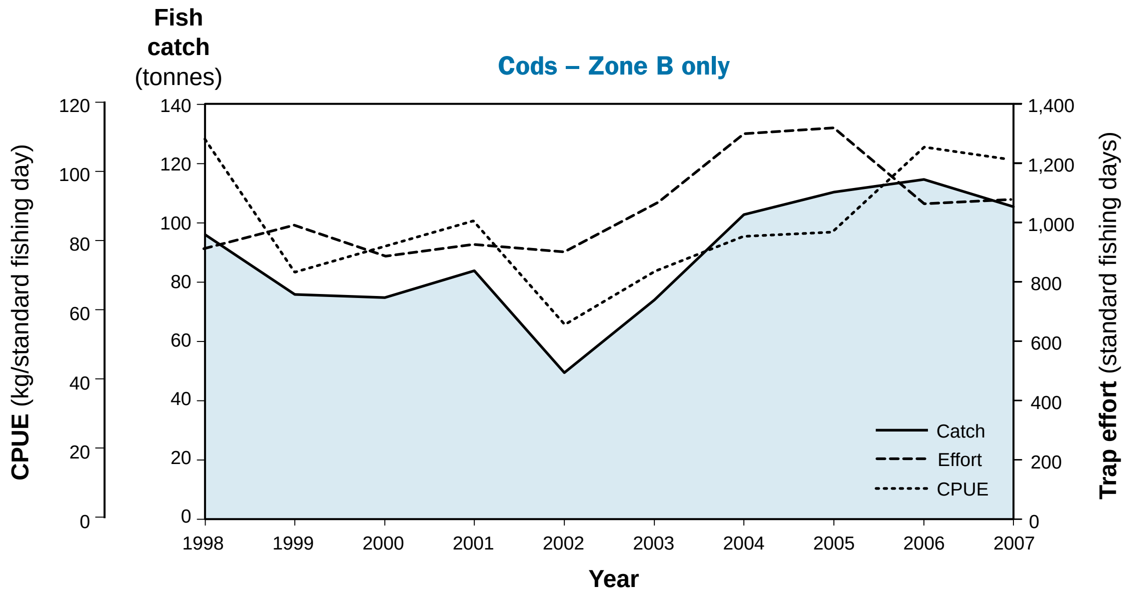
NORTHERN DEMERSAL SCALEFISH FIGURE 3

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998 – 2007.



NORTHERN DEMERSAL SCALEFISH FIGURE 4

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998 – 2007.



NORTHERN DEMERSAL SCALEFISH FIGURE 5

Catch, effort and catch per unit of effort of all cods in the NDSF by trap, 1998 – 2007.

Pilbara Demersal Finfish Fisheries Status Report

P. Stephenson

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 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 six 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

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

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 two 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 six 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.

Management arrangements

The fish trawl came into a formal management framework in 1998, with effort levels determined 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. The trap and trawl fisheries are both managed primarily by the use of input controls in the form of individual transferable effort (ITE) allocations monitored with a satellite-based vessel monitoring system (VMS).

Age-structured modelling of red emperor, Rankin cod and bluespot emperor is conducted every 3 to 4 years. 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 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. The catch range has since been increased in response to the increased stock size in the areas used by the trap fishers. There are 6 licences in the fishery, with the allocation used by three vessels in 2007.

The number of line boats allowed to fish in the Pilbara continues to be restricted by the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*. 9 vessels are exempted from the prohibition for the 5 months.

Comprehensive Ecologically Sustainable Development (ESD) assessments were submitted in 2004. 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 three years, which lapsed in December 2007. The Pilbara Fish Trawl Interim Managed Fishery is an approved Wildlife Trade Operation through several extensions until August 2009 provided a bycatch action plan is developed, there is an observer program, and progress continues in the development of strategies 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 logbooks, VMS pollings, and weighed catches from unload data. Otoliths are collected each year as part of the observer program for one of the following species – red emperor, Rankin cod, bluespotted 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 years.

The Department of Fisheries is looking at a collaborative project with CSIRO to update the work conducted by CSIRO in the 1980s on the North-West Shelf benthos abundance and scalefish species composition.

Retained Species

Commercial landings (season 2007): Trawl 1,704 tonnes
Trap 460 tonnes
Line 102 tonnes

Catches of the major species for 2007 are shown in Pilbara Table 1. The catches by different fishing methods for the years 1985 to 2007 are shown in Pilbara Table 2.

The trawl catch decreased in 2007 but still is within the target range. The decrease was due to lower catches of some of the smaller, short-lived species and also from technical difficulties associated with the implementation of selection grids, which are required to be used within their trawl gear. The major target species landed in 2007 (2006 catch in brackets) were bluespotted emperor 215 t (435 t), rosy threadfin bream 250 t (257 t), brownstripe snapper 112 t (153 t), crimson snapper 214 t (240 t), red emperor 75 t (92 t), saddletail snapper 55 t (62 t), goldband snapper 85 t (81 t), spangled emperor 13 t (27 t) and Rankin cod 26 t (46 t). The total retained by-product was 36 t (46 t) including shark (4 t), bugs, cuttlefish, and squid.

The trap fishery catch decreased slightly from 473 t in 2006 to 460 t in 2007. Major species taken by the trap fishery in 2007 (2006 figures in brackets) were bluespotted emperor 61 t (68 t), red emperor 111 t (85 t), Rankin cod 84 t (89 t), crimson snapper 56 t (47 t) spangled emperor 22 t (37 t) and goldband snapper 28 t (29 t). The trap catch was again outside the target catch range and the ESD catch-based performance indicator was triggered in 2007 for Rankin cod, crimson snapper, and red emperor, with 2007 catches more than 20% above the average for 2003 to 2006. It is unlikely that changed catchability or efficiency increases have caused these catch increases, with the most likely explanation being increased stock sizes. The acceptable catch range has been adjusted to 400 – 500 tonnes. There is no by-product in this fishery.

Demersal scalefish catches taken by line fishing in 2007 were similar to that in 2006. The catches in 2007 (2006 figures in brackets) were mainly goldband snapper 23 t (22 t), red emperor 1 t (5 t), saddletail snapper 8 t (6 t), spangled emperor 6 t (10 t) and Rankin cod 2 t (6 t). The Pilbara shark catch is reported in more detail 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 two recreational groups do not catch significant quantities of most species targeted by the commercial Pilbara fish trawl, trap and line fisheries. Due to the increasing populations in the Pilbara from mining developments, the overlap in catches may increase in the future.

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. For the trawl fishery, however, the effort from 1991 to 2007 is also recorded as the net bottom time (hours) taken from skippers' voluntary logbook data, validated by VMS data.

In the trawl fleet, there are the equivalent of four 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 – 2007 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 has not been permitted in either Area 3 or Area 6 since 1998, and trapping has not been permitted in Area 3 since 1998.

The number of trap days allocated, the number of days used and the percentage of the allocation used for the period 2000 – 2007 are shown in Pilbara Table 5. In 2007, the trap boats were allocated 5,867 trap units (days multiplied by number of traps), with 93% of the units used as calculated from the VMS. This number of units equates to 462 days allocated and 425 days fished, with an average of 12.7 traps per day.

In 2007, line fishers reported operating for 385 days, compared with 397 days in 2006. 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, both of which are reported on elsewhere on this volume.

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

There has been a decrease in the trawl catch rates of five species, including the long-lived species of spangled emperor, red emperor, and saddletail snapper. The decrease over the last 3 years for these 3 species has been 23%, 26% and 32% respectively. The opposite was observed in the trap fishery, with increased catch rates of Rankin cod and red emperor.

The total goldband snapper catch by the trawl, trap, and line sectors has decreased to 60% of that in 2005, due to line fishing effort being reduced.

Red Emperor: A comprehensive assessment using an age-structured model was conducted for red emperor in 2007. The model integrated catch and effort data, biological information and age-composition data, including ages from fish collected in 2006. The assessment indicated that the spawning biomass of this species as a whole was above the target level (Pilbara Figure 9) indicating healthy breeding stock levels.

The fishing mortality in 2007, determined from catch-curve analysis, using the data illustrated in Pilbara Figure 8, was variable with low levels in the east of the fishery and high levels in the west of the trawl fishery. The model estimate of the fishing mortality over the whole fishery was 0.17. This level is considerably higher than the natural mortality value of 0.12, indicating that reduced effort in the west of the fishery could provide a better economic return from the fishery by allowing more fish to grow larger before they are harvested.

Rankin Cod: A similar age-structured model for Rankin Cod indicated that their spawning biomass was above the target level of 40% of the 1990 level (Pilbara Figure 10) indicating adequate breeding stock levels. The fishing mortality over the whole fishery was 0.3 – more than twice the natural mortality estimate of 0.14.

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 2007 by synthesizing the available data in an age structured model.

Non-Retained Species

Bycatch species impact: Moderate

The bycatch in the trawl fishery continues to be monitored with an observer program coverage of 22% of the trawl shots. The trap and line fisheries have minimal bycatch.

Protected species interaction: Moderate

The trawl fishery has an incidental capture of bottlenosed 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' logbooks and reported 6-monthly to the Department of Environment and Water.

The reported catch of protected species in 2007 is shown in Table 6. The bycatch of dolphins and turtles is considerably lower in 2007 than in 2006, due to exclusion grids being used more effectively. 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.

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 2007, the dolphin mortality recorded was less than half the limit set and the turtle catch was well below 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 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 trawled (based on VMS pollings) is substantially less than this because much of the area is too rough to be trawled.

Social Effects

It is estimated that 22 fishers on 4 vessels were directly employed during 2006 in the Pilbara fish trawl fishery, and 8 fishers on 2 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 2007: $8.8 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 two 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 $5.8 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 $2.4 million (trap) and $0.5 million (line). The fish trawl fishery also has a small retained by-product valued at $0.1 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 in the last two years, due to the increased value of the Australian dollar.

Fishery Governance

Target catch range: **Trawl 2,000 – 2,800 tonnes**
Trap 400 – 500 tonnes
Line 50 – 115 tonnes

In the fish trawl fishery, the total catch was within the target catch range. In the trap fishery, the target catch range has been adjusted due to increased stock sizes with the current trap being in the centre of the catch range. The line catch is within the acceptable catch range.

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

The stock assessment models indicated the breeding stock levels are adequate for the indicator species red emperor and Rankin cod.

New management initiatives (2006/07)

In the Pilbara Trawl Interim Managed Fishery, the monitoring of catches of protected species and revised catch limits will need to be incorporated into future management arrangements. The interim management plan is due to expire in June 2009.

An interim management plan for the Pilbara line fishery will need to be developed in consultation with stakeholders in the next few years.

Given that the harvest rates are variable across different areas of the trawl fishery, it is proposed that effort levels will be reduced in the west of the fishery where they are currently highest.

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 catches as these closures and operations occur over a limited area.

PILBARA TABLE 1

Commercial catches (to the nearest tonne) and the percentages (to the nearest one%) of each major species taken by trawl, trap and line in the Pilbara in 2007.

Species		Trawl catch		Trap catch		Line catch		Total catch
		tonnes	%	tonnes	%	tonnes	%	tonnes
Bluespotted emperor	*Lethrinus* sp.	215	78%	61	22%	–	–	276
Crimson snapper	*Lutjanus erythropterus*	214	77%	56	20%	8	3%	278
Rosy threadfin bream	*Nemipterus furcosus*	250	100%	–	–	–	–	250
Brownstripe emperor	*Lutjanus vitta*	112	92%	10	8%	–	–	122
Goldband snapper	*Pristipomoides multidens*	85	62%	28	21%	23	17%	136
Red emperor	*Lutjanus sebae*	75	40%	111	60%	1	–	187
Saddletail snapper	*Lutjanus malabaricus*	55	72%	13	17%	8	11%	76
Spangled emperor	*Lethrinus nebulosus*	13	33%	22	52%	6	15%	42
Frypan snapper	*Argyrops spinifer*	70	99%	1	1%	–	–	71
Rankin cod	*Epinephelus multinotatus*	26	23%	84	75%	2	2%	112
Other demersal scalefish		588	82%	74	10%	54	8%	716
All demersal scalefish		**1,704**	**75%**	**460**	**20%**	**102**	**5%**	**2,266**

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
2007	**102**	**460**	**1,704**	**2,266**	**36**

* By-product in 2007 consists of shark (4 tonne), cuttlefish, rays, bugs, and tropical lobster.

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' logbook 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
2007	**385**	**425**	**841**	**14,197**

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. In recent years, the percentage of time used exceeded the allocation due to the licensing year changing to the financial year in 2005.

		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%
2007	**time allocation**	**9,596**	**3,797**	**0**	**3,528**	**4,627**	**21,548**
TRAWL	**time used**	**6,877**	**4,103**	**0**	**4,197**	**4,516**	**19,692**
	% of time used	**72%**	**108%**	–	**119%**	**98%**	**91%**

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.

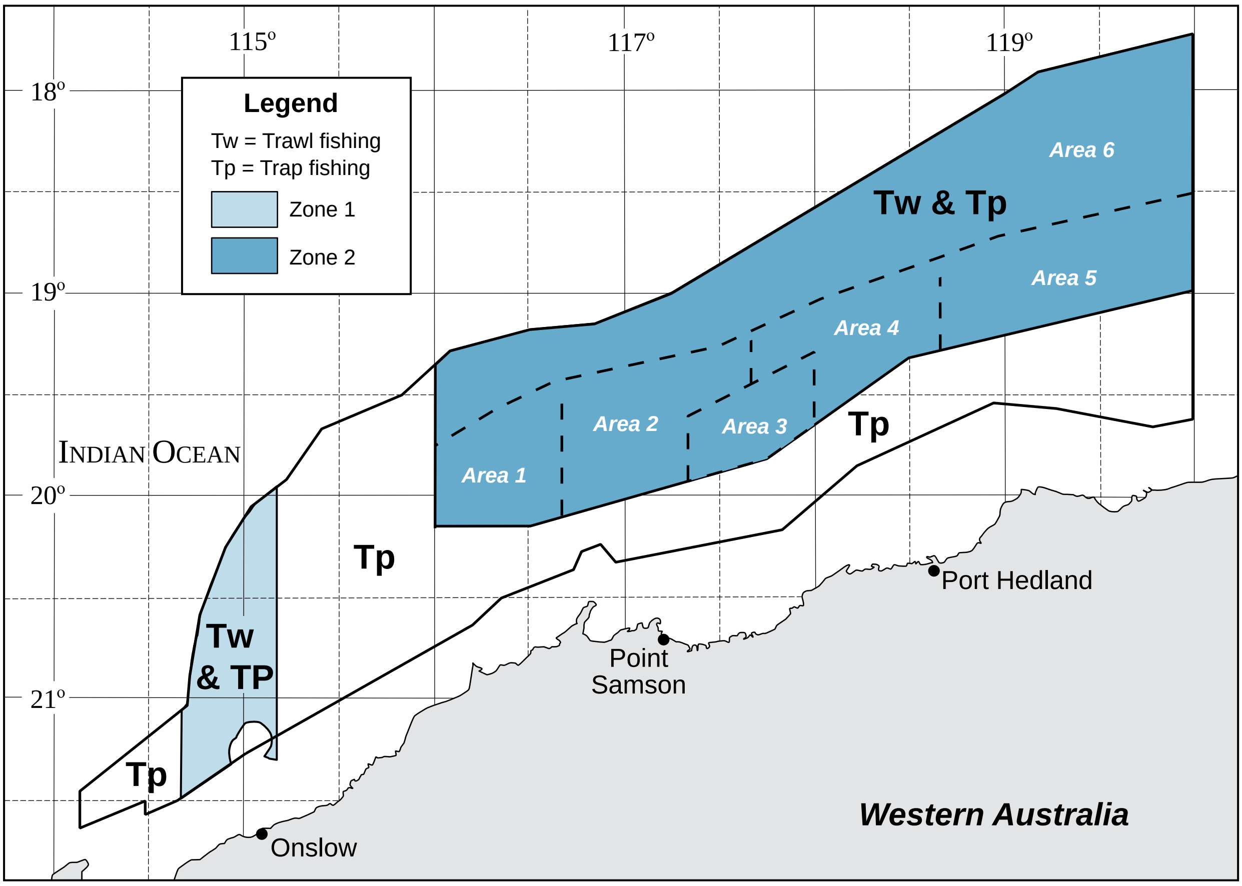
2000	time allocation	524
TRAP	time used	507
	% of time used	97%
2001	time allocation	420
TRAP	time used	414
	% of time used	99%
2002	time allocation	385
TRAP	time used	382
	% of time used	99%
2003	time allocation	399
TRAP	time used	389
	% of time used	98%
2004	time allocation	425
TRAP	time used	419
	% 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%
2007	**time allocation**	**462**
TRAP	**time used**	**425**
	% of time used	**92%**

PILBARA TABLE 6

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2007.

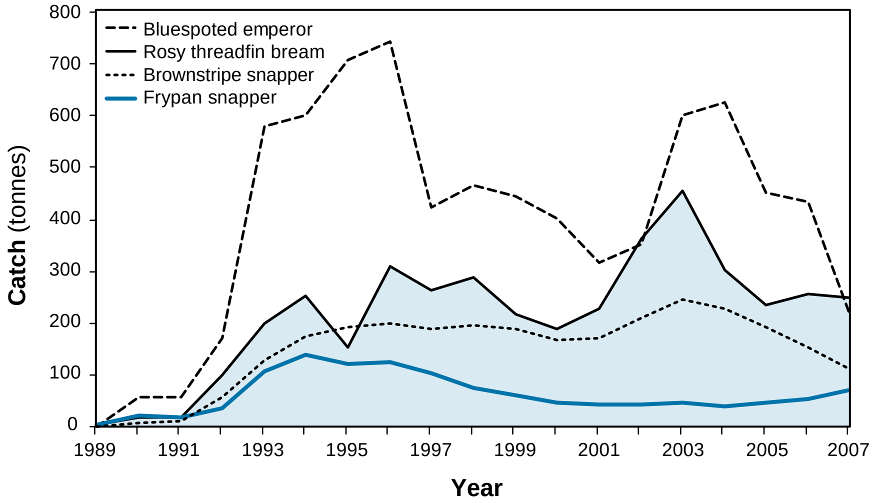
	Number Alive	Number Dead*	Total Reported
Bottlenosed dolphins	3	20	23
Pipefish	20	112	132
Sawfish, green	17	4	21
Sawfish, narrow	28	5	33
Seahorses	2	2	4
Sea-snakes	11	63	74
Turtles, green	3	0	3
Turtles, loggerhead	0	0	0
Turtles, olive ridley	0	0	0

*Where the condition was not reported, the animal was considered as dead.



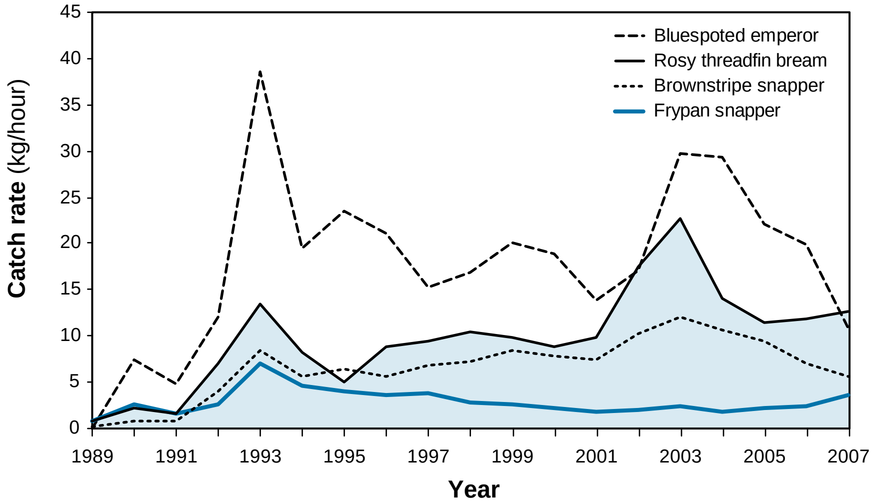
PILBARA FIGURE 1

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.



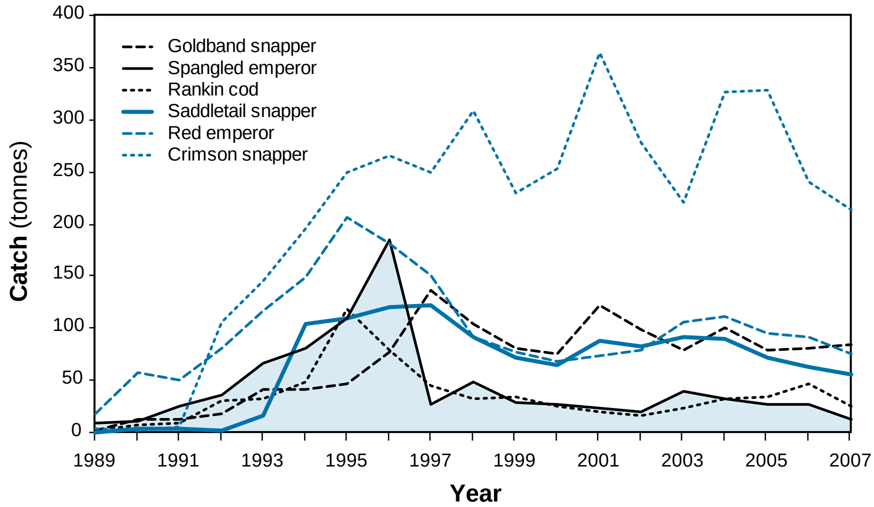
PILBARA FIGURE 2

Catch of four short-lived species in the Pilbara Trawl Fishery.



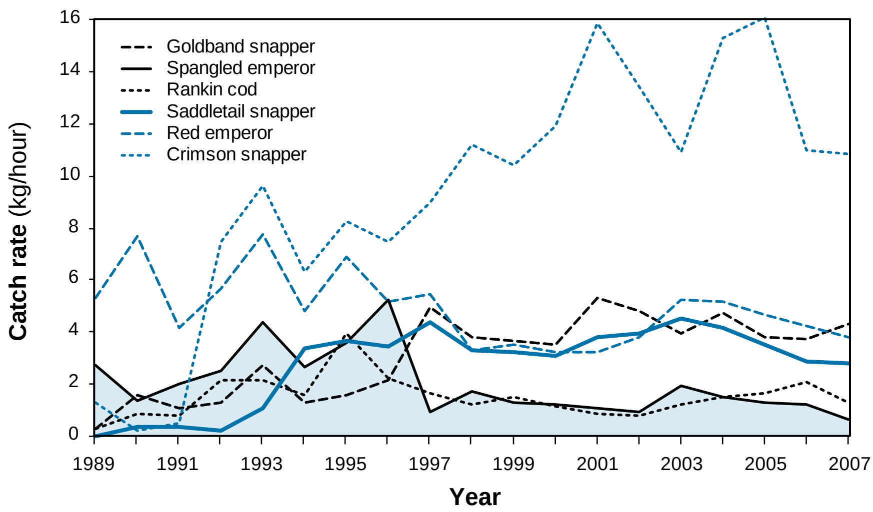
PILBARA FIGURE 3

Catch rates of four short-lived species in the Pilbara Trawl Fishery based on nominal effort



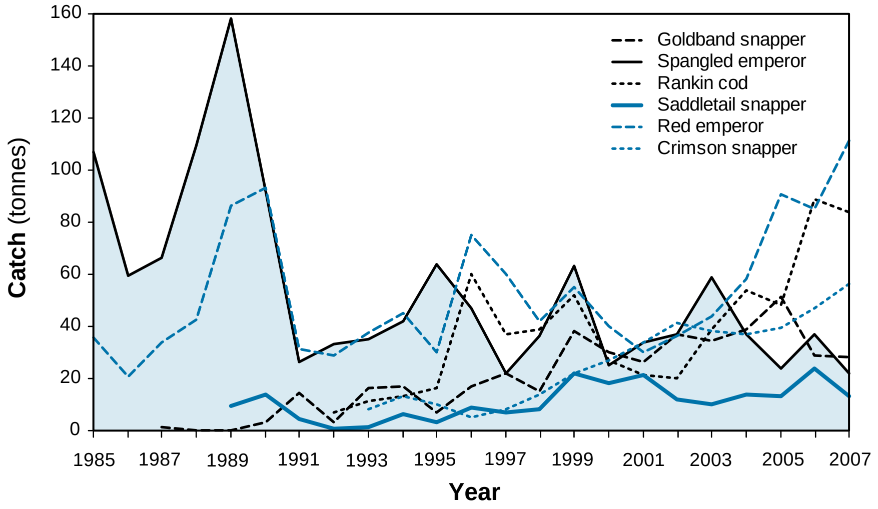
PILBARA FIGURE 4

Catch of six long-lived species in the Pilbara Trawl Fishery.



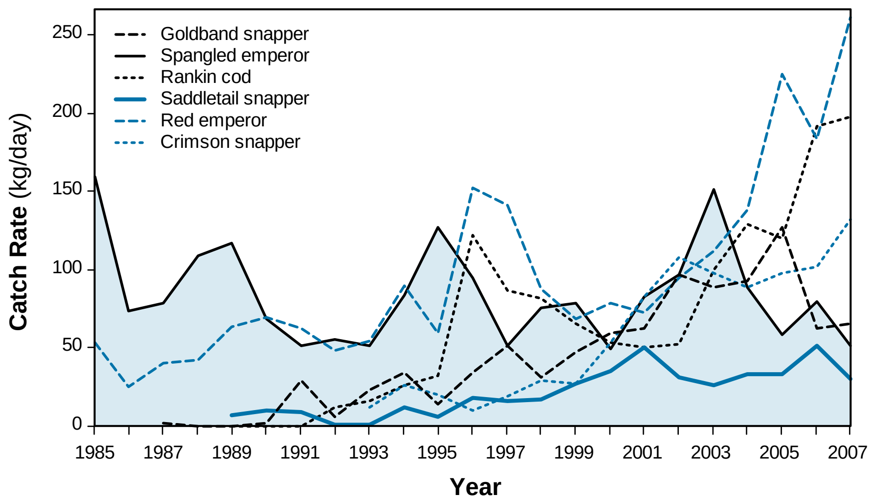
PILBARA FIGURE 5

Catch rates of six long-lived species in the Pilbara Trawl Fishery based on nominal effort.



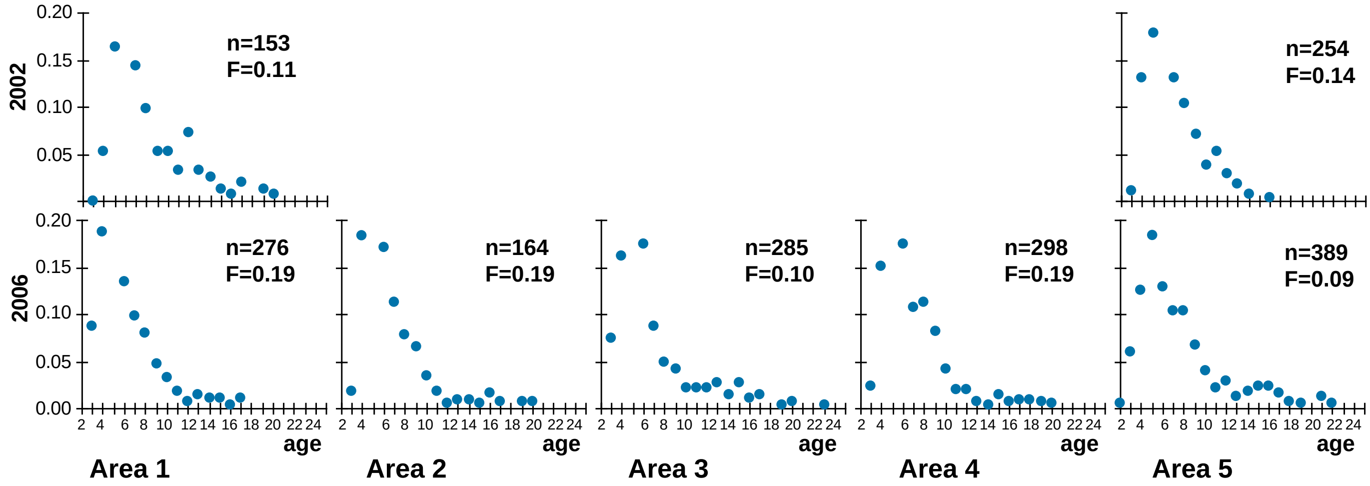
PILBARA FIGURE 6

Catch of six long-lived species in the Pilbara Trap Fishery.



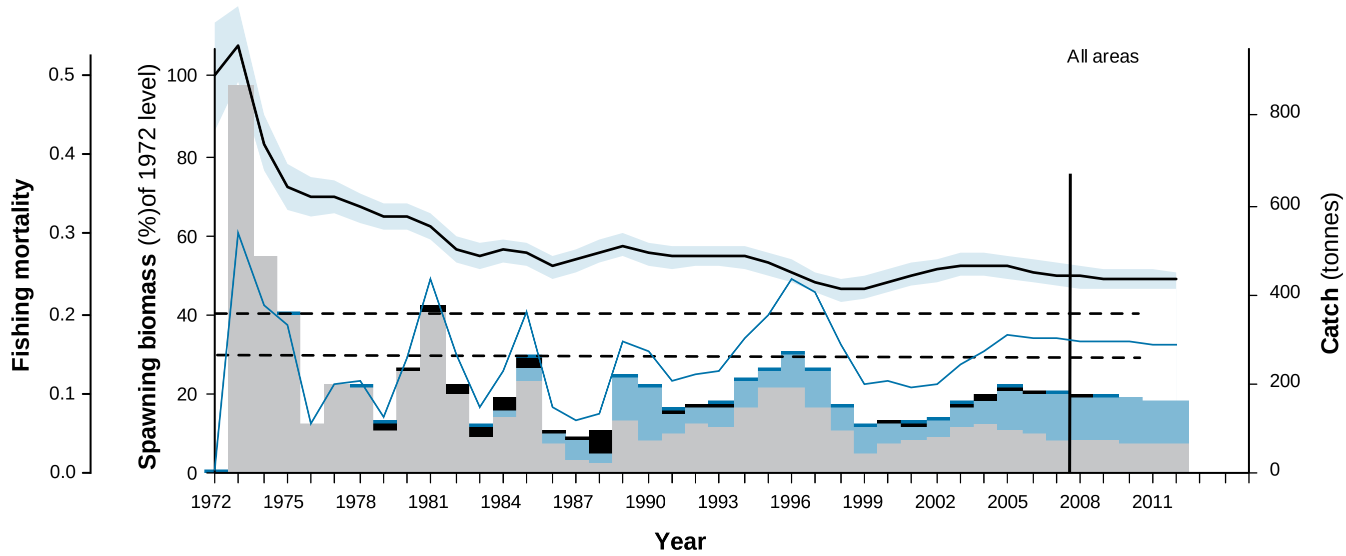
PILBARA FIGURE 7

Catch rates of six long-lived species in the Pilbara Trap Fishery based on nominal effort.



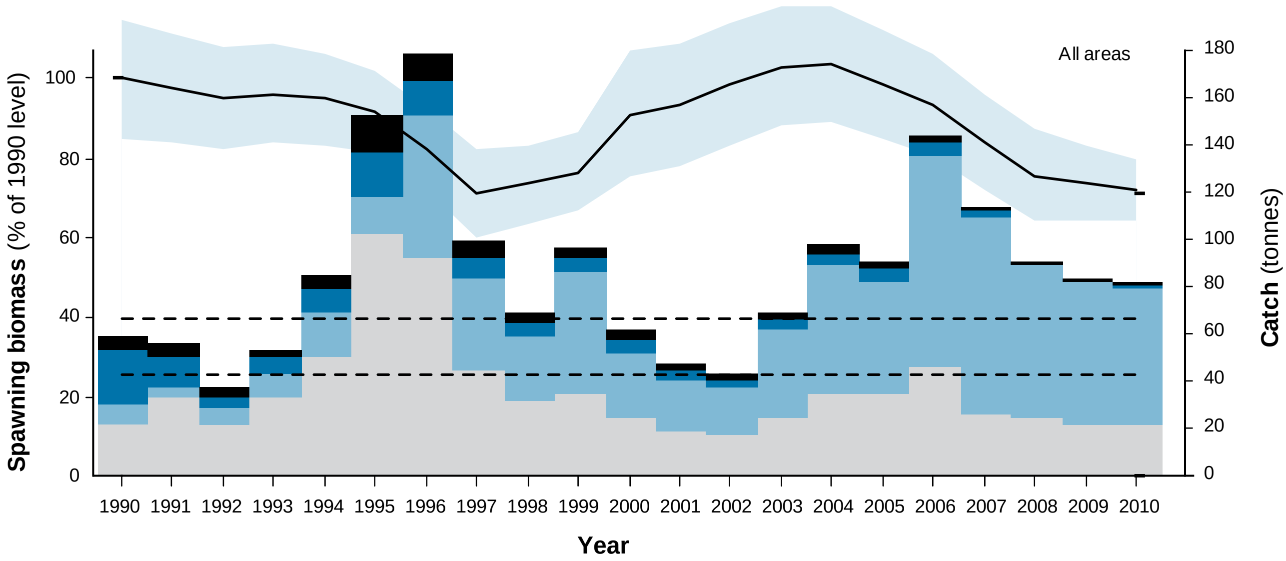
PILBARA FIGURE 8

Age-composition of red emperor derived form sectioned otoliths from fish collected in the Pilbara Trawl Fishery in 2002 and 2006. The sample sizes (N) and the fishing mortality (F), determined from classical catch curve analysis, are shown on each graph.



PILBARA FIGURE 9

Results of the red emperor assessment showing the catches in the column graphs (trawl: , trap: , line: , and recreational:). The spawning biomass is shown by the black line (with 95% confidence intervals) with the target and threshold levels shown as the black dashed lines. The fishing mortality is shown by the blue line.



PILBARA FIGURE 10

Results of the Rankin cod assessment showing the catches in the column graphs (trawl: ▭, trap: ▭, line:▬, and recreational: ▬). The spawning biomass is shown by the black line (with 95% confidence intervals) with the target and threshold levels shown as the black dashed.

Spangled emperor. Photo: Mako Mackie

Mackerel Managed Fishery Status Report

M. Mackie and P. Lewis
Management input from M. Coloper

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
Regional Recreational Fishing Advisory Committees

Boundaries

Catches are reported for three areas: Kimberley (121º E to WA/ NT border), Pilbara (114º E to 121º E), and Gascoyne/ West Coast (Cape Leeuwin to 114º E). The managed fishery is comprised of Area 1 (Kimberley), Area 2 (Pilbara) and Area 3 (Gascoyne and West Coast).

Management arrangements

The fishery is subject to an interim management plan, which commenced in August 2004, with fishing commencing under the plan in 2005. In 2006, the Minister amended the plan to allow further application for entry into the fishery and also introduced a Total Allowable Commercial Catch (TACC) for each area of the fishery at:

	Spanish and other mackerel	Grey mackerel
Area 1:	205 t	60 t
Area 2:	126 t	60 t
Area 3:	79 t	60 t

The plan includes limitations on the number of permits to fish in the Fishery and the type of gear that can be used, as well as a closed season. Seasonal closures in the fishery are implemented by way of fishing prohibitions. Commercial fishing for mackerel was prohibited between 16 December 2006 and 30 May 2007 in the Kimberley area, 13 November 2006 and 31 March 2007 in the Pilbara area, and 1 October 2006 and 28 February 2007 in the Gascoyne – West Coast area.

During 2007 the mackerel fishing season was extended until 20 December 2007 in all areas of the fishery.

Permit holders may only fish for mackerel by trolling or handline. There are currently 62 permits in the fishery with 22, 19 and 21 in Zones 1, 2 and 3 (respectively). Of these, 38 permits are active on 4, 7 and 6 boats operating within Zones 1, 2 and 3 (respectively).

A comprehensive Ecological Sustainable Development (ESD) assessment of this fishery determined that levels of Spanish mackerel breeding stock should be used as an annual performance measure for the fishery. The annual assessment of performance is provided within the boxed text.

Research summary

Two mackerel-related Fisheries Research and Development Corporation (FRDC)-funded research projects were completed in 2002. Both projects ran for three 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 provided descriptions of the biology, spatial structure and status of Spanish mackerel stocks in Western Australian waters, and served as a basis for management arrangements to control future catches from the fishery. This status report for the mackerel fishery is based on analyses of Spanish mackerel catch and effort during 2007.

Retained Species

Commercial landings (season 2007):
Spanish mackerel 326 tonnes
Grey mackerel 11 tonnes
Other mackerel < 1 tonne

Spanish mackerel (*Scomberomorus commerson*) is the main target species and may comprise more than 90% of the catch. Grey or broad-barred mackerel (*S. semifasciatus*) is the secondary target, particularly in the Gascoyne and West Coast areas where it is sometimes captured in large numbers. Other species caught by the trolling operation for Spanish mackerel include spotted mackerel (*S. munroi*) and shark mackerel (*Grammatorcynus bicarinatus*), wahoo (*Acanthocybium solandri*), cobia (*Rachycentron canadum*), tunas, trevally, smaller sharks and the occasional reef fish such as spangled emperor and coral trout.

The reported catch of 325.5 t of Spanish mackerel in 2007 comprised 216.6 t from the Kimberley area, 66.5 t from the Pilbara area, and 42.4 t from the Gascoyne/West Coast area (Spanish Mackerel Figure 1 and Table 1). The catch of other mackerel species in 2007 was 12.1 t, including 11.3 t of grey mackerel.

Historic trends in commercial catches were detailed in the *State of the Fisheries Report 2000/01.* Overall catches of Spanish mackerel have increased through time, particularly in the Kimberley and Pilbara areas.

In 2007 the reported catch of Spanish mackerel in the Kimberley and Pilbara areas was 216.6 and 66.5 tonnes, respectively. Combined catches of Spanish mackerel in the Gascoyne and West Coast areas were similar to those reported in 2006, although catches increased in the Gascoyne and decreased in the West Coast during 2007 (40.0 and 2.4 t in each area, respectively).

The catches of other species of mackerel is comprised mainly (up to 90%) of grey mackerel, particularly in the Gascoyne area where grey mackerel are exported to overseas markets, and so separate reporting of grey mackerel in the CAES since 2000 has improved the reliability of catch data. In 2007 a review of log book records led to further improvements and a significant shift in data from other mackerel to Spanish mackerel. This has resulted in a low reported catch of other mackerel in 2007 (Spanish Mackerel Table 1). Catches of grey mackerel during 2007 were also low, reflecting a decline in all areas, in particular the Pilbara area.

Recreational catch

Gascoyne /West coast 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 2001/02*. 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. 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.

Fishing effort/access level

The commercial fishing effort for Spanish mackerel recorded in the CAES database for the 2007 season was:
(Effort in previous years)

			(2006)	(2005)	(2004)
Kimberley area	4 boats	351 days	(303)	(401)	(612)
Pilbara area	7 boats	236 days	(160)	(362)	(475)
Gascoyne/West Coast	6 boats	189 days	(214)	(341)	(1,275)

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 logbook introduced in 2006 under the interim management plan is providing more detailed and reliable data on effort (and catch) in the mackerel fishery.

Following a substantial decrease in fishing effort in all areas during 2006 as a consequence of the new management arrangements, the overall number of days fished rose by 13 % in 2007. This reflects a rise in the Kimberley area of 14 %, with 351 fishing days fished by four boats, and a more substantial rise of 32% by 7 boats in the Pilbara. Although the Gascoyne/West Coast area had a drop in fishing effort of 13% in 2007, when examined separately the effort in the Gascoyne rose by 21 % whereas the fishing effort in the West Coast area – the southern limit of the mackerel fishery – dropped considerably.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

An initial assessment of Spanish mackerel stocks (which are used as the indicator species 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 2001–2002*. Since this time catches of Spanish mackerel have provided a performance measure for the fishery, as described below. This data has historically been based on the catch rates of fishers known to target Spanish mackerel, since prior to formal management of the fishery the data for many fishers did not provide an accurate reflection of mackerel fishing.

In the Kimberley area estimated catch rates have increased steadily since 1987 steadied during 2007 at 307 kg/day (Spanish mackerel Figure 2). Fishers continue to report high abundance of Spanish mackerel in this area. Catch rates in the Pilbara area increased significantly during 2007 following two consecutive years of decline. In 2007 the estimated catch rate in this area was 308 kg/day. 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 2007 the estimated catch rate in this area continued to increase, with 175 kg/day captured by fishers.

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. The total catch for 2007 was within the target catch range.

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 2007. 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 six 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 2007: Spanish mackerel $3.0 million; Other mackerel $68,000

Ex-vessel prices obtained by fishers during 2007 varied from $8-11.5 per kg for Spanish mackerel, depending on how the product was landed, and from $3-6 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 include catches of all mackerel species except grey mackerel. This is consistent with TACC arrangements in the interim management plan. In 2007 the total catch of 325.4 t is within the acceptable catch range. The reported catches were above the acceptable catch range for the Kimberley area (110 – 205 t). This is currently being investigated. In contrast, reported catches were below the acceptable catch range in the Pilbara (80 – 126 t) and Gascoyne/West Coast (56 – 79 t) area. The declines in recent years are considered to be due to a combination of management changes, as well as environmental conditions. In addition, catches in both areas increased by approximately 12% from 2006 levels.

Current fishing level: Acceptable

Fishing effort throughout the fishery appears to have stabilised in 2007 following declines due to management changes. A significant decline in the number of boats and days fished in the West Coast area during 2007 reflects the limited presence of tropical mackerel in southern waters as a consequence of environmental conditions.

New management initiatives (2007/08)

In 2008 a number of changes to the interim management plan will be considered including abolishing area closures, changes to rules relating to onboard processing of fish and varying the unit values to take account of the new entrants to the fishery.

It is anticipated that consideration of the further applications for entry into the fishery will be concluded in 2008.

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 and adult movement due to environmental fluctuations. Increasing activity by the petroleum industry may also be impacting catches by mackerel fishers in some parts of the Pilbara area due to decreased access to fishing grounds.

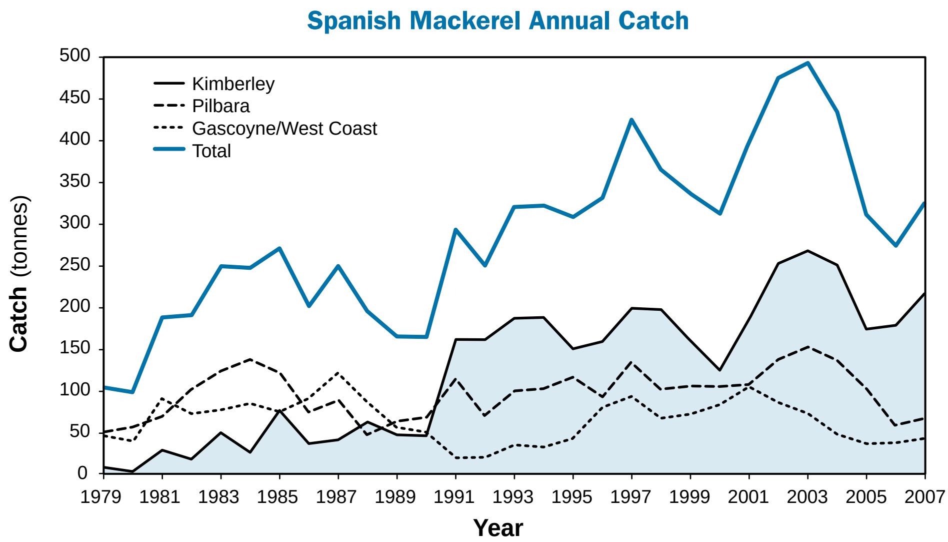
SPANISH MACKEREL TABLE 1

Catches of Spanish, grey and other mackerel, 1980 – 2007. '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 logbook data.

Year	Spanish mackerel (tonnes)				Grey mackerel (tonnes)	Other mackerel (tonnes)
	Kimberley[1]	Pilbara	Gascoyne/WC	Total		
1980	2.8	56.0	39.1	97.9		10.8
1981	28.3	68.7	90.2	187.2		2.5
1982	17.6	100.7	71.8	190.1		19.9
1983	49.5	123.0	76.3	248.7		3.6
1984	25.5	136.9	84.6	247.0		1.8
1985	75.9	120.4	74.0	270.3		19.4
1986	36.4	73.5	85.2	195.1		43.5
1987	40.6	87.8	120.9	249.3		23.9
1988	62.0	47.1	86.4	195.5		89.3
1989	46.6	62.7	55.5	164.8		104.5
1990	45.4	68.0	50.4	163.8		166.5
1991	160.7	116.8	19.1	296.7		116.2
1992	160.6	69.3	19.3	249.2		79.5
1993	186.1	99.3	34.5	319.9		75.0
1994	187.1	101.8	31.8	320.7		87.9
1995	149.7	115.8	42.8	307.9		56.1
1996	156.4	90.3	79.5	326.2		92.4
1997	198.2	133.2	92.5	423.9		120.7
1998	196.7	101.2	66.4	364.3		65.8
1999	159.5	104.7	71.4	335.6		72.7
2000	123.8	104.5	83.0	311.3	21.6	53.0
2001	179.3	107.0	103.5	389.9	14.7	41.4
2002	245.8	136.8	85.5	467.9	24.2	32.7
2003	267.0	152.0	72.7	491.8	22.5	19.4
2004	249.9	135.5	47.5	433.0	23.3	9.4
2005	173.4	101.0	35.9	310.4	12.4	23.1
2006	177.9	57.9	37.1	272.9	17.4	1.3[2]
2007	**216.6**	**66.5**	**42.4**	**325.5**	**11.3**	**0.7**

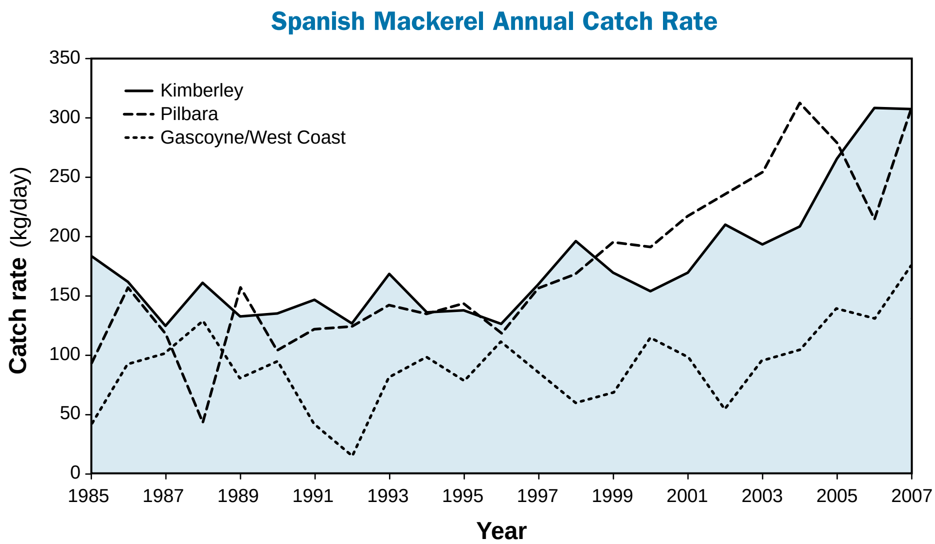
1 Catches by Taiwanese gillnet fishers of approximately 5 – 90 t per year (mean approximately 50 t) between 1980 and 1986 (Stevens and Davenport 1991) are not included in these estimates. These gillnet catches include data east to longitude 131° E and therefore are not directly comparable with Kimberley catches.

2 New reporting arrangements indicate that catch previously recorded as other mackerel is actually Spanish mackerel. Catches in 2006 reflect this change in reporting.



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 and R. Gould

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. 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 two 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 129 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 able to operate in each fishery. A comprehensive package of management arrangements for the northern shark fisheries was agreed with the Northern Shark Industry Association and 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 is still subject to discussion with 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 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 three 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 a vessel monitoring system (VMS) and daily logbooks.

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 proposed JANSF management arrangements are still under discussion.

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 three-year research project funded by the Fisheries Research and Development Corporation 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 that 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, Catch and Effort Statistics (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 logbooks.

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[1]): Northern Shark Fisheries: 189 tonnes Other Fisheries: 31 tonnes

As there were fewer than five active licenses in 2006/07, the most recent season's catch cannot be reported due to confidentiality arrangements. In 2005/06, the northern shark fisheries' reported catch declined to its lowest level since 1999/2000 as a consequence of the introduction of new management arrangements. The fisheries' combined shark catch[2] was 189 tonnes – 85% lower than its record maximum of 1,294 tonnes in 2004/05 (Northern Shark Figure 1). Longlines have historically accounted for the majority (84% in 2005/06) of this catch, which was mainly comprised of 'blacktip' (40%), pigeye (23%), hammerhead (14%) spottail (9%) and tiger (6%) sharks (Northern Shark Table 1).

The fisheries landed a negligible quantity of sandbar shark (< 1 tonnes) in 2005/06. The only reported scalefish catch by the northern shark fisheries during 2005/06 was 270 kg of black pomfret (*Parastromateus niger*). Due to the reduction in the number of active licenses, the 2006/07 catches of all species were significantly lower than pre-2005/06 levels.

Sharks are also incidentally caught by other commercial operators in waters off the north coast. During 2006/07, vessels licensed in other managed fisheries operating in the area between North West Cape and the Western Australia/Northern Territory border reported catches of sharks and rays totaling 3 t, which was 21 t less than the previous year. There was a negligible reported catch (<0.1 t) of sharks and rays by 'wetline' methods (i.e. taken by vessels not operating in managed fisheries) in 2006/07. 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 and the commercial protection of sharks and rays has reduced retention rates in other non-target fisheries.

The total shark catch by all State-managed sectors in the north coast bioregion during 2006/07 was therefore less than previous years. It is expected that shark catches will remain at these low levels or be further reduced in the future.

Recreational catch: Not assessed

Fishing effort/access level

There were two active licenses in the northern shark fisheries during 2006/07. 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) is 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 was previously standardised in terms of hook days, using comparative longline and gillnet catch and 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).

Due to the reduction in active licenses to less than five in 2006/07, details of effort (and catches) cannot be reported due to confidentiality arrangements. However, total fishing effort in the northern shark fisheries during 2006/07 was significantly lower than pre-2005/06 levels.

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 a demographic model and time-series of Catch Per Unit Effort (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, unreported catches in domestic fisheries and an apparent change in the species composition of blacktip catches. Given these issues, the maximum sustainable yield (of at least 2,000 tonnes 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

1 These are the most current data available for the fisheries.

2 All total shark catches given in this report include rays, unless specified otherwise.

of stocks taken by the northern shark fisheries will necessarily rely on analysis of commercial fishery CPUE data and limited fishery-independent survey 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. There is some discarded bycatch of unsaleable species of sharks, rays and scalefish, which was rated as a low to negligible risk by the Ecologically Sustainable Development (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 ESD 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 are anticipated 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 any 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.

The risk to all protected species posed by these fisheries has been significantly reduced due to the reduction of active licenses from 9 in 2004/05 to 2 in 2006/07.

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 with only two vessels fishing for only part of each year, the fishery represents a part-time source of 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 2006/07: **Not reported**

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 levels of effort were again significantly reduced in 2006/07 and catches of all species were again significantly below their pre-2005/06 levels. The catch of sandbar sharks was much less than the upper target limit of 20 tonnes.

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, catches of sandbar sharks have been significantly less than the 20 t sustainable yield estimated from the demographic analysis model since 2005/06 and should therefore allow 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 subject to discussion between Commonwealth and State governments. It is anticipated that these issues will be resolved in 2008/09.

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 Demersal Gillnet and Longline Fisheries status report elsewhere in this volume).

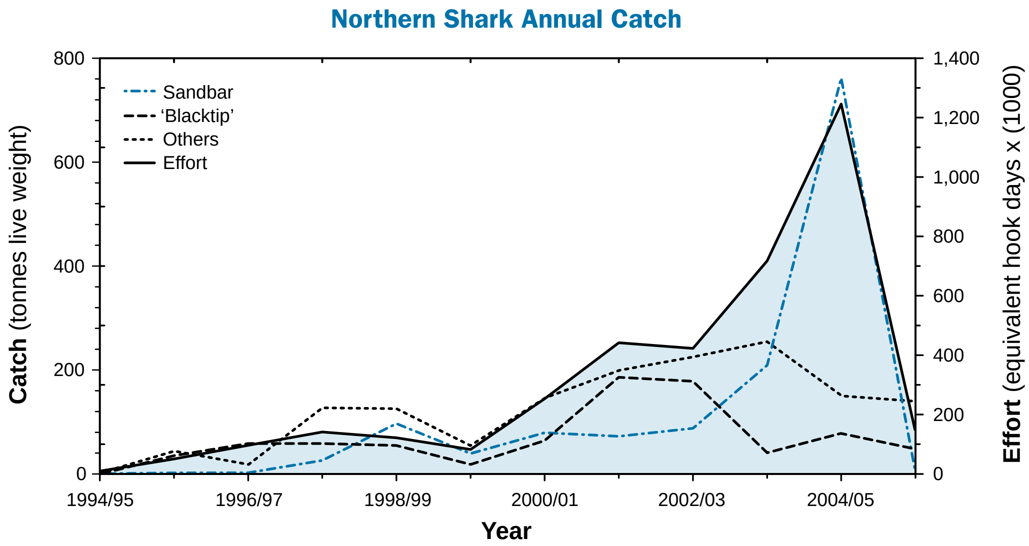
Possibly most importantly though, there has apparently been a rapid escalation of illegal foreign shark fishing in northern Australian waters, which has significant potential for impacting all of the stocks taken in these fisheries. These circumstances mean that the abundance of the stocks harvested by the two 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. Data for 2006/07 are not reported due to confidentiality of records from fewer than five vessels.

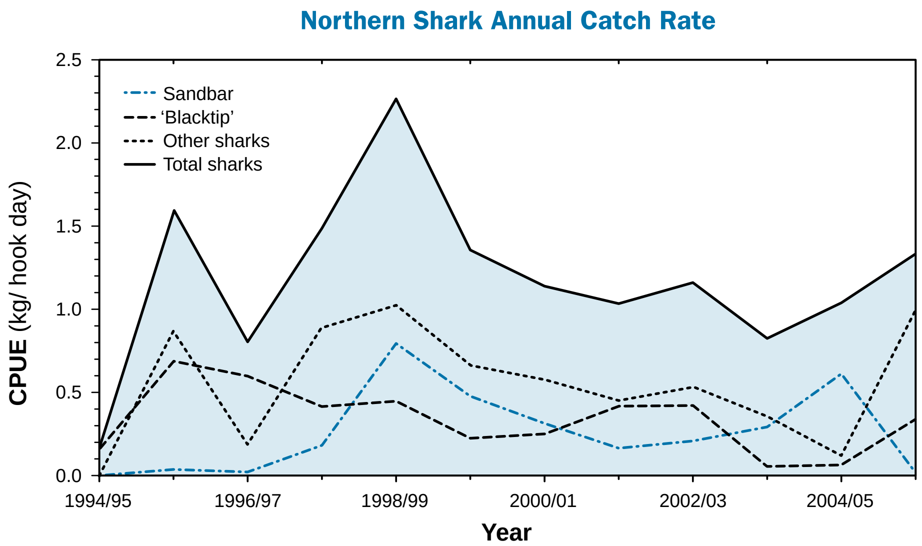
Species		Catch (tonnes)				
		2001/02	2002/03	2003/04	2004/05	2005/06
Sandbar shark	*Carcharhinus plumbeus*	72	88	209	762	<1
Hammerhead shark	Sphyrnidae	43	45	33	114	27
Pigeye shark	*Carcharhinus amboinensis*	25	32	43	83	43
Tiger shark	*Galeocerdo cuvier*	37	43	51	81	12
Blacktip shark	*Carcharhinus* 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**

WEST COAST BIOREGION
GASCOYNE COAST BIOREGION
NORTH COAST BIOREGION
SOUTH COAST BIOREGION
NORTHERN INLAND BIOREGION
SOUTHERN INLAND BIOREGION
STATE-WIDE
REFERENCES AND APPENDICES



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. Data for 2006/07 are not reported due to confidentiality of records from fewer than five vessels.



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. Data for 2006/07 are not reported due to confidentiality of records from fewer than five vessels.

WEST COAST BIOREGION
GASCOYNE COAST BIOREGION
NORTH COAST BIOREGION
SOUTH COAST BIOREGION
NORTHERN INLAND BIOREGION
SOUTHERN INLAND BIOREGION
STATE-WIDE
REFERENCES AND APPENDICES

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 six to eight 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 three 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 allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32) and 350 hatchery quota units allocated amongst 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 2007, wild stock quota units were valued at 1,200 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, recruitment and length-frequency sampling, and population surveys 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 Fisheries Research and Development Corporation project entitled ‘Management of bio-eroding sponges (*Cliona* sp.) in wild stocks of *Pinctada maxima* in Western Australia’ began in 2005 and is due for completion in 2008. The overall objective is to determine whether the incidence of *Cliona* sp. is increasing in wild stocks over time.

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 2007): 600,658 oysters

In 2007, the number of wild-caught pearl oysters was 600,658 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 603,400 oysters (including a 2,000 special quota for tourism purposes), thus a total of 99.6% of the TAC was caught. In comparison, 538,882 oysters were caught in 2006.

The catch in Zone 2 was 550,972 oysters, increasing from 467,000 in 2006 (Pearl Table 1), and 49,686 oysters were caught in Zone 1 – a reduction from 71,000 in 2006 (Pearl Table 2). No catch was taken from Zone 3 in 2007 as the stocks were closed to fishing because of a low abundance of pearl oysters.

Recreational catch estimate (season 2007): Nil

There is no recreational fishing for pearl oysters.

Fishing effort/access level

Total effort in all zones was 14,652 dive hours (Pearl Tables 1 and 2). The total effort for 2007 in Zone 2/3 was 12,514 dive hours – a 4% increase on the 2006 Zone 2/3 effort of 11,992 dive hours.

The total effort in Zone 1 during 2007 was 2,138 dive hours, which was an increase of 26% over the 2006 effort of 1,692 hours (Pearl Table 2).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2007 fishing season based on catch and effort statistics, recruitment (70,400 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (18,100 shells measured), shell discard rates by size and location, population surveys, 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 2008 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 3/4 to 6/7-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 2007, CPUE was 44 shells per dive hour – a 13% increase from the 2006 catch rate (39 shells/hour – Pearl Table 1).

Catch Prediction: 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 again in the 2+ age class from population surveys in 2007. This cohort will enter the commercially fished population over the 2008 and 2009 fishing years.

The 2008 stock abundance is predicted to be higher than the 2007 levels in Zone 2, but similar in Zone 3. Consequently, TAC in Zone 2/3 has been increased by 20% in 2008 (Pearl Table 1) to a total quota unit value of 1,400 oysters per quota unit, or 40% above baseline.

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 2007, the Zone 1 CPUE was 23 shells per hour, which was a slight reduction from the 2006 CPUE of 27 shells per hour (Pearl Table 2). Despite the lower CPUE, it is still higher than in the previous 13 years, indicating that a substantial recovery has taken place.

***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 2007. 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 44 oysters/hour.

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). 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 eight in 2007, due to increased fleet efficiency and increased reliance on hatchery-produced shells. However this situation may change in the short-term if the hatchery production sector of the industry is reduced and emphasis turns back to the wild fishery.

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 2007: **$113 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. Based on information provided by the industry, the value of cultured pearls and by-products was considered to be approximately $113 million in 2007.

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 603,400 oysters (548,400 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 catch with 12,514 dive hours (Pearl Table 1), which was within the target range, albeit at the lower end, indicating stocks are at a high abundance level.

Zone 1 of the pearl oyster fishery achieved its quota with 2,138 dive hours (Pearl Table 2), which was below the target range, indicating improved catch rates and hence abundance.

The overall pearl oyster fishery effort of 14,652 hours in 2007 with an increased TAC indicates that stocks are at higher than average levels.

Current effort level: **Acceptable**

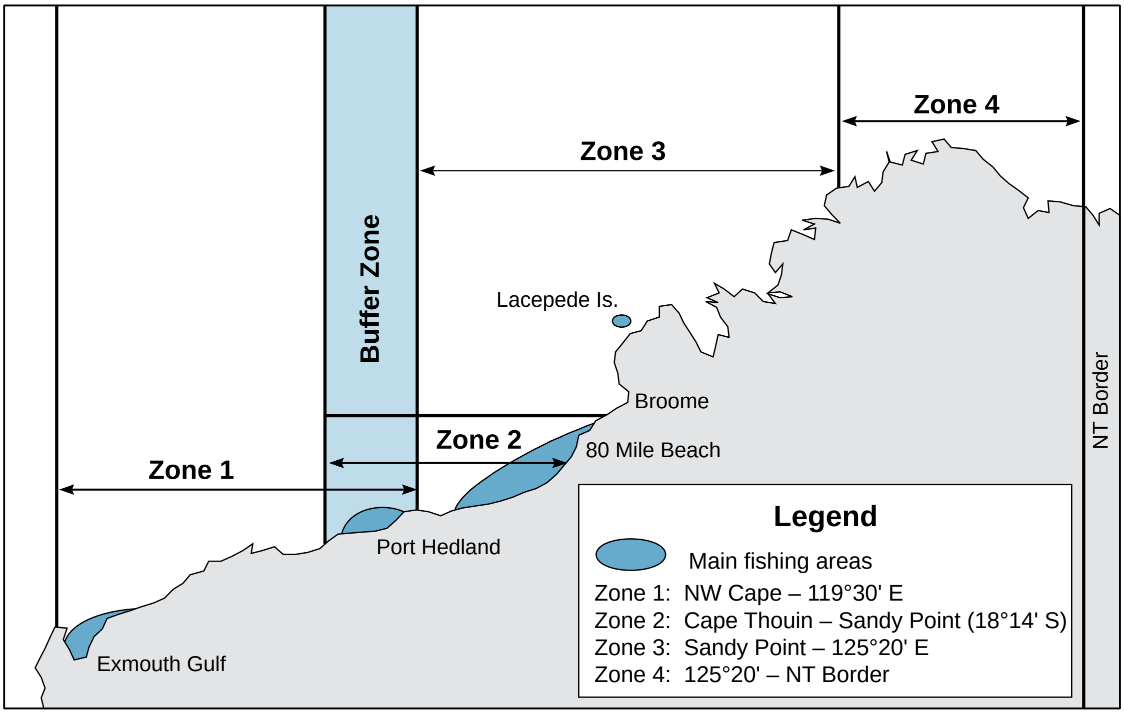
Fishery effort level is at the lower end of the historical range, indicating a higher than average stock abundance.

New management initiatives (2007/08)

An independent review panel has recently completed a Ministerial review of the pearling industry in Western Australia, the findings of which will be released shortly. An independent compliance review of compliance activities in the pearling industry has also been undertaken by the Chief Fishery Officer of the New Zealand Ministry of Fisheries.

External Factors

The pearl oyster stocks underpinning the fishery in Zone 2/3 continue to provide a sufficient level of production to support this major Western Australian industry. However, a disease incident on some farm sites has reduced the amount of hatchery-produced shell available for seeding. The matter is being investigated though a Government-led taskforce and independent specialists with a view to mitigating any potential impacts on wild stocks. To date, the disease does not appear to have affected wildstocks or any other marine organisms.



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	548,400	550,972		550,972	12,514	44.0	12.9	44.0
2008	**639,800**							

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	5,893	11.3
2001	115,000	68,931	9,480	7.3
2002	55,000	29,126	2,729	10.7
2003	45,000[4]	22,131	1,647	13.4
2004	45,000[4]	0[5]		
2005	55,000[6]	25,572	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	49,686	2138	23.0
2008	**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 an 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.
3. Hatchery stock used since 1999 has reduced the need for wild-stock shell between 1999 and 2005.
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. Post 2005, the wild-stock quota for management and compliance purposes was returned to its long-term sustainable level of 55,000.
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.

Beche-de-mer Fishery Status Report

A. Hart and D. Murphy
Management input from R. Green

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 six commercial target species in Western Australia, but 99% of the catch prior to 2007 has been sandfish (*Holothuria scabra*). In 2007, a new fishery for redfish (*Actinopyga echinites*) was being developed, with substantial catches.

Governing legislation/fishing authority

Fisheries Notice no. 366 – Prohibition for commercial fishers unless otherwise endorsed for shellfish, coral, starfish, urchins and beche-de-mer

Instrument of Exemption (Section 7(3)(c) of the *Fish Resources Management Act 1994*)

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 Fishing Boat Licence holders listed in the Instrument of Exemption enabling the take of beche-de-mer.

Beche-de-mer may only be harvested by hand or diving by licensed commercial fishers operating under the authority of a Fishing Boat Licence that is listed on the Instrument of Exemption. Aboriginal communities may also be granted a non-transferable exemption to fish, but these applications are considered on a case-by-case basis.

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 6 crew 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 echinites (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 logbook has been tested and designed for the fishery and was implemented in 2007. The logbook obtains species-specific, fine-scale catch and effort data and appropriate environmental information, such as the depth (of water) fished.

Retained Species

Commercial landings (season 2007): 92 tonnes (live weight)

Recreational catch estimate (season 2007): Nil

Landings

In 2007 the total beche-de-mer catch was 92 t live weight (Beche-de-mer Table 1), which is the highest level of catch since 2003.

On a species-specific level, the 92 t catch was made up of 17 t (18%) *Holothuria scabra* (sandfish) and 75 t (82%) *Actinopyga echinites* (redfish) (see Beche-de-Mer Figure 1). This is the first time that *Actinopyga echinites* has been caught in high numbers and represents a new target species.

Fishing effort/access level

Only 2 licensed vessels fished for beche-de-mer in 2007, one less than 2006. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 312 crew days – about 50% lower than in 2006 and the lowest effort since 1995 (Beche-de-mer Table 1).

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Uncertain

The overall catch rate for beche-de-mer (diving only) was 296 kg/crew day, which is the highest in the history of the fishery. The principal reason for this was the development of a new fishery for redfish, which sustained a CPUE of 320 kg/day, and a high catch rate in the existing sandfish fishery (Beche-de-mer Figure 1).

Estimates of Maximum Sustainable Yield (MSY) of Sandfish were obtained for the entire WA fishery and Kimberly sub-regions 1425 and 1426 using a biomass dynamics model. Current average catch in the fishery is below the MSY (Beche-de-mer Table 2), indicating that the level of fishing is sustainable. However, large variability in the estimates of *q* (0.185 – 0.550) for the same species suggests that a cautious interpretation of the model outputs is required.

Breeding stock levels should be adequately protected by the imposed size limits. The preliminary performance indicators were met for 2007.

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 2007.

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 and redfish 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 that 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 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 and each with a maximum of 6 crew. In 2007, vessels with a total of 10 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, or in the Northern Territory where the fishing fleet is based.

Economic Effects

Estimated annual value (to fishers) for year 2007: **$292,000**

The estimated annual value for 2007 was $292,000 based on an average product price of $9.50/kg (gutted and boiled) or $3.20/kg live weight.

Fishery Governance

Target catch range: **50 – 150 tonnes**

This target catch range is preliminary, noting that this is a developing fishery. Current fishing level of 92 t is within this target range.

New management initiatives (2007/08)

A review of the developing Beche de mer fishery is planned for 2009. A daily catch and effort logbook has been implemented and is beginning to provide species-specific information on catch and effort. This will enable management response and performance indicators to be adapted to better suit the nature of the fishery.

External Factors

The remoteness of the currently fished stock and the large tidal ranges where it occurs 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 and effort of Beche-de-mer in Western Australia since 1995.

Year	[1]Live Wt (t) (all methods)	Crew Days (all methods)
1995	92.7	737
1996	257.3	945
1997	382.1	1,852
1998	309.7	2,565
1999	175.7	1,757
2000	82.9	607
2001	90.1	663
2002	87.1	535
2003	122.4	1,019
2004	80.9	470
2005	77.7	545
2006	56.0	660
2007	***92.2***[2]	***312***

[1] Sandfish represented 99% of catch until 2006

[2] Redfish represented 82% of catch in 2007

BECHE-DE-MER TABLE 2

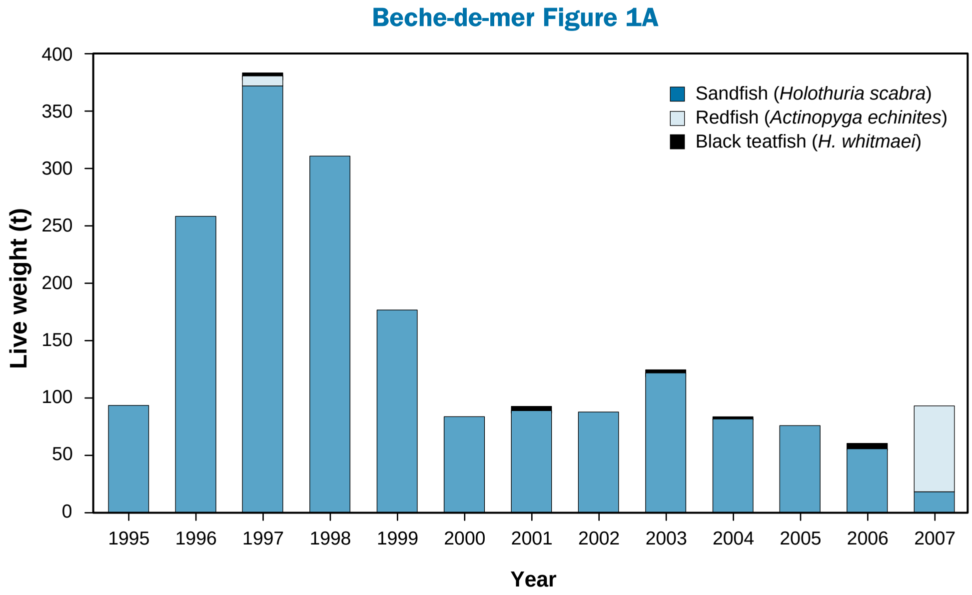
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

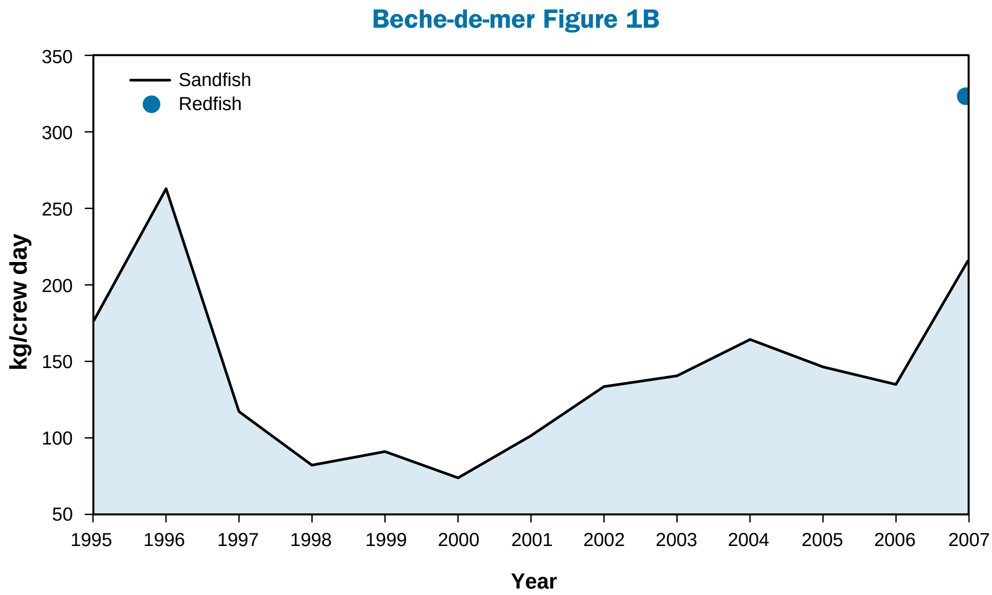
Area	MSY (t)	Current average catch (2005-2007) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	144	67	0.80504	1,020	0.185
Grid 1425 and 1426	69	56	0.928	427	0.550

* *r* – intrinsic rate of increase

k – carrying capacity (virgin biomass)

q – catchability or fishing power





BECHE-DE-MER FIGURE 1

A) Production (tonnes/live weight) by species, and B) catch rate (kg per crew day) from the Western Australian Beche-de-mer fishery for the period 1995 to 2007.

North Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from N. Harrison

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 metres in depth. 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.

Two exemptions to explore the commercial viability of fishing crab stocks along the Pilbara coastline were issued in 2002. Both fishers are endorsed to take blue swimmer crabs in the coastal waters between Onslow and Port Hedland, although only one exemption allows for fishing in Nickol Bay. The fishery has been assessed as part of the Developing New Fisheries Review, with outcomes on the future of the fishery due in 2008/09.

Dedicated blue swimmer crab fishers in the North Coast bioregion use purpose-designed 'hourglass' traps. The various Pilbara invertebrate trawl fisheries that target prawns 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 authorised 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 authorised 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 described in the Onslow Prawn Managed Fishery status report within this document. The boundaries of the Nickol Bay Prawn Managed Fishery are described in the Nickol Bay Prawn Managed Fishery status report within this document.

Management arrangements

Exemptions were issued in 2001 for two 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 exemptions, making a total of three 200-pot exemptions authorizing operations in the fishery.

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 size of 135 mm carapace width in the Pilbara fisheries is set well above the size at sexual maturity (80 – 115mm carapace width), 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 fleet is composed of trawlers up to 23 metres 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 (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 carapace width applies in waters of the North Coast bioregion, 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 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.

Information on the biology and ecology of blue swimmer crabs was 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.

The Pilbara Experimental Crab Fishery was assessed as part of the Developing New Fisheries Review process completed in 2007, with outcomes on the future of the fishery due in 2008/09.

Retained Species

Commercial landings (season 2006/07): 60 tonnes

The combined commercial catch of blue swimmer crabs from dedicated crab fishers and prawn trawlers operating in the North

Coast Bioregion during 2006/07 was 60 t – a marginal increase from the 55 t landed in 2005/06 (North Coast Blue Swimmer Crab Figure 1).

Recreational catch: 20 tonnes (approximately 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 based on current commercial catches.

Fishing effort/access level

While there was only a modest increase in landed catch from the Pilbara Experimental Crab Fishery during 2006/07, there was a significant increase (48%) in effort over the same period. Commercial crab fishers operated on 192 fishing days, compared to 141 days fished during the previous year.

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Adequate

Length-frequency data gathered from ongoing monitoring programs in the Pilbara Experimental Crab Fishery suggests that management controls currently in place provide adequate measures to maintain a sustainable level of breeding stock.

Catch rates from each fishery provide an index of abundance that can be used to assess fishery performance from year-to-year. Trap catch rates in the Pilbara Experimental Crab Fishery have generally increased since the commencement of exploratory fishing along the Pilbara coast. This reflects a 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.

Despite a 12% increase in landed catch during 2006/07, the mean catch rate for the Pilbara Experimental Crab Fishery over the same period actually decreased. The fishery recorded a mean catch rate for 2006/07 of 1.2 kg/trap lift – down from 1.7 kg/trap lift the previous year. This decrease was primarily due to a considerable reduction in catch from the first six months of 2007.

Following a very successful season in 2006, dedicated crab fishers undertook a significant amount of fishing in the first six months of 2007. Despite this effort, fishing during this period resulted in a catch rate of just 0.64 kg/trap lift. In contrast, a CPUE of 1.6 kg/trap lift had been achieved during the second half of 2006.

Non-Retained Species

Bycatch species impact: Negligible/Low/Moderate

The traps 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 traps, 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 that retain crabs as a by-product is dealt with in those sections of this report 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 uprooted and 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 2006/07, 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 2006/07: $0.27 million

Beach prices for blue swimmer crabs remained between $4/kg and $6/kg live weight in the major fisheries during 2006/07, with the average price for the year around $4.50. The catch from the Pilbara region was valued at approximately $270,000 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 a target catch and effort have yet to be set.

Current fishing (or effort) level: NA

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 harvested 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 climatic conditions experienced during the summer months, which restricts fishing effort to the cooler months between May and November.

New management initiatives (2006/07)

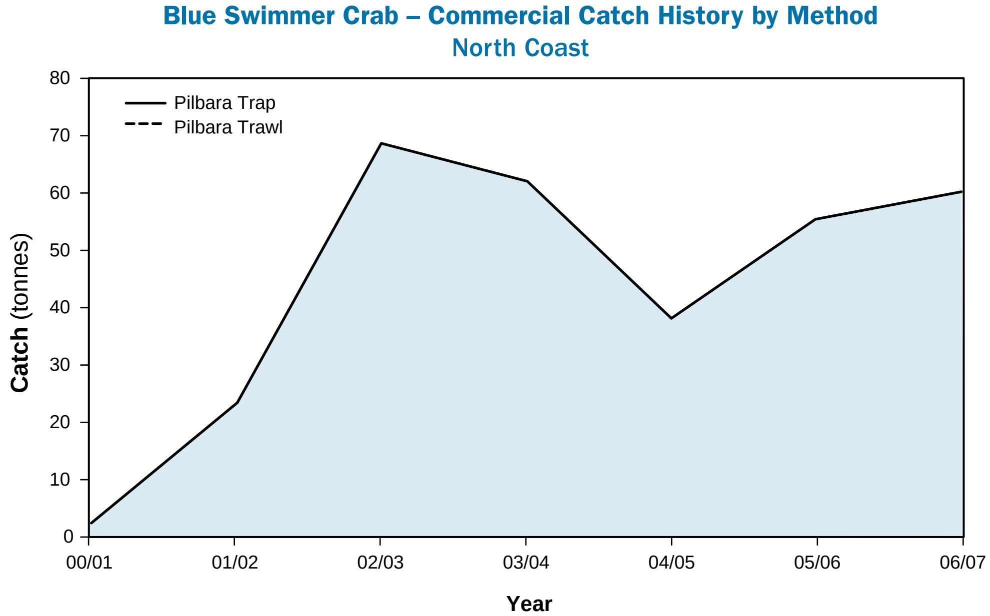
The Pilbara Experimental Crab Trap Fishery was formally reviewed in mid-2007 as part of the 'Developing New Fisheries' process. The Department of Fisheries is considering the review and intends to make clear recommendations in 2008/09 regarding the future viability of a fishery in this region.

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 for the blue swimmer crab (*Portunus pelagicus*) in the North Coast bioregion between 2000/01 and 2006/07.

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 in the North Coast bioregion 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 independent public interest review of the pearling industry, including the Phase III Hatchery Policy, commissioned by the Minister for Fisheries is now complete. 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.

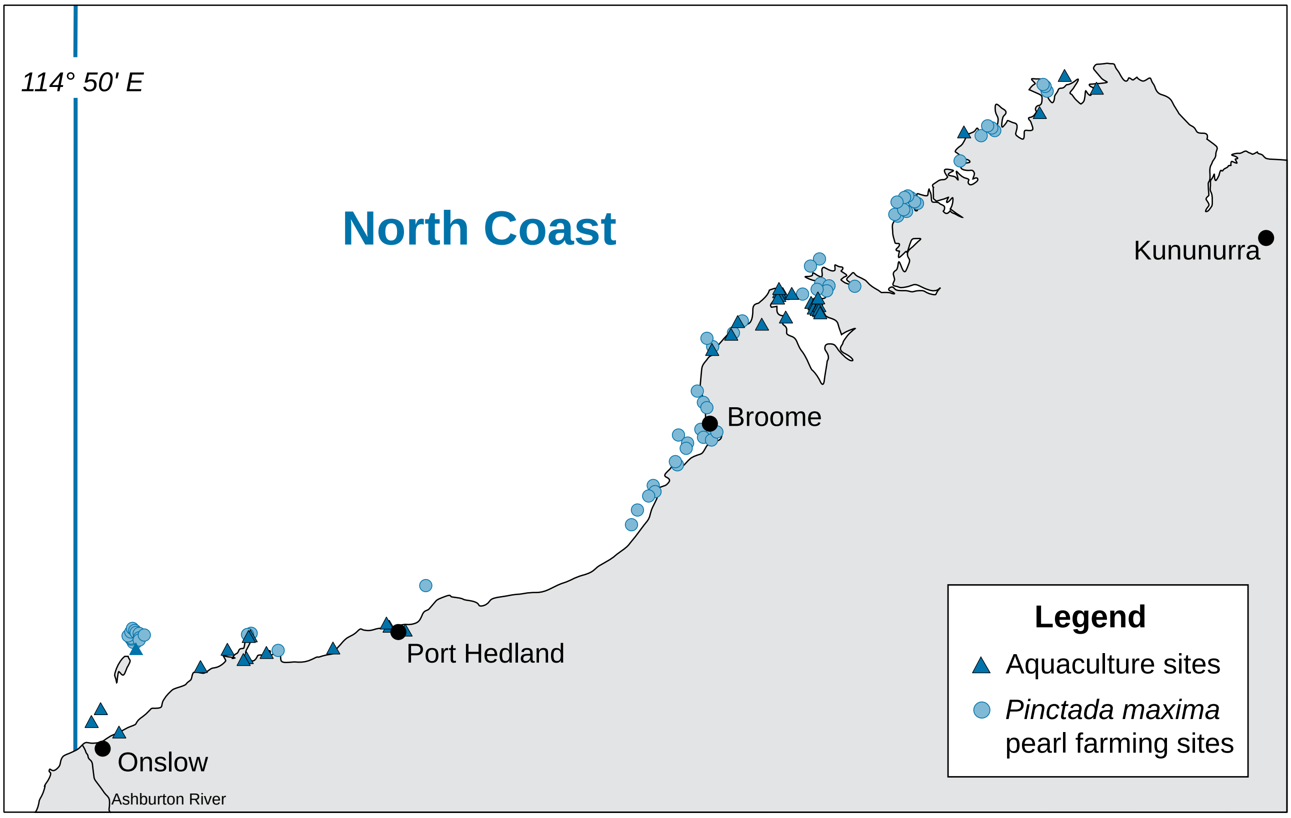
The Department of Fisheries' Research Division's Fish Health Unit is actively involved in assisting the commercial hatcheries, in terms of disease control and the annual certification of hatchery facilities as required under the *Fish Resources Management Act 1994* and the *Enzootic Diseases Regulations 1970.*

The Department continues to assist the Department of Land Information with negotiations associated with the proposed development of a prawn farm at Wyndham.

A fish farm located in Cone Bay is currently producing barramundi and the operator is seeking approval to scale up to commercial size.

The Department of Fisheries continues to support 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*), edible rock oysters (*Saccostrea* sp.) and ornamental species.

The Department is undertaking a review of the aquaculture sites issued to several operators along the Kimberley coast.



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 WA. 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 two district offices at Karratha and Broome – located 800 km apart by road – deliver compliance and community education services across the bioregion. During 2006/07 the two 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 two 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 a large 23 m fisheries patrol vessel 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's dive-team undertake a variety of underwater inspections including pearling, vessels for introduced marine pests (i.e. for biosecurity purposes) and habitat monitoring.

In delivering fisheries compliance duties throughout the bioregion, FMOs use both a risk-based and random approach to perform investigations, 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 a variety of expos, fishing competitions and community fairs.

The community education role extends to conducting children's fishing clinics and school talks. Officers also coordinate and facilitate Fisheries Volunteer patrols who provide advice to the community.

From 1 July 2006 the role of the International Operations Group (two state officers based at Broome) providing services to the Australian Fisheries Management Authority (AFMA) reverted back to the Commonwealth Government and the officers concerned were deployed elsewhere within the Department of Fisheries. The Commonwealth Government now administer and resource all patrols, apprehensions and prosecutions of foreign fishing vessels in Commonwealth waters adjacent to WA.

Activities during 2006/07

During 2006/07, the North Coast bioregion's FMOs delivered a total of 2,783 officer hours of active compliance patrol time – a small increase from the previous year (North Coast Compliance Figure 1). FMOs also achieved 7,096 personal compliance contacts with the community and fishers.

FMOs undertook prosecution action as a result of compliance targeting in 2006/07. This resulted in 23 infringement warnings and 48 infringement notices being issued, with 12 matters resulting in prosecution action.

The Bardi Marine Patrol pilot program operating from the One Arm Point Community was introduced in October 2006. 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 WA.

The pilot program 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.

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 consists 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.

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.

FV groups from across the bioregion were provided with support and training.

Initiatives in 2007/08

A Regional Community Education Officer based in Broome will be appointed in early 2008. This officer will develop and deliver schools based community education programs as well as co-ordinate and develop the existing FV program throughout the northern region. The position will take over these roles and responsibilities from the existing FMOs in the region enabling these officers to spend more time in the field.

Pilbara Iron and the Department of Fisheries have entered into a Memorandum of Understanding (MOU) whereby Pilbara Iron will fund the purchase of a specially-designed FV trailer to allow Pilbara-based volunteers and new volunteers to conduct additional 'fish for the future' community education activities.

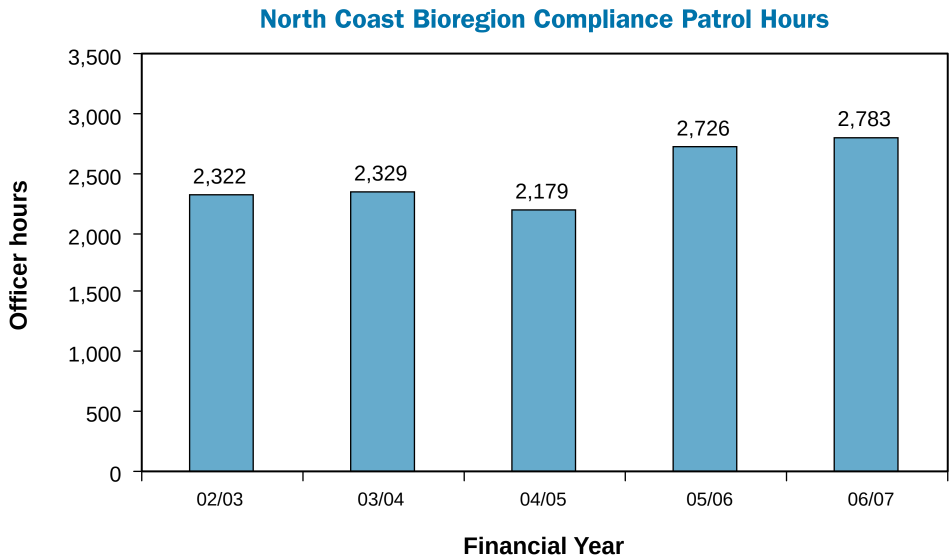
Pilbara-based FV will have access to the off-road trailer, which will be equipped with equipment to run 'hands-on' fishing clinics, carry audio visual equipment to conduct presentations at isolated locations, and offer a 'one-stop' learning centre for all Department of Fisheries volunteer initiatives. As a part of the MOU, FV will also receive reimbursement for personal vehicle fuel costs incurred when conducting educational activities, new uniforms and hats, and additional training and support from the Regional Community Education Officer.

Another important ongoing 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 experienced greatly increased international vessel movement.

The 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 a 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.



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 five years. The 2006/07 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.

* This does not include 1,823 'on-patrol' hours delivered in 2006/07 by *PV Walcott*. In the version of Figure 1 published in the previous edition of State of the Fisheries, the hours patrolled carried out by *PV Walcott* were included in the North Coast totals, leading to consequent higher totals for each financial year.

The total on-patrol hours for each of the Department's 3 large patrol vessels is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV MacLaughlan* and *PV Hamelin* in West Coast.

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 2006/07 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	2,783 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries and Marine Officers	66
District Office contacts	825
Infringement warnings	1
Infringement notices	3
Prosecutions	8
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries and Marine Officers	6,281
District Office contacts	2,179
Infringement warnings	22
Infringement notices	45
Prosecutions	4
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY***	
Field contacts by Fisheries and Marine Officers	749
District Office contacts	2,342
Fishwatch reports***	17

* 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 *McLaughlan* 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 2006/07 fishing season.

Total compliance hours*	3,617 Officer Hours
Field contacts by Pearling Officers	29
District Office contacts	1,018
Letters of Warning issued**	0
Prosecutions	2

* This includes all time spent on compliance-related tasks by district staff, e.g. investigations, prosecutions, etc, but does not include 45 days of pearling activities by *PV Walcott*.

** No legislative capacity to issue infringement notices

SOUTH COAST BIOREGION

Albany coastline. Photo: Gilbert Stokman

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 that are 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 that 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 and Biosecurity Branch currently has a number of 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 Western Australia.

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. Further research on this issue will continue, hopefully with the development of an independent observer program aimed at determining the incidental bycatch of all threatened, endangered and protected species (TEPS) as well as some aspects of target stock biology in the two temperate demersal gillnet fisheries.

Further research on the foraging ecology of the sea lion and the spatial patterns of interaction with these fisheries will look at developing interaction models to predict the rate of interaction and some further satellite tracking with state-of-the-art GPS tags will better inform our understanding of habitat use by this *threatened* species.

Another 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.

A project evaluating the extent of introduced marine species in Western Australian waters and developing strategies to minimise further introductions is being undertaken in parallel with the state-wide introduced marine pests project. Part of the project was a trial of new national monitoring methods in Albany. One result of the trial was finding a single individual of the invasive marine alga *Codium fragile fragile* in Princess Royal Harbour. A survey was then made of the harbour for *Codium*. While no specimens were found at that time, two have recently been identified.

A separate, but related, study funded by South Coast Natural Resource Management is developing information on introduced marine species in the Albany and Esperance marine areas.

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.

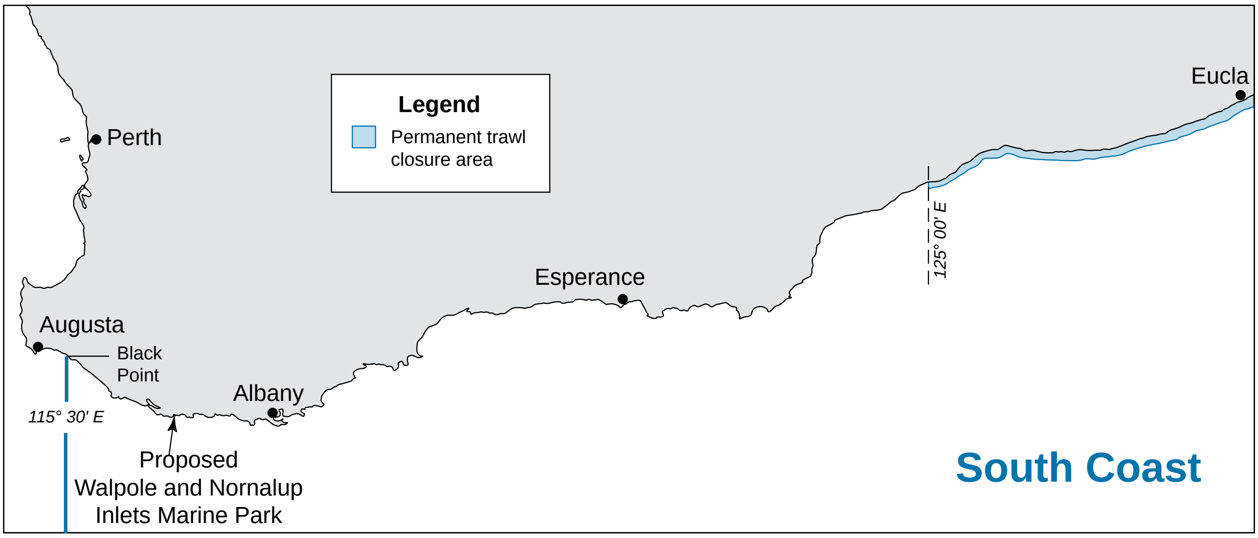
The only marine protected areas currently in place along the south coast are s.43 closures under the *Fish Resources Management Act 1994* surrounding the wreck of the 'Perth' (Albany), wreck of the 'Sanko Harvest' (east of Esperance), and Esperance Jetty. A proposed marine conservation reserve under the *Conservation and Land Management Act 1984* within Walpole–Nornalup Estuary is likely to be proclaimed in the near future.

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 released for public comment in late 2008, and will identify all sector interests along the coast, including areas of fishing, and include management recommendations to improve the long-term sustainable use of the near-shore marine environment within State waters. It is anticipated that these recommendations will complement fishing management arrangements already in place.

The Australian Government's Department of Environment, Water, Heritage and the Arts is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Kangaroo Island, South Australia and Shark Bay, with a view to completing a draft South West Marine Bioregional Plan (MBP) in mid 2009, which will contain individual marine protected areas.

The Department of Fisheries continues to provide advice to the Environmental Protection Authority on development proposals, which if implemented, have the potential to impact on the aquatic environment. The Department also 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.

The invasive marine macroalga (seaweed) *Codium fragile* spp. *fragile* was reported in Princess Royal Harbour in May 2008. This seaweed is included within the Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) Trigger List under "*Species Established in Australia, but not Widespread*". *Codium fragile* ssp. *fragile* has not previously been recorded in Western Australia, and has only been reported from south-eastern Australia. This record therefore represents a significant range extension beyond the previously documented distribution of this species in Australia. The Department and other key stakeholders have been undertaking further studies to establish the distribution and abundance of *Codium fragile* ssp. *fragile* in the Albany Marine Area.



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 and P.Unsworth
Management input by N. Chambers

Fishery Description

The 'south coast crustacean fisheries' are pot-based 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 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 albus*) 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 deeper than 200 metres, excluding those of the ERLF, where crabs may only be taken by the holders of an Esperance Rock Lobster Managed Fishery 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 2006/07, 2 vessels were licensed to fish for rock lobsters in the Windy Harbour/Augusta Rock Lobster Managed Fishery, 9 were licensed to fish in the Esperance Rock Lobster Managed Fishery and 28 vessels were endorsed to fish in the Great Australian Bight 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 2006/07): Southern rock lobster 53 tonnes

The 2006/07 season total catch of southern rock lobsters was 53 t – an increase of 33% from the 2005/06 season (South Coast Crustacean Table 1). A catch of 35 t of southern rock lobsters was taken in the ERLF in 2006/07 – an increase of 40% on the catch taken in the 2005/06 season (25 t).

The combined catch for the Great Australian Bight and Albany southern rock lobster fishery zones in 2006/07 was 18 t – a 12% increase of the catch taken in 2005/06 (Figure 2). The catch in the Albany zone was 2 t – a decrease of 63% compared to the 2005/06 season – but the catch in the Great Australian Bight zone increased by 41% to 16 t.

As a secondary target of the rock lobster fishery, a total of 21 t of deep-sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 0.7 t of giant crabs (a decrease of 0.5 t over the 2005/06 season), 3.6 t of champagne crabs (a decrease of 6.5 t over 2005/06 season) and 10.5 t of crystal crabs (an increase of 6.5 t over the 2005/06 season). In the ERLF, 3.8 t of giant crabs were landed (a increase over the 2005/06 figure of 1.6 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 Esperance fishery (ERLF) had a further 30% increase in effort in 2006/07 after a 30% increase in 2005/06.

Following on from last season's decline there has been a further decline in effort in the Albany Zone from 2005/06 to 2006/07 of 70%. The Great Australian Bight Zone in contrast had a 42% recovery in effort in the 2006/07 after the decline in effort from 2004/05 to 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 2006/07 season remained unchanged from the 2005/06 season at 0.57 kg/pot lift.

CPUE in the ERLF was 0.62 kg/pot lift – an increase of 9%. CPUE also increased in the Great Australian Bight Zone by 14% – from 0.48 kg/pot lift in 2005/06 to 0.58 kg/pot lift in 2006/07. 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 0.19 kg/pot lift in 2005/06 to 0.25 kg/pot lift in the 2006/07 season.

The Southern Crustacean Fishery had experienced significant declines for an eight-year period to season 2004/05, especially for the southern rock lobster (South Coast Crustacean Figure 2). However, there has been a recovery over the last two seasons. To what extent the downturn and upturn in landings represents natural fluctuations in catch, or just variations in fishing effort needs to be determined.

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 to 35 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 since the mid-1990s have been retreating to levels near to those that were stable in the 1970s and 1980s (South Coast Crustacean Figure 2). In the last two seasons the trend of decreasing catches over time has reversed, which will necessitate a close watch being kept on the way that the fishery reacts to those changes in the short term.

Catches in the Great Australian Bight 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 Great Australian Bight Zone are from a number of shallow-water inshore areas, which are dispersed along the coast. As with the Esperance Zone, catches in the Great Australian Bight have decreased in recent years. According to model estimates, this has led to a positive response in the fishable biomass of southern rock lobsters in this zone.

There is currently no information on the local biological characteristics, such as growth rates and size at maturity, of southern rock lobsters and information obtained for other regions was used to generate current management settings. However, these parameters vary across the distribution range of this species, which generates a level of uncertainty for the values used here in WA. Given the small size of this fishery and expenses involved in the collection of such data, it has not been a high priority for research support. It has now been recognised that either this basic research must be done, or the management arrangements must be suitably robust to these uncertainties. Meetings have been held with industry to discuss future management and research options (see new management initiatives 2007/08).

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 2006/07 the catch was 35 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 Great Australian Bight 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 Great Australian Bight 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 2006/07: $1.6 million

The beach value of the southern rock lobster fishery was about $1.3 million in 2006/07, based on a beach price of $25.50/kg. Giant crabs ($35.00/kg) crystal crabs ($13.00/kg) and champagne crabs ($12.00/kg) added an additional $209,000 to the value.

Fishery Governance

Target catch (or effort) range: southern rock lobsters 50 – 80 tonnes

In 2006/07, the south coast catch of 53 t was just inside the target range. This target catch range will be reviewed as a part of the overall review of the management for this fishery. It will take into account the level of catch the Esperance fishery is capable of sustaining, with additional allowance for catches taken from the adjacent fishing grounds discovered in the Albany and Great Australian Bight zones.

Current fishing (or effort) level: Acceptable

Current fishing effort levels will need to be monitored in order to allow the stock to rebuild. In the previous 4 years, the catch in the ERLF had been below 25 t and the residual biomass at the end of each fishing season, as estimated by the model for that zone, had increased each year. In the 2006/07 season the catch from the Esperance fishery has risen to 35 t and the effort has increased in the last 2 years.

New management initiatives (2007/08)

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.

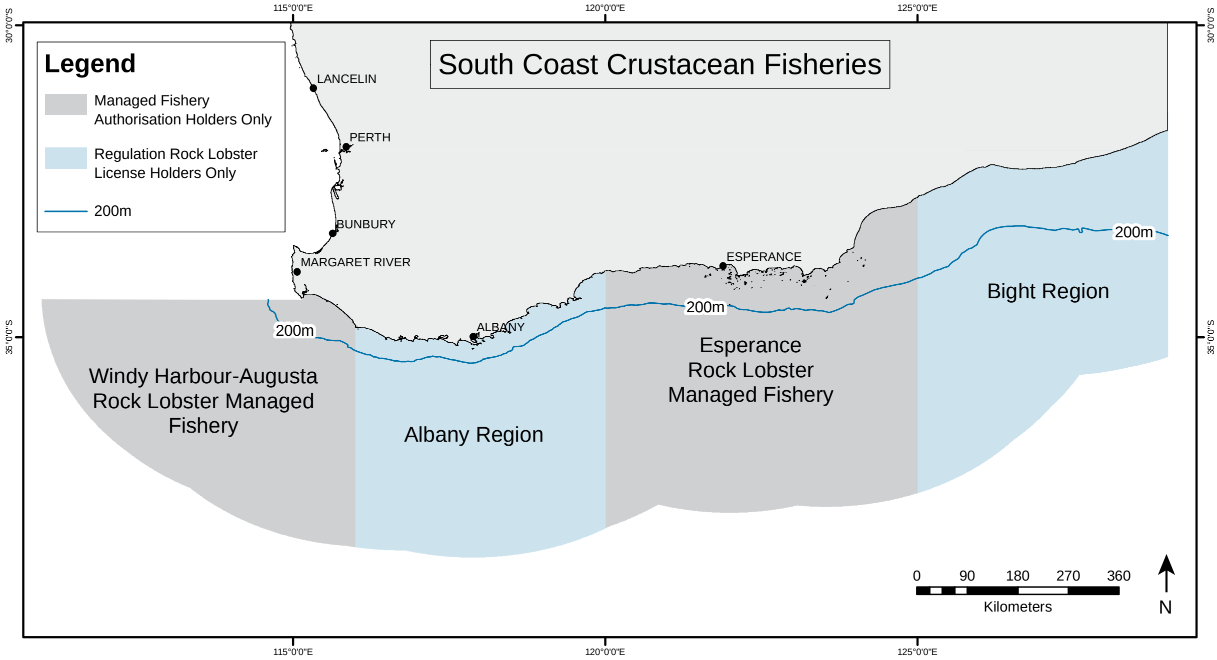
External Factors

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

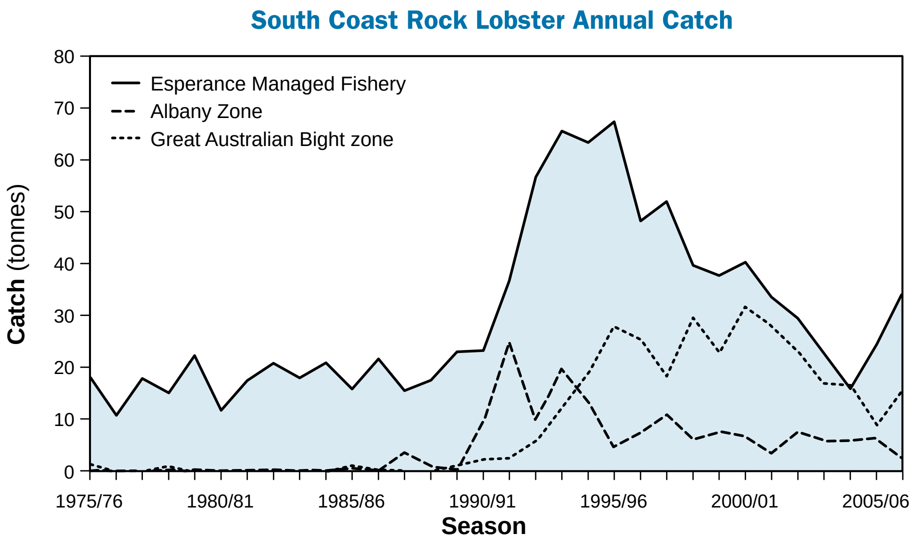
Comparisons of fishing effort and southern rock lobster catch in 2005/06 and 2006/07 in the south coast crustacean fisheries.

Management zone	Season	Pot lifts	Southern rock lobster catch (tonnes)	Deep-sea crabs catch (tonnes)
ERLF	2005/06	43,000	25	3
	2006/07	56,000	35	6
	difference	+30%	+40.0%	+100%
Albany	2005/06	33,000	6	14
	2006/07	10,000	2	15
	difference	-70%	-200 %	+7%
Great Australian Bight	2005/06	19,000	9	0
	2006/07	27,000	16	0
	difference	+42%	+77.7%	0%



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 and T. Baharthah
Management input from M. Holtz

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 can grow to around 200 mm shell length.

The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA 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 metres 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

Boundaries

Commercial

The Abalone Management Plan covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas (Greenlip/Brownlip Abalone Figure 1).

Recreational

The recreational abalone fishery regulations relate to three 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 2007 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 five 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

Current research is focused on stock assessment using catch and effort statistics, meat weight indices, and length-frequency sampling. Commercial 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 abalone shells from each fishing day, and these are measured and used to estimate fishing mortality.

An annual standardized catch per unit effort (CPUE) model was developed that took into account diver and month of fishing as well as technological improvements that aid fishing efficiency.

Current research initiatives include digital video imagery 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.

The telephone diary survey estimates the catch of greenlip and brownlip abalone on a state-wide basis. In 2007, around 500 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 every 3 months by telephone for the duration of the abalone season.

Research on stock enhancement and greenlip abalone habitat continued in 2007, with surveys being undertaken on experimental release sites. Results from this experiment will be used to obtain a robust estimate of the growth and survival of stocked abalone that will inform debate on the effectiveness of stock enhancement as a management tool for this fishery.

Retained Species

Commercial landings (season 2007): 205 tonnes

In 2007 the overall greenlip/brownlip catch was 205 t whole weight (Greenlip Brownlip Abalone Table 1), which was similar to the 2006 catch of 206 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t.

Greenlip catch at 166.6 t whole weight, from a total quota of 171.8 t, was similar to the level taken in 2007. The brownlip catch of 38.7 t whole weight for the 2007 season was 97% of the quota of 39.8 t (Greenlip Brownlip Abalone Table 1).

Recreational catch (season 2007): 8 tonnes

Recreational catch: 3 – 4% of total catch

The estimate of recreational catch of greenlip and brownlip abalone, based on the telephone diary survey of recreational licence holders in 2007, was 8 t (range: 0 t – 16 t), which is similar to the 2006 estimate of 7 t. Given the catch estimates from 2004, 2006 and 2007, the recreational catch corresponds to approximately 3 – 4% of the total (commercial and recreational) catch (Greenlip Brownlip Abalone Table 2).

Fishing effort/access level

Commercial

Total effort for the main stocks in 2007 was 1,139 days. This was a 2% decrease in effort from 2006 (1,161 days), but catch was similar.

Recreational

For the 2007 season, around 22,500 licences were issued. This was a 6% increase over the 2006 figure of 21,200 licenses (Greenlip Brownlip Abalone Figure 2), but overall license numbers have been fairly stable for 7 years.

Effort estimates for recreational abalone fishing on the west coast (excluding the Perth metropolitan area), from the 2007 telephone diary survey, was 6,300 days (3,800 – 8,800 days), while the estimated effort on the south coast was 4,900 days (1,700 – 8,000 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 2007 fishing season, based on commercial catch and effort statistics, length-frequency and shell morphometry sampling, biological growth studies, and some fishery-independent surveys.

Catch per unit effort: The annual average catch rate of commercial divers is used as the principal indicator of the abundance of legal-sized abalone. In 2007, the catch rate for the combined greenlip stocks was 137 kg whole weight (51 kg meat weight) per diver day. This represents an increase from 2006 (131 kg whole weight per diver day), but it is still below the long-term average of 150 kg per diver day (Greenlip Brownlip Abalone Table 1).

A standardised catch per unit effort (CPUE) analysis was also undertaken, which should provide a more robust estimate of abalone abundance compared to the use of raw CPUE data. This methodology is still under development and may eventually be used as one of the performance indicators to set the TACC. A report that reviews performance indicators for this abalone fishery is due for completion in 2008.

For brownlip, the assessment showed that the TACC was being caught at high average weights and the TACC was increased by 5% to 41.9 t in 2008 (Greenlip Brownlip Abalone Table 1).

Fishing mortality: This analysis determines the proportion of the available abalone stock that is being harvested. The current estimates of fishing mortality are still preliminary, due to the low numbers of shell collected by industry divers.

Fishing mortality of greenlip abalone declined by 9% in the west coast (Augusta) stocks between 2005 and 2007 (Greenlip Brownlip Abalone Figure 3). However, it increased in the South Coast stocks from 2005 to 2007, the increase being 12% in the Area 2 south coast stocks (0.43 to 0.48), and 17% in the Area 3 south coast stocks (0.44 to 0.52 – Greenlip Brownlip Abalone Figure 3).

Fishing mortality of brownlip abalone declined by 40% between 2006 and 2007 (Greenlip Brownlip Abalone Figure 3).

***Breeding stock*:** Greenlip abalone mature between 80 and 110 mm shell length, and brownlip abalone mature between 90 and 130 mm shell length. These are both 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 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 that reflect the average size of breeding individuals and the overall biomass of breeding stock.

In 2007, the average sizes of greenlip and brownlip caught were 201 g and 271 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 (1,139 days) were within the set range that indicates sufficient biomass of breeding stock for the fishery overall (907 – 1,339 days – see 'Fishery Governance' section).

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 22,500 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 2007: $8.8 million

The estimated average price received by commercial fishers was $116/kg meat weight (approximately $43/kg whole weight) for greenlip and $99/kg meat weight (approximately $39/kg whole weight) for brownlip abalone, resulting in a fishery valued at $8.8 million, compared to $9.0 million in 2006, and $9.7 million in 2005.

Greenlip prices are similar to 2006 ($118/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 a full season's quota (211.5 t in 2007) 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 2007 was 1,139 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

There was a minor reduction in overall greenlip/brownlip quota – from 211.5 t in 2007 to 205.1 t whole weight in 2008 (Greenlip Brownlip Abalone Table 1), as a result the small increases in fishing mortality in some sections of the greenlip fishery.

Current effort level: Acceptable

New management initiatives (2007/08)

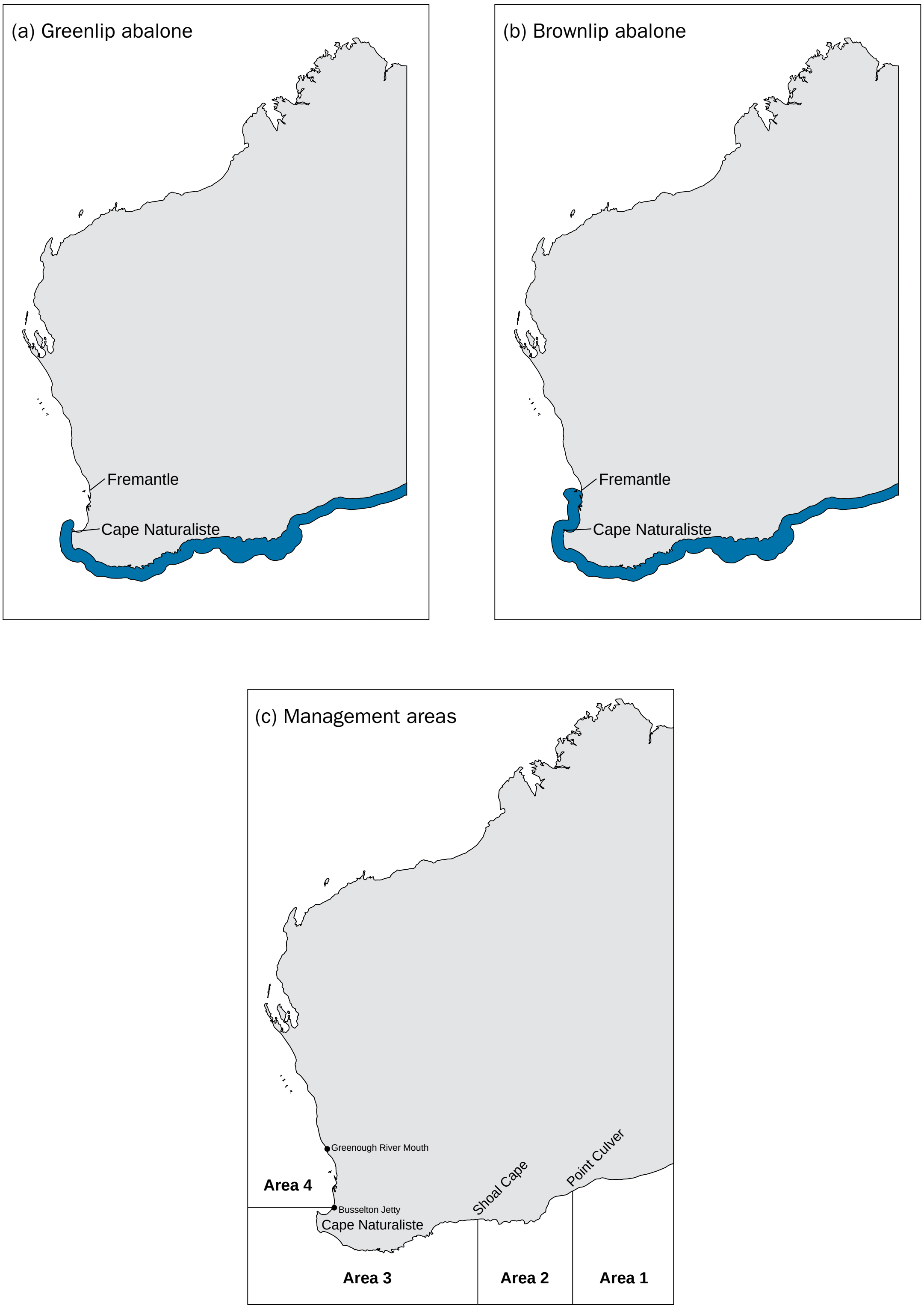
The main new management initiative in 2007/08 was the review of performance indicators for the abalone fishery. Substantial consultations and discussions of these performance indicators have taken place with stakeholders, and a draft report of the outcomes is being prepared. This process will be completed within the 2008/09 fishing year, with TAC setting for 2009 being undertaken with revised performance indicators alongside existing indicators.

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

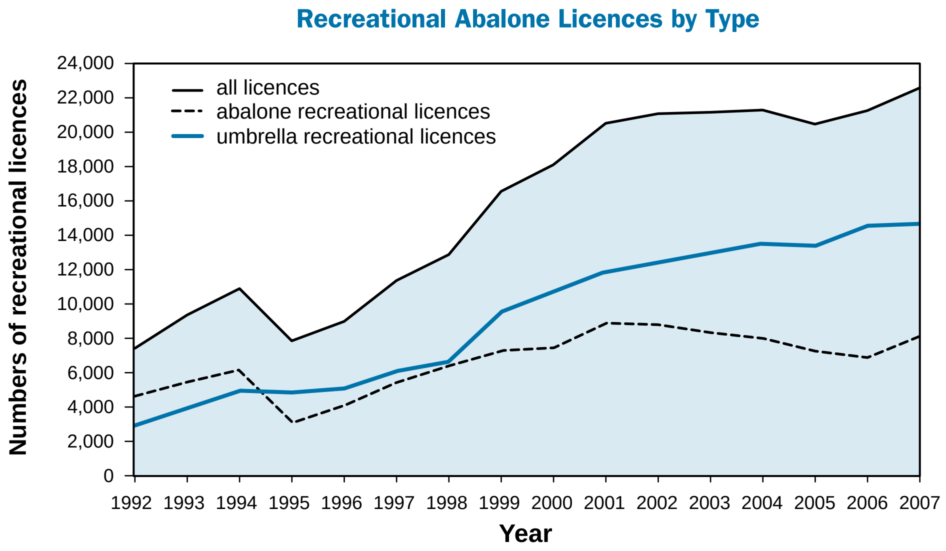
In the last few years there have been a number of changes which impact on fishery governance, and particularly on catch rates. Lease divers are becoming more common, industry size limits have been varied substantially above the legal minimum sizes and the value of the abalone has decreased. While the traded price of abalone in $US is very high, no gains to the sector have been made due to the increasing value of the Australian dollar against the $US.

In addition, environmental effects, such as weather conditions, and the effect of technology changes, such as the introduction of Global Positioning Systems, continue to have significant effects on diver efficiency.



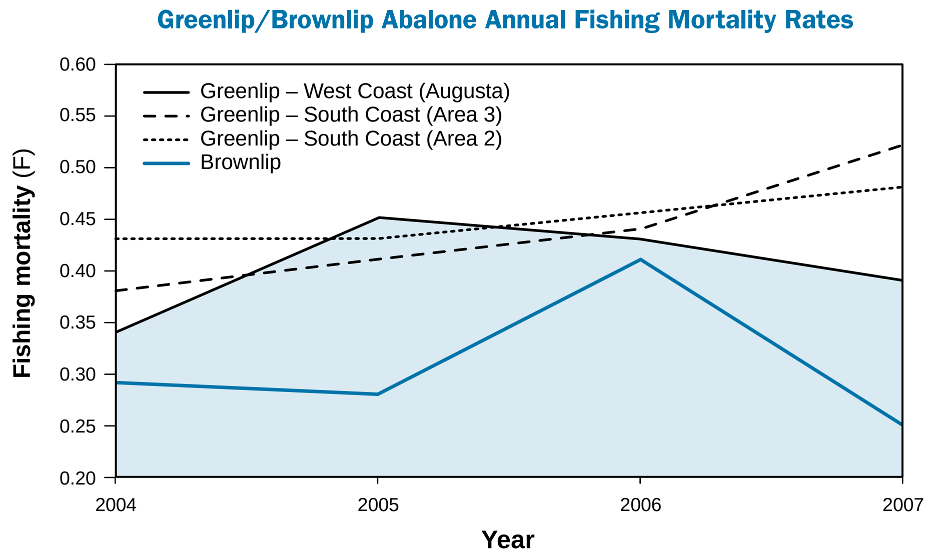
GREENLIP/BROWNLIP ABALONE FIGURE 1

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. Area 4 currently has no quota allocated.



GREENLIP/BROWNLIP ABALONE FIGURE 2

The number of licences issued in the recreational abalone fishery, by licence type, for the period since 1992. Data are license counts at the end of the Perth metro abalone season (mid-December).



GREENLIP/BROWNLIP ABALONE FIGURE 3

Fishing mortality for greenlip and brownlip abalone. Estimates of fishing mortality (F) apply only to harvest-size animals, and are derived from catch-curve analysis using length-frequency data, and annualised growth increments based on following growth models. West Coast Greenlip: $L\infty$=185 mm, K = 0.30; South Coast Greenlip: $L\infty$=179 mm, K = 0.25; Brownlip: $L\infty$=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[4]	Combined catch kg whole weight	Diver days (main stocks only)[3]	Greenlip kg whole (meat)[4] wt per diver day (main stocks only)
1989	–	229,619	20,774	–	36,977	266,596	1,324	158 (59)
1990	126,500	118,395	3,967	–	19,118	137,514	696	164 (62)
1991	148,500	132,194	2,989	–	14,658	146,852	816	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	177 (66)
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	166 (62)
1999	184,023	175,765	7,781	28,000[5]	28,047	203,812	922	182 (68)
2000	194,691	189,511	6,709	34,875	34,179	223,690	1,029	178 (67)
2001	194,691	187,459	22,283	33,075	31,091	218,550	1,002	165 (62)
2002	194,691	166,828	29,110	33,075	27,458	194,286	1,027	134 (50)
2003	202,521	180,730	25,044	37,453	33,449	214,179	1,144[3]	136 (51)
2004	190,520	170,385	21,380	35,000	34,196	204,581	1,154[3]	129 (48)
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	166,647	13,106	39,750	38,660	205,307	1,139	137 (51)
2008	**163,220**			**41,900**				

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 years.
3. Effort (diver days): main stocks are separated from stunted stocks, which are subject to controlled fishing regimes and not directly comparable.
4. Greenlip conversion factor (meat weight to whole weight) is 2.667. Brownlip conversion factor for meat weight to whole weight is 2.5.
5. 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.

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, 2006, and 2007.

			Greenlip		Brownlip	
Location	Year	Effort	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)
	2007	6,300 (3,800 – 8,800)	0.7	3 (0–6)	0.1	<1 (0–1)
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)
	2007	4,900 (1,700 – 8,000)	1.8	4 (0–8)	0.2	<1 (0–1)

1. Survey area is South Coast bioregion (i.e. east of Black Point).

South Coast Trawl Fishery Status Report

M. Kangas, E. Sporer and S. Brown
Management input from N. Chambers

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 four 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 two 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). Condition 79 provides for the use of demersal trawl nets for taking scallops within the Recherche Archipelago. All four 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, Water, Heritage and the Arts 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 2007): 258 tonne whole weight

Landings

The scallop catch was 258 t whole weight, which is a moderate catch for this area (South Coast Scallop Figure 1). Less than 1 t each of bugs and squid were also reported as being landed.

Fishing effort/access level

The annual effort expended in this scallop fishery is mostly affected by scallop recruitment levels. These are determined from exploratory fishing by skipper(s) to estimate stock abundance of scallops and if it is economic to continue fishing. As a consequence, the level of effort utilised each year closely follows stock abundance and catch levels. For the 2007 season all 4 boats completed logbooks, recording a total effort of 1,760 hours over 153 fishing days. This effort is substantially up on the very low effort expended by one boat in 2006.

All 4 boats fished during May and June and two boats ceased fishing by the end of June. The introduction of the daily logbook to collect catch and effort information in this fishery will provide more detailed spatial data to allow for preliminary stock assessment to commence.

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 bycatch species impact 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 that 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 for the year 2007 was 12 skippers and crew.

Economic Effects

Estimated annual value (to fishers) for year 2007: $0.9 million

Fishery Governance

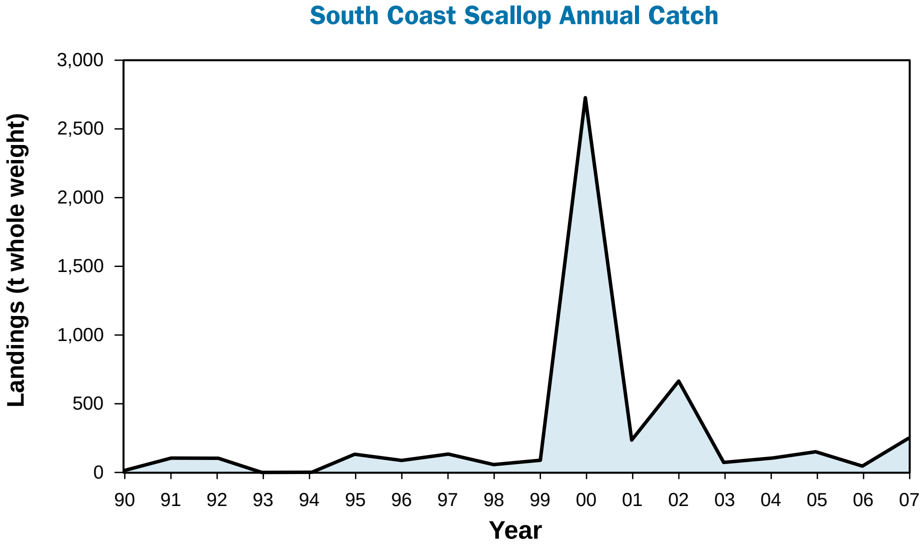
Acceptable catch range for next season: Not available

New management initiatives (2008)

The interim management plan will include 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 consultation round, prior to implementation.

External Factors

The level of fishing activity and quantity of catch within the South Coast Trawl Managed Fishery is highly variable. This variability has largely been driven by the level of scallop recruitment to these grounds, the product price paid to fishers and, in recent times, the cost of fishing. Scallop catches in 2007 were moderate, with one boat searching and then 3 additional boats fishing for scallops, during the year.



SOUTH COAST SCALLOP FIGURE 1

South coast scallop annual catch from 1990 – 2007

South Coast Estuarine Managed Fishery Status Report

K. Smith and J. Brown

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. However, levels of commercial fishing activity have been declining since 1992 as a result of voluntary buy-back of commercial access. CAES data are still important for stock assessments, but these are now used in combination with increasing amounts of data from recreational fisheries and fishery-independent surveys. Therefore, 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.

Recreational catch levels are estimated only 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 of Fisheries. 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 2007): 251 tonnes

The 2007 SCEF catch contained approximately 36 different species, including finfish, sharks, rays, molluscs and crustaceans. The majority of landings were finfish, with cobbler, sea mullet (*Mugil cephalus*) and black bream comprising over two-thirds of the total catch (South Coast Estuarine Table 1).

Total annual commercial landings in south coast estuaries reached a peak of 501 t in 1992, having steadily increased from approximately 200 t during the early 1980s (South Coast Estuarine Figure 1). Between 1992 and 1994 total landings declined sharply but were then relatively stable until 2003, averaging 277 t for the 10-year period. In 2004, the total catch dropped to 180 t and remained low, with the lowest catch on record of 170 t reported in 2006.

The 2007 catch of 250.7 t was an increase of 81 t from the previous year and only just below the 10-year (1997 – 2006) average annual catch of 254 t. The increase in catch in 2007 from 2006 levels can be attributed to increases in catches of sea mullet (up 38.5 t), cobbler (23.7 t), black bream (12.4 t) and Western Australian salmon (*Arripis truttaceus*) (8.1 t). The 2007 catches of other species were similar to 2006 levels, except for yellowtail scad (*Trachurus novaezelandiae*), which declined by 2.4 t in 2007.

Despite significant increases in the catch of the above species in 2007, the catch level of many species remained well below their 10-year (1997-2006) annual average, including King George whiting (13.3 t lower), blue swimmer crabs (*Portunus pelagicus*) (9.2 t), yellow-eye mullet (*Aldrichetta forsteri*) (7.8 t), leatherjacket (Monocanthidae) (6.6 t), Australian herring (*Arripis georgianus*) (5.0 t) and silver bream (*Rhabdosargus sarba*) (3.5 t). Only landings of sea mullet (28.0 t higher), black bream (14.1 t) and Western Australian salmon (10.1 t) were substantially above their 10-year annual averages in 2007.

For the first time in the past 10 years, all of the 13 individual estuaries that SCEF licensees are currently permitted to fish had some level of fishing effort. Wilson Inlet again recorded the highest catch, with 110.7 t or 44% of total SCEF landings. Combined landings from Oyster Harbour, Princess Royal Harbour, Beaufort Inlet, Irwin Inlet and Gordon Inlet contributed a further 51% of total SCEF landings in 2007. Only minor catches were recorded in Stokes Inlet, Broke Inlet, Hamersley Inlet, Jerdacuttup Lakes, Waychinicup Inlet, Oldfield Inlet and Culham Inlet.

The 2007 catch in Wilson Inlet was just below the 10-year (1997-2006) average annual catch of 118.2 t for this estuary. Oyster Harbour and Princess Royal Harbour also produced total landings in 2007 that were below their 10-year averages (25.3 and 12.4 t respectively).

Annual catches have followed a declining trend since 2001 in Oyster Harbour and since 2004 in Princess Royal Harbour. In 2007, only Princess Royal Harbour and Stokes Inlet recorded a significant decrease in catch from 2006 levels.

Cobbler: Cobbler is the most dominant species in the SCEF catch, comprising 26% of the total catch over the past 10 years (1997-2006). In 2007, the total SCEF cobbler catch was 67.8 t, which was 23.7 t higher than the 2006 catch, and 1.2 t higher than the 10-year (1997-2006) average annual catch of 66.6 t.

The 2007 catch, as in previous years, was primarily taken in Wilson Inlet (88%), with smaller catches in Irwin Inlet (6%), Oyster Harbour (4%) and Princess Royal Harbour (1%). In 2007, 99% of the total state commercial catch of cobbler was caught in the SCEF.

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). The 2007 catch of 60.0 t in Wilson Inlet is above the 10-year (1997-2006) average of 52.5 t

Black bream: The catch of black bream averages 32.0 t per year (or 12.4% of the total SCEF catch). They are important because of their widespread distribution and comprise a significant component of commercial landings within each estuary (unlike cobbler which is essentially only caught in Wilson Inlet). The annual black bream catch has increased significantly in numerous south coast estuaries recently, with a steady rise in total annual SCEF landings over the past 10 years. In 2007, the total SCEF black bream catch was 46.1 t, which was 8.6 t more than in 2006 and 10.0 t more than the average catch (South Coast Estuarine Figure 3). In 2007, black bream catches were reported in all 13 of the SCEF estuaries. Consistent with the last 10 years, Beaufort Inlet, Wilson Inlet, Stokes Inlet and Oyster Harbour contributed the majority (89.8%) of black bream landings.

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. Similarly, high rainfall levels in the Albany region in 2005 led to sharp increases in the catch of black bream in Oyster Harbour, Wilson Inlet and Beaufort Inlet.

The higher catches (and catch rates) of black 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.

King George whiting: In 2007, the total SCEF King George whiting catch was 6.0 t, most of which (52%) was taken in Wilson Inlet, with Irwin Inlet, Oyster Harbour, Princess Royal Harbour, Beaufort Inlet, Gordon Inlet and Broke Inlet contributing the remainder. The 2007 catch from Wilson Inlet was 3.1 t, which was 12.5 t less than the 10-year (1997 – 2006) average catch in this estuary (South Coast Estuarine Figure 4). However, the 10-year average of 15.6 t is inflated by very high catches during 1997 to 2000, which resulted from high juvenile recruitment into Wilson Inlet by the 1995 year-class.

Approximately 56% of the total WA commercial catch of King George whiting in 2007 was caught in the SCEF.

Other key species: Over the past 10 years, sea mullet has made the third highest contribution by weight to total SCEF landings, averaging 26.6 t per year (or 10.4% of the total SCEF catch). Sea mullet is also a significant component of commercial landings within many individual estuaries, although over half (53.5%) of the catch in the past 10 years has been caught in Wilson Inlet and Oyster Harbour. The 2007 catch of sea mullet was 54.5 t, which was 38.5 t more than in 2006 and 28.0 t above the 10-year (1997-2006) average catch. This reverses the declining trend in sea mullet landings over the past 10 years. The increase in total catch of sea mullet in 2007 was largely due to increased catches in the Gordon and Beaufort Inlets.

In contrast to sea mullet, yellow-eye mullet has continued a declining trend since 1998. In 2007, yellow-eye mullet catches were reported in 8 of the 13 SCEF estuaries, with Irwin Inlet, Wilson Inlet and Beaufort Inlet contributing the majority (83.7%) of the catch. The majority of yellow-eye mullet catches (78.7%) over the past 10 years were caught in Wilson Inlet and Broke Inlet. However, the catches in these two estuaries declined substantially in 2007 and their combined catch in 2007 was approximately 90% below the 10-year average. The low catches may reflect low abundance due to low recruitment by this species on the south coast since 2001.

The 2007 SCEF catch of leatherjackets (11.0 t) was below the 10-year (1997-2006) average catch (16.2 t), mainly due to relatively low catches in Oyster Harbour, where leatherjacket landings have been declining since the late 1990s. Leatherjackets were also caught in Princess Royal Harbour, where landings have been stable over the last 10 years.

Recreational catch: 29% of total catch (approx)

Two 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

Access level

Since July 2002, the level of access has been 25 fishing units. All south coast licensees have access to each of the individual south coast estuaries listed under the South Coast Estuarine Fishery Management Plan 2005, except for Beaufort Inlet where only 3 licensees are granted access each year.

Commercial fishing effort

Commercial fishing effort has traditionally been recorded 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. 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 through the implementation of the voluntary Fisheries Adjustment Scheme. This buy-back system has resulted in the number of licensees being reduced from 51 in 1994/95 to 25 in 2002 – a level that has maintained to the present time. In 2007, the average number of boats fishing per month was 16.6 – up slightly from the 16.1 boats per month in 2006.

The total annual reported fishing days also peaked in 1992 – at 6,747 days – then progressively declined, reaching a record low of 3,276 days in 2006 and then increasing to 3,617 fishing days in 2007 (South Coast Estuarine Figure 1). An increase in fishing days between 2006 and 2007 occurred in Wilson Inlet, Gordon Inlet, Irwin Inlet, Beaufort Inlet, Waychinicup Inlet, Jerdacuttup Lakes, Culham Inlet and Hamersley Inlet. The reported fishing effort in 2007 in each of these estuaries was above the 10-year (1997-2006) average.

Oyster Harbour, Princess Royal Harbour, Broke Inlet, Stokes Inlet and Oldfield Inlet each experienced a decrease in reported effort between 2006 and 2007. Fishing effort in 2007 was below the 10-year average in each of these estuaries. Effort in Oyster Harbour experienced a particularly rapid decline, from 917 days fished in 2001 to a record low of 230 days fished in 2007.

The lower levels of effort in Oyster Harbour and Princess Royal Harbour largely reflect 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.

In 2007, SCEF fishing effort was primarily focused in Wilson Inlet (64.0% of fishing days), Princess Royal Harbour (9.5%), Irwin Inlet (7.6%) and Oyster Harbour (6.4%).

Recreational fishing effort

Recreational fishing effort in 17 south coast estuaries was estimated by a creel survey conducted by the Department of Fisheries 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 long-term total annual catch per unit effort (CPUE) of the commercial fishery has been relatively stable since the 1980s, averaging 62.3 kg/day fished from 1982 to 2007 (South Coast Estuarine Figure 1). This suggests that the total biomass of the suite of species in the catch has been relatively constant over this period. Historically, the targeting of multiple species has ensured consistent total annual landings and contributed to the viability of the commercial fishery.

Fish abundances in south coast estuaries are influenced by many factors, including climate, oceanography, human-induced catchment impacts and fishing pressure. The complex interactions between these local and remote factors make it difficult to explain changes in the composition of fish communities in each estuary.

In 2006, the CPUE dropped to a historically low level of 51.8 kg/day fished which was assumed to reflect a decline in total estuarine fish abundance. However, the stock levels of the key target species were considered adequate at that time. This assessment is supported by the increase in the total commercial catch rate in 2007 to 69.3 kg/day fished, primarily due to above-average catches of the key species (discussed below).

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. The catch and CPUE remained relatively low in 2005 and 2006, before climbing in 2007 to be just above the long-term average (1987 – 2006).

The rapid decline in CPUE during 2004 to 2006 occurred at a time of relatively low and stable fishing effort, thus suggesting a decline in stock abundance, probably due to several consecutive years of low recruitment as a result of environmental factors. The Department of Fisheries undertook a fishery-independent survey of cobbler in Wilson Inlet in 2006. High numbers of juveniles were observed throughout the estuary during this survey. 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 are now being repeated annually by the Department of Fisheries 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 within each south-west estuary are independent and genetically distinct. 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 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. In 2007, both the catch and CPUE in these estuaries again increased.

Annual rainfall was very high in 2005 and 2007 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 these two years.

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 (1997 – 2006), 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.

In 2007, the Wilson Inlet sand bar remained closed due to low estuary water levels following low rainfall. In future years, the non-breaching of the bar may occur more frequently, due to lower annual rainfall as a result of climate change. Recruitment by marine-spawned fish, such as King George whiting, will not occur during years when the bar is closed.

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 2007, 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 are 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 within each estuary can vary markedly and is primarily recruitment-driven, independent of fishing. Food chain effects due to fishing are likely to be insignificant compared to the effects of these 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. Additionally, a small quantity is sold to zoos across Australia as animal food. During the 2007 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 2007: $1,306,000

The top three most valuable species to the fishery were cobbler, black bream and sea mullet. King George whiting recorded the 4th highest overall value even though it was only the 8th highest catch by weight, due to it commanding the highest market price of any of the commercial estuarine finfish. The next highest value finfish were flounder, pink snapper, black bream and garfish.

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 2007 of 251 t was within 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 (2007): 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 (2007/08)

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 was increased on 6 July 2007 from 28 cm to 41 cm, in line with existing minimum sizes 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 and 2007.

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.

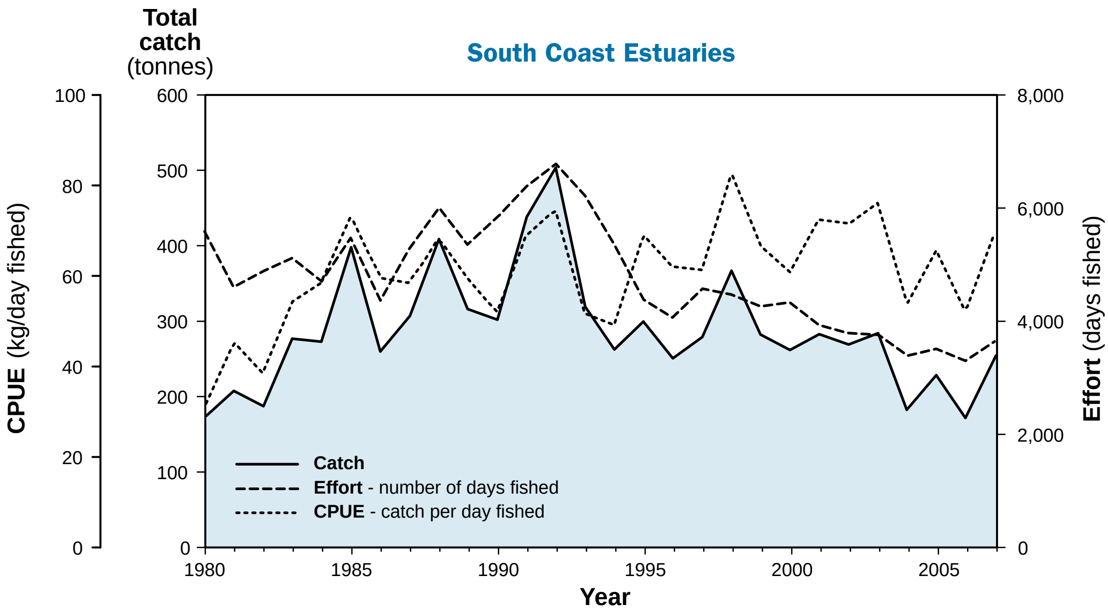
The influence of environmental factors on recruitment to estuaries is further complicated by the practice of human intervention to breach estuarine sandbars, mostly for reasons related to estuarine amenity coupled with ecosystem 'health'.

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 Fishery for the year 2007.

Species	Scientific name	Catch (tonnes)
Cobbler	*Cnidoglanis macrocephalus*	67.8
Sea mullet	*Mugil cephalus*	54.5
Black bream	*Acanthopagrus butcheri*	46.1
Australian herring	*Arripis georgianus*	16.2
WA salmon	*Arripis truttaceus*	11.5
Leatherjacket	*Monocanthidae*	11.0
Flathead	*Platycephalidae*	8.5
King George whiting	*Sillaginodes punctata*	6.0
Pink snapper	*Pagrus auratus*	3.2
Silver bream	*Rhabdosargus sarba*	3.1
Other species		22.8

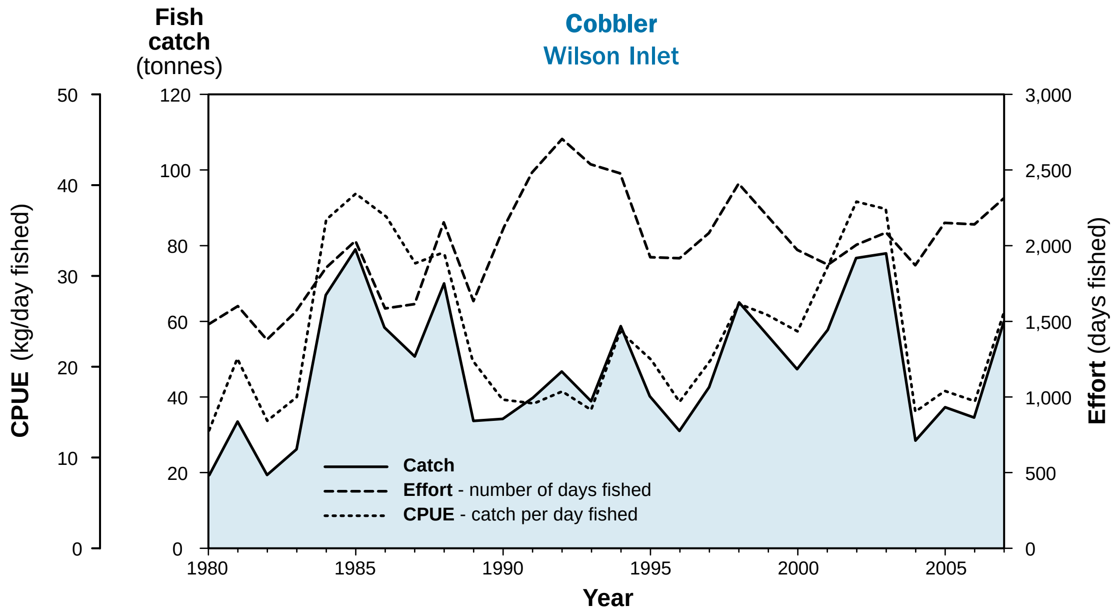


SOUTH COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980 – 2007.

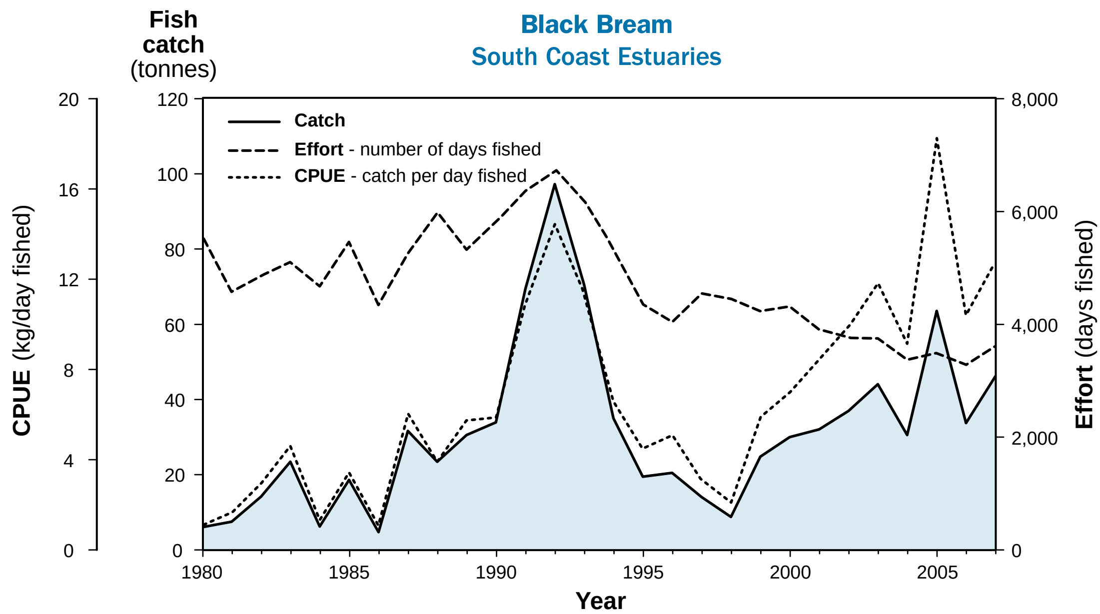
Note 1: Prior to 1993, the South Coast estuarine catch figures included King George Sound, which was not part of the SCEF. From 1993, when a separate fishing block was created for Princess Royal Harbour, the catch figures include Princess Royal Harbour but not King George Sound.

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.



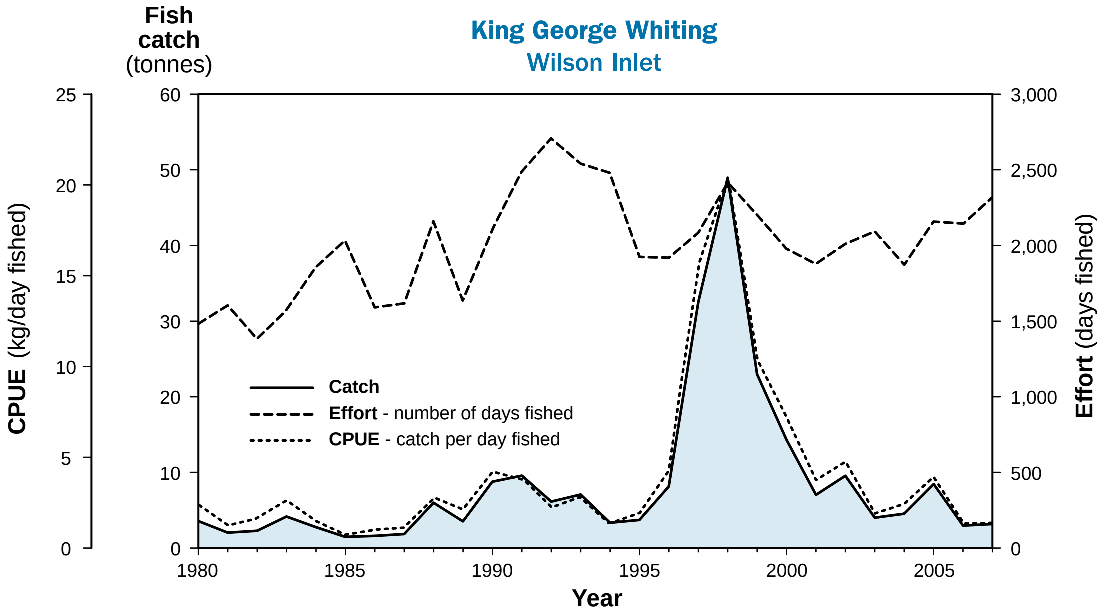
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the cobbler (*Cnidoglanis macrocephalus*) fishery of Wilson Inlet over the period 1980 – 2007.



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 – 2007.



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 – 2007.

Australian Salmon Managed Fisheries Status Report

K. Smith and J. Brown

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, industry and peak body members (e.g. the Western Australian Fishing Industry Council and Recfishwest).

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 two 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 along the lower west coast, 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 daily 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 logbooks 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 monthly 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 two 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 2007): 871 tonnes

The total state commercial catch of Australian salmon for the 2007 season was 871 t, which was 1,115 t less than in 2006 (Salmon Figure 1). The 2007 catch was well below the average catch of 2,250 t for the past 10 years (1997 – 2006) and outside the long-term catch range for this fishery (1,200 – 2,800 t). The 2007 catch was the second lowest catch since 1978, when 755 t was recorded.

On the south coast, the commercial catch of salmon was 248 t in 2007, which was 544 t less than in 2006 and 1,414 t less than the 10-year (1997 – 2006) average. The 2007 south coast catch was the lowest catch recorded in this region over the past 44 years.

The 2007 catch was mainly taken from the western (Windy Harbour to Albany) and central (Albany to Cape Riche) regions of the fishery (53.7% and 34.2% of total catch, respectively). A small proportion (11.5%) was taken from the eastern sector of the fishery (from Cape Riche eastwards).

Historically, almost the entire south coast catch (approximately 97%) was taken between February and May each year, which coincides with the time of the spawning run along the south coast. In 2007, 85% of the total annual catch was taken during this period, with the remaining 15% being taken during the 'back run' (June to December).

The west coast catch for 2007 was 623 t, which was 571 t less than in 2006 but still above the 10-year average (1997-2006) of 588 t. The Geographe Bay and Capes regions contributed nearly all (99%) of the south-west coast catch in 2007.

For the third consecutive year – and the third time in the history of the WA commercial salmon fishery – the west coast catch exceeded the total south 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 share 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, two 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, Sumner *et al.* 2007). In 1996/97, an estimated 2,740 salmon were retained and a further 1,095 released by boat-based fishers. In 2005/06, an estimated 3,891 salmon were retained and 6,583 released. The retained catch was approximately 12 t in 1996/97 and 17 t in 2005/06.

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 and 2007.

Fishing effort/access level

Commercial

In 2007, there were 18 south coast and 9 west coast commercial fishing teams, plus 3 licensees with access only from Busselton Jetty to Tim's Thicket (condition 68). The number of south-west fishery 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.

In 2007, only 5 of the 18 south coast licensees reported any salmon catch, while 7 of the 9 licensees on the west coast reported catches.

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, provide relative indices of breeding stock abundance.

On the south coast, the commercial catch rate has been declining since the mid-1990s. In 2007, the average commercial catch rate was 49.6 t per year per active team – down from the 60.9 t in 2006, and much lower than the 10-year (1997-2006) average of 104.4 t. However, the declining trend is believed to result primarily from a lack of market demand and environmental factors on the south coast affecting catchability, rather than a decline in total stock level.

On the west coast, the commercial catch rate has been increasing since 2000. In 2007, the average commercial catch rate on the west coast was 51.9 t per licensed team – down from the 99.5 t in 2006, but still higher than the 10-year (1997-2006) average of 41.2 t.

Surveys of boat-based recreational fishing in the West Coast region in 1996/97 and 2005/06 provide the only indication of trends in recreational catch rates of salmon. The number of salmon retained by boat-based fishers increased by 42%, whereas the total boat-based effort in the zones where salmon was caught increased by only 15% between these surveys (Sumner *et al.* 2007). This suggests an increase in the abundance of salmon on the west coast between surveys.

Juvenile salmon recruitment measured during fishery-independent surveys since 1995 suggest that annual recruitment on the west coast was low/moderate until 2005 and then increased in 2006 and again in 2007. In 2007, west coast recruitment was the highest level recorded. The opposite trend was evident on the south coast, where annual recruitment was relatively high in 1998 and 1999, but low/moderate in subsequent years. Contrasting recruitment trends within each region probably reflect the differing influence of the Leeuwin Current – a year of weak current will encourage high west coast and low south coast recruitment, while a strong current will encourage low west coast and high south coast recruitment.

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 2007, the catch was below the target range. However, the low catch was primarily due to limited targeting and low catchability along the south coast. The west coast catch level was at a historically high level in 2007. Collectively, all available information suggests that the total breeding stock level was adequate in 2007.

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 a seal from their seine net without injury to the animal.

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 2007 fishing season there were approximately 27 commercial fishers involved in the south coast fishery and 24 in the south-west 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 and 2007, recreational targeting on the west coast may have been higher than average, in response to reports of above-average salmon abundance.

Economic Effects

Estimated annual value (to commercial fishers) for year 2007 $348,400

The price paid to south coast commercial fishers for Australian salmon remained at an average of $400/t in 2007. 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 2007, the total commercial catch (871 t) was below the target range. The main reason for this low catch was the low effort expended in the South Coast Salmon Managed Fishery. In 2007, only 5 of the 18 teams expended significant effort in targeting salmon, due to a lack of market demand.

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 WA.

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, to maintain the fishery’s permit to export under the *Environment Protection and Biodiversity Conservation Act 1999.*

Current fishing level: Acceptable

Current total commercial catch and effort levels are very low relative to historic levels. Fishing levels are considered acceptable to ensure the sustainability of the stock.

New management initiatives (2007/08)

A voluntary Fisheries Adjustment Scheme remains in progress for the South-West Coast Salmon Managed Fishery. Three 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 Managed Fishery is under consideration.

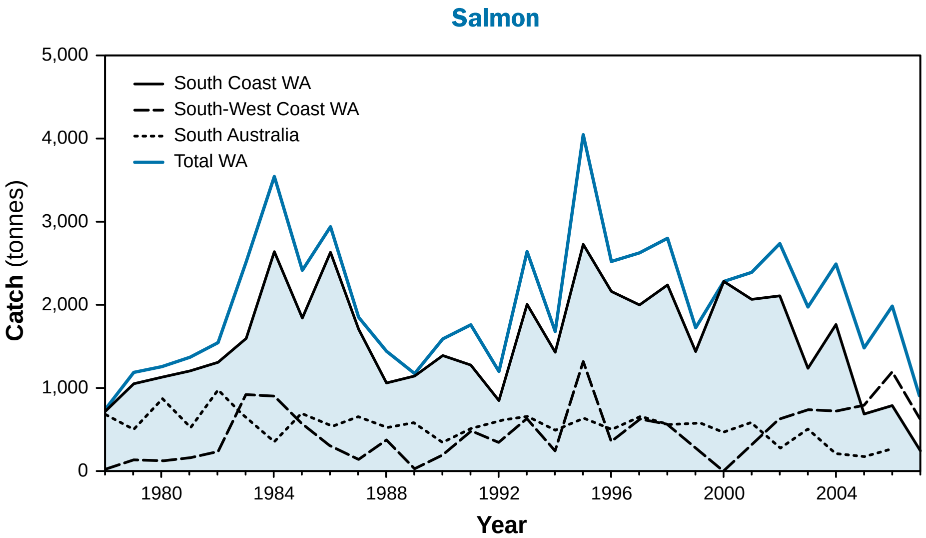
A closure to commercial salmon fishing in Geographe Bay during Easter was implemented in 2007 to reduce conflict between the fishing sectors. In 2008 this closure was expanded to include all public holidays and the weekends of the April school holidays. In July 2009 the commercial closure of a large proportion of Geographe Bay will become permanent.

To update the plan and reflect the current needs of the fishery it is proposed to review the South Coast Salmon Management Plan.

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 landed catches for Western Australia and South Australia for the period 1978 to 2007.

Australian Herring Fishery Status Report

K. Smith and J. Brown

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, industry and peak body members (e.g. the Western Australian Fishing Industry Council and Recfishwest).

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 logbooks, 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. Using a beach seine net, the number of juvenile herring caught per haul 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 logbooks 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. Commercial fishery catch rates, determined as the landed catch per active team per year, was previously considered to be a reasonable indicator of breeding stock level, but reduced levels of effort in the fishery (only 3 of the licenced 11 teams fished in 2007) and the release of unsaleable fish (which is not recorded as landed catch) have made this method less useful as an index of breeding stock levels.

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. 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.

Sampling of the recreational catch of Australian herring to determine the age structure recommenced in 2005 (it was last sampled in 1996 to 1998). 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 2007): State 234 tonnes South coast 192 tonnes

The total commercial catch of Australian herring reported in 2007 was 233.7 t. This was a decrease on the previous year, when a total of 345.8 t was landed. The 2007 catch is the lowest on record and is well below the 10-year average of 647.9 t.

The low catch in 2007 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, apart from a slight increase in 2006 (Herring Figure 1).

In 2007, the south coast catch was 192.0 t, which comprised 82.2% of the total commercial catch. This catch was below the target catch range for the south coast (475 – 1,200 t). The historically-low catches in recent years are partly attributable to the recent low marketability of this species, resulting in lower effort expended by fishers. Only 3 of the 11 licensed trap net teams reported fishing for herring in 2007.

The majority (84.5%) of the south coast catch in 2007 was caught using trap nets, with gillnets, haul nets and beach seine nets comprising equal shares of the remainder of the catch. Approximately 91% of the south coast landings were from ocean waters, with the remainder from estuaries and embayments.

In 2007, the west coast catch of herring was 41.7 t. This is the lowest catch on record for this region and was well below the 10-year (1997-2006) average of 95.5 t. The majority (69%) of these landings were from embayments (Geographe Bay and Cockburn Sound), with the remainder from estuaries (20%) and from ocean waters (11%).

The 2007 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 (33.9 t below the 10-year average) and the south-west (Bunbury) region (16.3 t below the 10-year average).

The vast majority of commercial herring landings are taken between January and May each year. In 2007, 83.7% 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 (2007). 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).

A boat-based creel survey undertaken by the Department of Fisheries in 2005/06 estimated that the number of herring retained by boat-based recreational fishers in the west coast region was 288,392 fish (40 t) during the 12-month survey period. An estimated 364,932 fish (46 t) were retained by boat-based recreational fishers during a similar survey in 1996/97 (Sumner *et al.* 2008).

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 2007, 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 3 teams recorded effort during the season. This was a decrease from the 8 active teams in 2006. These historically-low effort levels were in response to the lack of markets and low wholesale prices paid for herring.

Recreational

In 2000/01, it was estimated that 28% of the WA population aged 5 years or more 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 that 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 displayed a downward trend since 1998 and the annual catch rate of the south coast trap net fishery (measured as landed catch per active team) declined accordingly from 2001 to 2006. In 2007, the fishery catch rate increased, but this was probably an artifact of the very low number of active fishers operating in the fishery in this year (Herring Figure 2).

Compared to annual recruitment levels observed in the late 1990s, recruitment from 2005 to 2007 was very low in both west and south coast regions.

The estimated number of herring retained by boat-based recreational fishers on the west coast declined from approximately 364,932 fish in 1996/97 to 288,392 fish in 2005/06 (i.e. a decline of 21%) despite a 15% increase in fishing effort between surveys. This suggests a decline in abundance of herring in west coast waters.

The average age of herring in recreational catches on the west coast appears to have declined slightly since the late 1990s. From 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 catch per unit effort (CPUE) is increasingly unreliable as an index of herring abundance.

Recreational CPUE from logbooks provide a more reliable index of abundance than current commercial CPUE. The average catch rate of herring by logbook fishers in the West Coast region was similar in 2006 and 2007, suggesting similar stock abundance on the west coast in these years. However, since logbook data have only been available since mid-2005, it is difficult to interpret this initial data in the absence of comparable historical data.

Despite the uncertainties, the available information strongly suggest that the abundance of herring in south-western WA is lower than in the late 1990s, due to consecutive years of low recruitment. The reasons for low recruitment are unclear but are probably related to environmental factors.

A more recent estimate of the total catch by shore-based recreational fishers, who catch the majority of herring on the west coast, would help to reduce uncertainty about the current stock status. More intensive monitoring of the age structure of the catches by each sector would also assist.

In 2008, a new research project proposal will be developed to provide a more rigorous monitoring and assessment of the status of Australian herring and other inshore species. Funding for this project will be sought from the Fisheries Research and Development Corporation.

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. The capture of bycatch in 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. It is compulsory for commercial fishers to report all interactions with protected and listed marine 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 16 fishers participated in commercial trap net fishing in 2007. Numerous other commercial fishers take part 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 are relatively abundant and are 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 2007: $272,000

The estimated value to fishers of the total state commercial catch for the year 2007 is $272,000.

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 2007, the south coast catch was 192 t, which 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 3 of the 11 licensed trap net teams fished for herring in 2007.

In 2007, the west coast commercial fishery catch was 42 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 Australian salmon. Landings of Australian salmon have increased significantly on the lower west coast in the last few 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 the reduction in commercial effort has probably resulted in a significant reduction in total fishing pressure on the stock in recent years. The total commercial fishing level is very low and is considered acceptable at this time.

The stock level has apparently declined over the last 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 in regard to the sustainability of the fishery.

Shore-based fishers on the west coast take the majority of the recreational herring catch. No recent estimates of shore-based recreational catch or effort are available from this region. 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.

New management initiatives (2007/08)

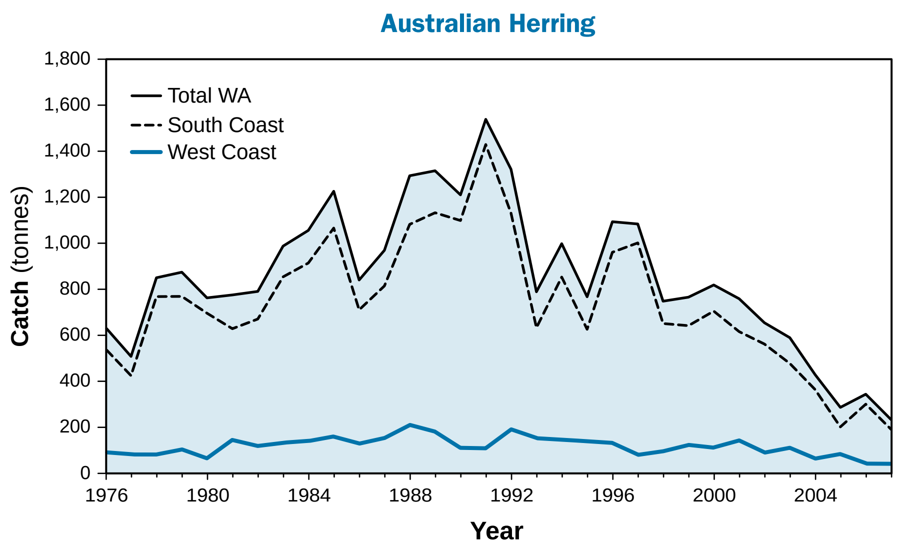
The Minister has approved the drafting of a new Order to regulate the use of herring ‘G’ trap nets. The new Order will list operators in the fishery in the schedule to the Order.

A review of the management of the recreational fishery will commence in 2008.

External Factors

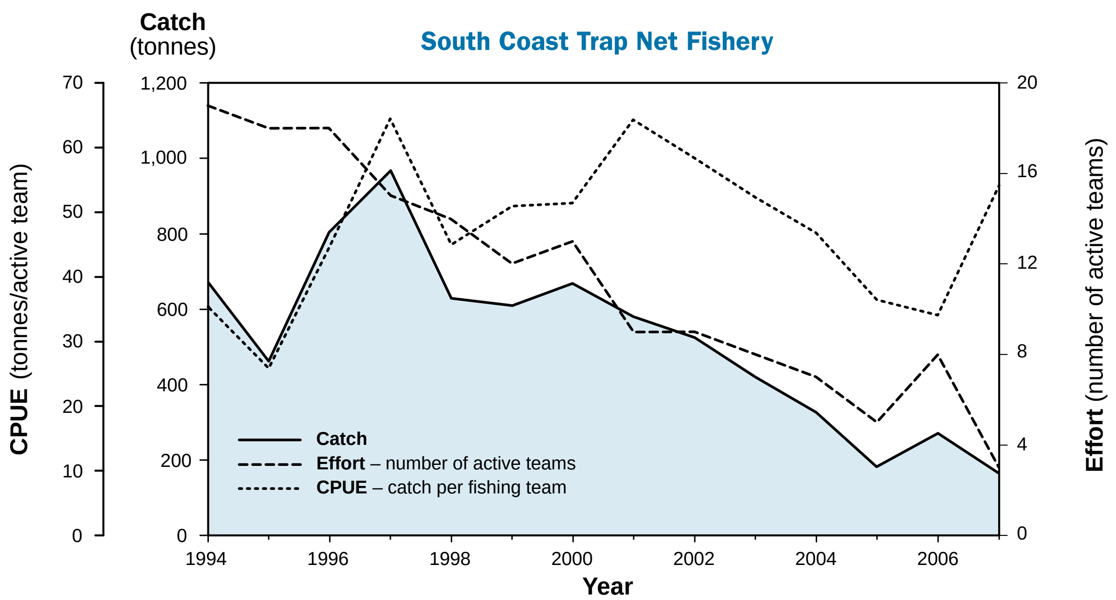
It is likely that factors other than fishing (especially the strength of the Leeuwin Current) significantly influence the migration patterns of pre-spawning adults, the distribution of spawning and the dispersal of larvae. These factors will then affect juvenile recruitment success and the catchability 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. New markets for this species are currently being investigated by industry, which could increase demand for, and commercial targeting of, this species.



HERRING FIGURE 1

Australian herring catches landed from the south and west coasts, and the total Western Australian catch, for the period 1976 to 2007.



HERRING FIGURE 2

Catch, effort and CPUE for Australian herring from the south coast trap net fishery for the period 1994 to 2007.

South Coast Purse Seine Managed Fishery Status Report

T. Leary and B. Molony
Management input from N. Chambers

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 Western Australia/South Australia 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

Meetings between the Department of Fisheries and industry

Boundaries

The South Coast Purse Seine Managed Fishery consists of three primary management zones. The Albany zone extends from Point D'Entrecasteaux to Cape Knob. The King George Sound zone is a subset of this area and the two 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 one year equates to an annual total allowable catch (TAC). The total quota units allocated across each of the five 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 usually 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 three management regions. The model outputs, along with analyses of catches, together allow the annual review of stocks in each major zone. Age-composition data was not updated during 2006/07 and an update of the assessment model was not undertaken. Catch analysis was performed for the 2006/07 year. A project funded by the Fisheries Research and Development Corporation was undertaken by the Department of Fisheries' Research Division's Fish Health Unit to assess the virus disease, which decimated pilchard stocks in the 1990s (2002/044); another project to examine the recovery of the stock has also been completed (FRDC 2000/135).

A collaborative research project with Murdoch University and SeaNet commenced in 2005. The project examined the extent of fishery interactions with wildlife (pinnipeds, cetaceans and seabirds) and potential mitigation methods to reduce these interactions. For the 2007/2008 season, temporal closures and specific mitigation methods, along with a continuing observer presence, is anticipated

Retained Species

Commercial landings (season 2006/07): 1,623 tonnes

Following the recovery of the pilchard stocks from the mass mortalities of last decade, pilchard TACs are approaching previous levels. For the 2006/07 season the catch cap was set at 2,722 tonnes for the two Albany zones combined and a nominal 1,500 tonnes each for the Bremer Bay and Esperance zones. Landings of pilchards for the 2006/07 season were:

Albany zone:	1,440 t
Bremer Bay zone:	167 t
Esperance zone:	11 t

These figures represent a small catch increase for Albany of 7% over the previous year, while Bremer Bay had a substantial decrease in catch (58%) over the same period. Landings for Esperance fell to a historic low – an order of magnitude smaller than 2005/06. The Albany fishery secured a tuna feed market, which overcame previous difficulties with exploiting catches of smaller or mixed-size fish. Only a very small proportion (<2%) of the Albany catch came from the zone outside King George Sound this season. The Bremer Bay and Esperance fisheries landings reflect the low level of effort, in part exacerbated by a difficulty in attracting labour to regional areas.

Catches of yellowtail scad, another small pelagic species, were estimated at 5 tonnes, representing a minor component of the catch in 2006/07 from the Albany zone.

Recreational catch estimate (season 2006/07): N/A

Fishing effort/access level

Fishing effort from the Albany fleet remained stable at 98% of the previous season's input. A continuing slide in the number of fishing days recorded for Bremer Bay saw effort reduced again – in this reporting period, 32% less days were recorded. Effort in Esperance was reduced to 23% of the fishing days of the previous season.

Albany zone: The recorded number of Catch and Effort Statistics (CAES) days in 2006/07 was 1,060, compared to 1,081 in 2005/06.

Bremer Bay zone: The recorded number of CAES days in 2006/07 was 115, compared to 169 in 2005/06.

Esperance zone: The recorded number of CAES days in 2006/07 was 31 days, compared to 130 in 2005/06.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

In Albany, the catch rate was slightly higher than the previous year, but it was lower in Bremer Bay and much 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 unlikely to be accurately reflecting fish abundance.

Albany zone: The 2006/07 catch rate for the Albany zone was 1,358 kg/day, compared to 1,187 kg/day in 2005/06.

Bremer Bay zone: The 2006/07 catch rate for the Bremer Bay zone was 1,452 kg/day, compared to 2,305 kg/day in 2005/06.

Esperance zone: The 2006/07 catch rate for the Esperance zone was 377 kg/day, compared to 1,105 kg/day in 2005/06.

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 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 (i.e. higher TACs). A significant contributor to this uncertainty is the possible 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 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 three primary management zones was at adequate levels. The estimates below are presented with lower and upper bounds.

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)

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 and anchovies. All of these species have a cosmopolitan distribution and are locally, if seasonally, abundant.

Protected species interaction: **Moderate**

A number of protected species, including seabirds, seals, dolphins and 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 research project to examine the extent of wildlife interactions and potential mitigation actions commenced in late 2005 and finished with the 2006/2007 season. The Albany fishing fleet is to adopt mitigation methods identified by the research project report in the 2007/08 season – including net management, temporal fishing closures and deterrent methods. Data from monthly returns now include mandatory wildlife interaction reports but are not currently available for this reporting period and will be reported in future years.

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 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 the benthos actually touched, as it is hazardous to the fishing gear.

Social Effects

There were 9 vessels fishing in Albany in 2006/07 for at least part of the year, providing income for 27 crew members. Fewer vessels worked in Bremer Bay and Esperance with concomitantly fewer onshore employees.

Economic Effects

Estimated annual value (to fishers) for year 2006/07: **$1.22 million**

The total catch value calculated for 2006/07 was $1.22 million. Prices paid amongst processors are relatively uniform with the quality (size of individual) of fish dictating price paid to fishers and processors end use. This season Albany processors (90% of total catch) reported many smaller-sized fish (40 – 60 fish/kg), which were processed as lower-value tuna and pet feed.

The different product types for each zone are shown in South Coast Purse Seine Table 1. In 2006/07, south coast pilchards processed as block ('tray') form and 'individually quick frozen' fish accounted for 53% of the catch, mainly destined for recreational bait markets, with some finding interstate markets for human consumption. The increased proportions of tuna grow-out feed and lowest-value 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 2007/08 season, the TAC for the Albany region is set at 2,683 tonnes whilst the TAC for Bremer Bay and Esperance remains at 1,500 t, giving a maximum expected catch for the fishery of 5,683 t. The fleet and infrastructure for this fishery is rebuilding, but irregular availability of market-sized fish, particularly in Bremer Bay and Esperance, 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 three primary management zones was at adequate levels. Thus, the current level of fishing activity is regarded as acceptable.

New management initiatives (2007/08)

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 instigated a working group to examine the issue. A joint research project with Murdoch University, the Western Australian Fishing Industry Council and the Conservation Council of Australia began in 2006, to develop strategies for the mitigation of seabird bycatch. The project agreed on a code of practice which is supported by industry and reviewed annually.

External Factors

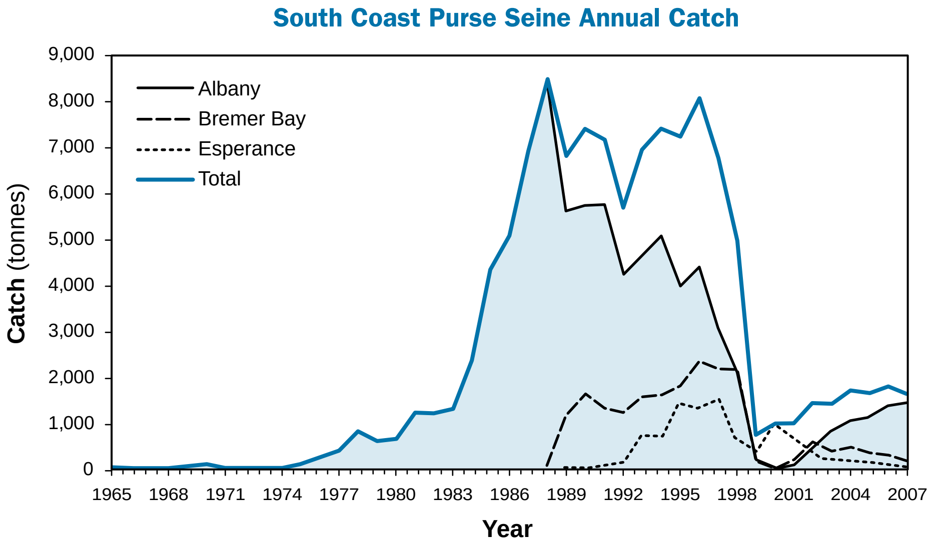
The unpredictable availability of market-size fish in this region continues to negatively impact on this fishery in the Bremer Bay and Esperance zones. These two zones, based in smaller regional towns, are also experiencing labour shortages as the growing state-wide economy offers other employment choices. Consequently, it cannot be predicted when these fisheries might recover to a point where the TAC of 1,500 t can be consistently achieved in each zone. The issue is not a resource sustainability issue.

Previous research has shown that environmental factors, such as variations in the strength of 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. Recognition of global climate change raises the possibility of longer-term environmental changes, on a time-scale unrelated to inter-annual environmental variations.

SOUTH COAST PURSE SEINE TABLE 1

Processing details (in tonnes) for pilchards from Albany, Bremer Bay and Esperance for 2006/07.

Product	Albany	Bremer Bay	Esperance	Total (South Coast)
Trays	464.7	89.8	0.3	554.7 (34.7)
Individually quick frozen	198.4	78.1	11.0	287.5 (18.0)
Pet food	242.4	2.5	0.0	245.0 (15.3%)
Tuna feed/other	509.4	0.0	0.5	509.9 (31.9%)
TOTAL	**1,414.9**	**170.4**	**11.8**	**1,597.1**



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

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 both fisheries' catch. The two fisheries are reported together here because extensive research has demonstrated 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 (WADNHFMAC)

Meetings between Department of Fisheries, the 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 effectively composed of two 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/South Australia border (129° E).

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery extends north from latitude 33° S to a line drawn north of North West Cape (114°06´ E). However, shark fishing has been prohibited between Steep Point (26°30´ S) and North West Cape since 1993.

Management arrangements

The south and west coast fisheries are regulated through two 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 one 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 one month, although there are a small number of units which permit the use of 378 metres 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 to be used to fish for 288 hours.

Additional measures to address remaining sustainability concerns for key stocks were introduced for the 2006/07 season. These include a two-month closure of the fisheries between the northern boundary of the WCDGDLF (26°30´ S) and 118° E longitude in the JASDGDLF to assist recovery of the whiskery shark stock; a maximum size limit for dusky sharks; and prohibition of metal trace wire and large hooks, which had previously been used to target large whaler sharks. Both fisheries' management plans will also be revised in coming seasons to reduce identified high levels of latent effort and set more explicit effort ceilings for each management zone. These new and pending arrangements have been complemented by more precautionary management regulations for 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 WA, 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 three FRDC final reports and numerous international journal papers. 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.

Prior to 2006/07, monitoring and assessment of the performance of the fishery involved analysis of monthly Catch and Effort Statistics (CAES) 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.

To support the new and pending fishery management arrangements, improve assessments of key stocks and to facilitate the more detailed data requirements of the fisheries' export accreditation under the Commonwealth's *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*, a new daily/trip catch and effort reporting system was introduced in 2006/07. However, the transition to this new reporting regime has proven problematic for some fishers and some discrepancies have been identified in the reported daily/trip logbook data for 2006/07. Until new data validation procedures are developed, catch and effort statistics for the 2006/07 season cannot be updated with sufficient levels of confidence. *Thus, the data reported in last year's report remain the most current valid references for the performance of these fisheries.*

Retained Species

Commercial landings (season 2005/06[1]):

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	121 t	114 t
Total sharks & rays	**909 t**	**448 t**

Other fisheries' shark catches: Sharks are also caught off the south and west coasts in a variety of other commercial fisheries. However, due to the very poor identification of these (generally) non-targeted shark catches and their contribution to the overall sustainability risk to some stocks (eg. dusky shark), retention of sharks and rays on board Western Australian-managed commercial fishing vessels not operating in the managed target-shark fisheries (and a small number of other fisheries) was prohibited in November 2006.

The landed catch of sharks and rays by vessels operating in other managed fisheries in the same overall area (i.e. between North-West Cape and the South Australian border) consequently declined by 62% to 5 t in 2006/07. Despite the prohibition on retention of shark and ray catches, an additional 47 tonnes of sharks was taken by vessels using 'wetline' methods in the region (49% of the equivalent catch in 2005/06).

Recreational catch: **< 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[2]) 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.

Fishing effort/access level

There were 57 licenses in the JASDGDLF in 2006/07, 24 in Zone 1 and 33 in Zone 2. However, based on preliminary information, only 6 Zone 1 vessels (one less than in 2005/06) and 16 Zone 2 vessels (two more than in 2005/06) reported active fishing returns during the year. There were 26 licenses in the WCDGDLF in 2006/07, although only 9 (one less than in 2005/06) 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 and effort data. On this standardised basis, JASDGDLF and WCDGDLF fishing effort to 2005/06 is shown in Demersal Gillnet and Longline Figure 2.

Stock Assessment

Assessment complete: **Yes (indicator species)**

Stock assessment is carried out for the four main shark species caught by the fishery. In previous years' reports, sandbar shark assessments have been summarised in the Northern Shark Fisheries status report elsewhere in this volume. However, as the northern shark fisheries have now been excluded from most of this stock's range and the major remaining source of catch is the WCDGDLF, these assessments will henceforth be reported here. The 'effective' catch rates (catch per unit effort – 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[3] for details).

Gummy shark: Previous age-structured modelling 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.

Dusky shark: The status of the Western Australian dusky shark stock was reassessed using revised demographic modeling techniques, updated biological and fishing mortality parameters

1 These are the most current data available for the fisheries.

2 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 Austraila during 1996-97. Fisheries Research Report No. 117. Western Australian Marine Research Laboratories, Fisheries Western Australia.

3 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.

developed during the recently completed FRDC-funded project and analyses of CPUE (referred to below as CPUE or catch rate) trends.

The revised demographic analysis confirmed that rates of demersal gillnet and demersal longline fishing mortality experienced by sharks born in 1994 and 1995 were most likely sustainable. However, the model also predicted that an additional fishing mortality of as low as 1 to 2% per year applied to sharks older than 10 years of age resulted in negative rates of population growth. These results suggest that the stock is less productive than previously believed and provide a possible explanation for the declining trend in effective CPUE since 1994/95, when catches were approximately 58% higher than they were in 2005/06.

Sandbar shark. Stock assessment of the sandbar shark was undertaken using empirically-derived estimates of fishing mortality and demographic modelling 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.

Model 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 analysis has been completed. By incorporating fishing mortality estimates, the 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 (derived from catches of 250 – 440 tonnes per year) were unsustainable between 2001 and 2004.

As combined catches from the target fisheries were similar during the previous four years (230 – 290 tonnes per year), over-fishing is believed to have occurred since at least 1997/98. The highest estimated rate of stock depletion was in 2003/04 when, in addition to the 204 tonnes landed by the demersal gillnet and longline fisheries, the reported catch (of mainly adult sandbar sharks) in the northern shark fisheries was 209 tonnes. Given this result, the combined targeted catch of 918 tonnes in 2004/05 (762 tonnes of which was reported by the northern shark fisheries) is considered to have been highly unsustainable.

Effective sandbar shark CPUE estimates have declined markedly since 2002/03, approximately five 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 consistent with a decline in stock recruitment beginning in the late 1990s. It is thus inferred that the declining trend in effective CPUE is being driven 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 section 'Breeding stock levels' below).

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, was last updated in 2007 (based on CPUE data up to, and including, 2005/06). This latest assessment indicated that the whiskery shark stock had begun to recover after its significant depletion during the 1980s and slowly declining trend prior to the previous (2004) assessment.

Median estimates of total biomass were calculated to have increased by 3.4% per year in 2004/05 and 2005/06. 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. However, to ensure the continued recovery of this stock, catches should be constrained to their 2001/02 levels (9% less than in 2005/06) and further measures are necessary to improve recruitment.

Breeding stock levels:

Gummy shark:	**Adequate**
Dusky shark:	**Inadequate**
Sandbar shark:	**Inadequate**
Whiskery shark:	**Inadequate but recovering**

Gummy shark: 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: 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: Fishery-independent survey data collected from the area between northern Shark Bay and Eighty Mile Beach, where mature sandbar sharks are prevalent, suggest a 58% decline in the species' abundance between 2002 and 2005. The full extent of this 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 breeding biomass is already likely to be at the minimal acceptable limit reference point of around 40% of its unfished level and continuing to decline, this stock requires careful monitoring and may require additional species-specific recovery measures in the future.

Whiskery shark: 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 3.0% decline in the female breeding stock.

Non-Retained Species

Bycatch species impact: **Low**

The catch composition of the fishery was 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 being managed towards a lower level than during the mid-to-late 1990s in all management zones, bycatch levels are expected to be 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 between Steep Point (26°30´ S) and a line drawn north of North-West Cape (114°06´ E), 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 WA, 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 2006/07 **N/A**

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

Current fishing (or effort) level:

Not assessed (JASDGDLF Zone 1)
Not assessed (JASDGDLF Zone 2)
Not assessed (WCDGDLF)

The 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 number of unused (latent) units, which have caused excessive levels of effort over the last four years, more explicit (hourly) effort control arrangements are being developed (see section 'New management initiatives' below).

New management initiatives (2007/08)

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 two status reports were introduced prior to or during the 2006/07 fishing season. Remaining measures are expected to be in place by June 2009. The outstanding elements of this package are:

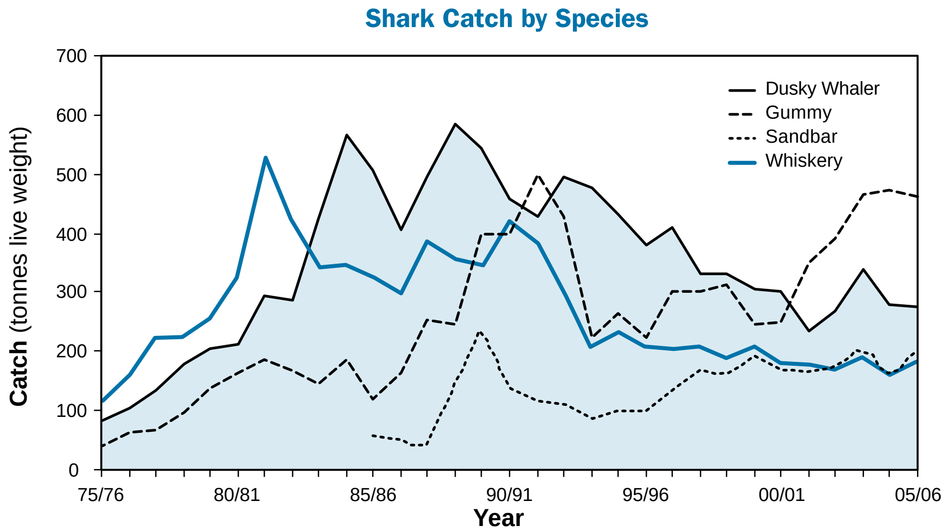
- conversion of existing monthly gear units to hourly gear units;
- explicitly capping fishing effort within each zone at their 2001/02 levels;
- implementation of the vessel monitoring system (VMS) in the JAS (partially implemented) in the WC;
- a prohibition on the use of wire traces in all commercial fisheries under State jurisdiction (except the northern shark fisheries) (partially 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 drafted for the South Coast and West Coast bioregions, this will be implemented in 2009.

External Factors

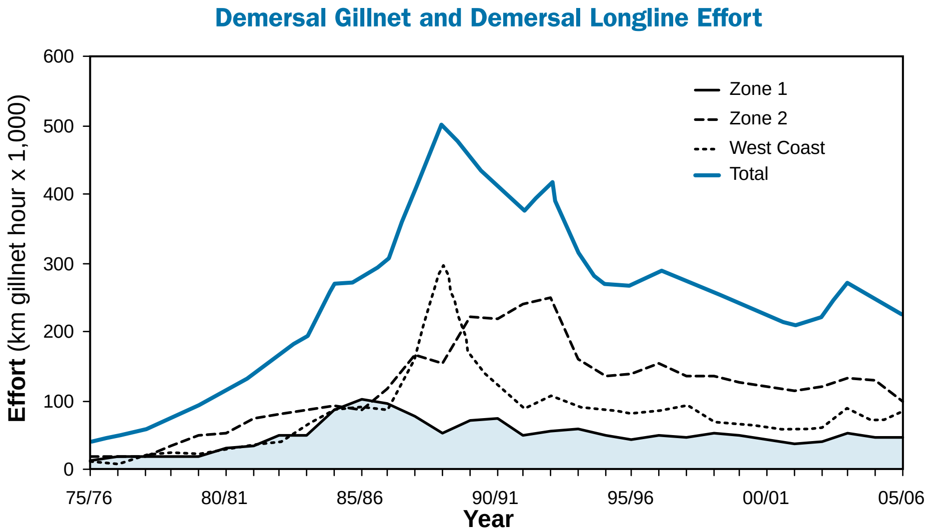
There are a number of factors outside of the control of the fishery that are negatively impacting the performance of key temperate shark stocks. These include incidental catches of dusky shark, sandbar and gummy sharks in offshore Australian Government-managed fisheries and in overlapping WA-managed fisheries. For the sandbar population particularly, the overlap with the northern shark fisheries that 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. However, all of these outside influences need to be taken into account in the stock assessment process for these species and accommodated in the management strategy.



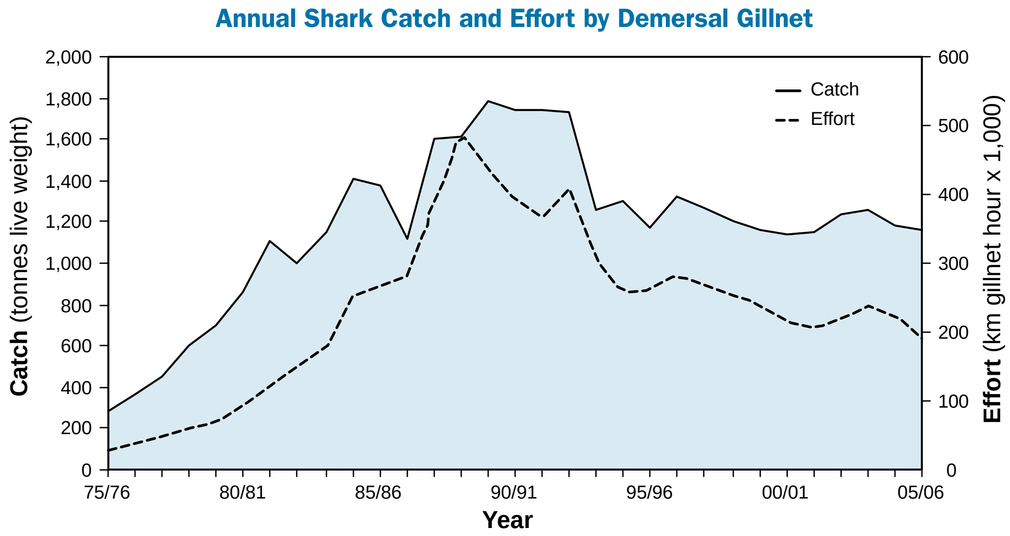
DEMERSAL GILLNET AND LONGLINE FIGURE 1

Annual catches of target shark species in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



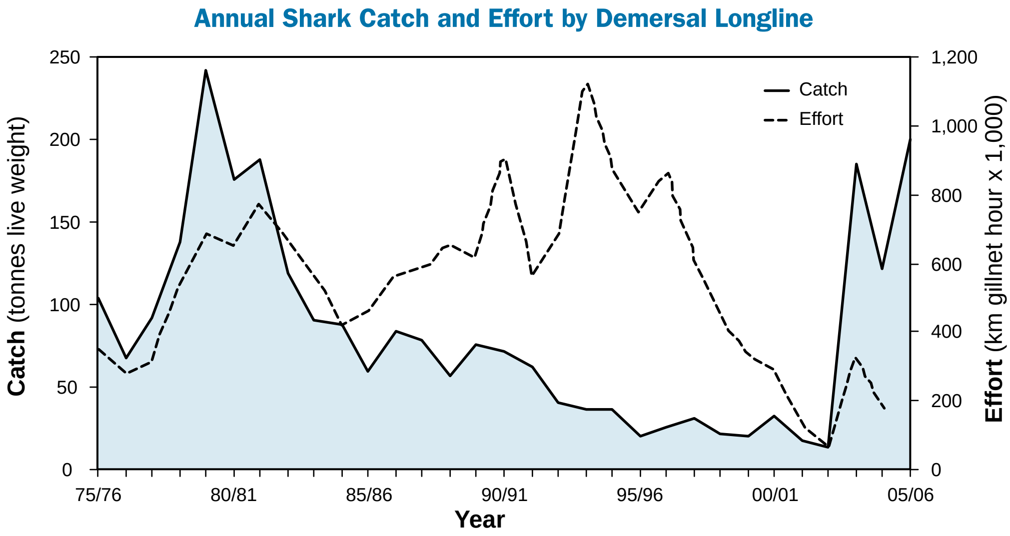
DEMERSAL GILLNET AND LONGLINE FIGURE 2

Effort in the demersal gillnet and longline fisheries (JASDGDLF and WCDGDLF) for the period 1975/76 to 2005/06.



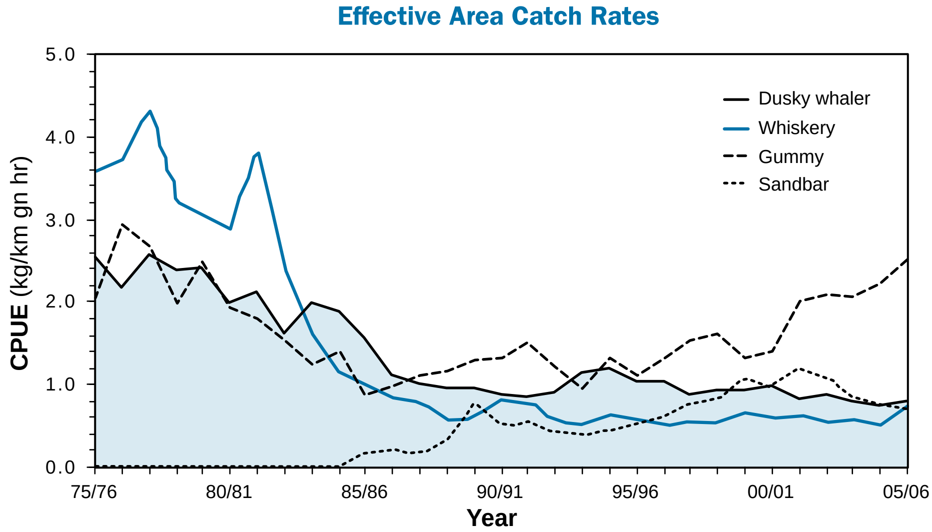
DEMERSAL GILLNET AND LONGLINE FIGURE 3

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 three target species of the demersal gillnet and longline fisheries for the period 1975/76 to 2005/06.

AQUACULTURE

Regional Research and Development Overview

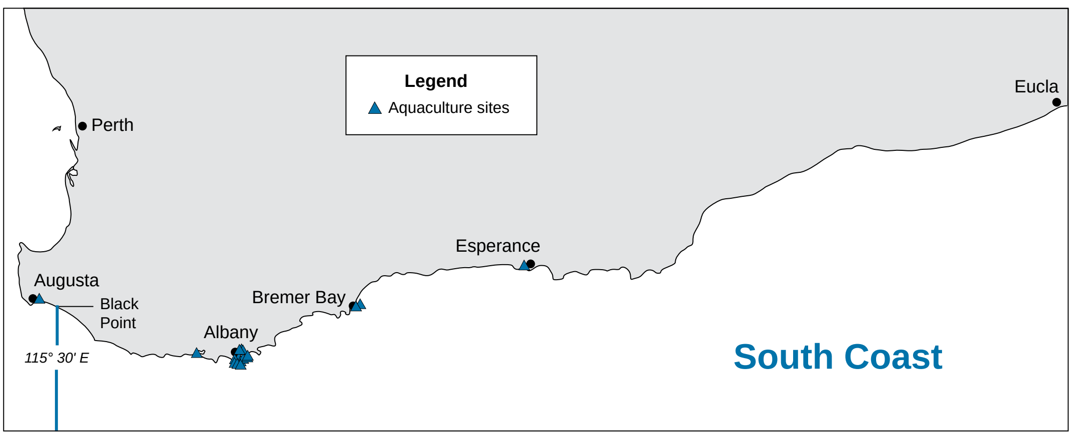
Abalone is considered a key species for aquaculture development on the south coast. The development of this industry sector is one of the priorities for the Aquaculture Development Council.

Previous abalone aquaculture research by the Department of Fisheries and Murdoch University has shown that specific red algae can be utilised in commercial abalone nurseries and that they can easily be grown with existing infrastructure from a commercial abalone farm. The results of this research have been taken up and applied by the industry, which is achieving improving growth and survival rates, particularly during the warmer months when feeding formulated diets is problematic and high mortalities are encountered on farms.

The abalone aquaculture sector has seen the consolidation of two land-based farms near Bremer Bay into a single operation. Its future expansion will be subject to the development of a biosecurity plan, which the proponent is developing with a contribution from the Department of Fisheries.

The Department of Fisheries has received and is processing an application for an offshore abalone farm near Augusta, which is linked to an existing, land-based hatchery. It is also reviewing leasing arrangements for the mussel industry on the south coast.

The Department is closely monitoring an abalone disease outbreak off the coast of Victoria and considering and implementing measures to prevent the entry of the virus into Western Australia.



SOUTH COAST AQUACULTURE FIGURE 1

Map showing the major licensed aquaculture sites of the South Coast bioregion.

COMPLIANCE AND COMMUNITY EDUCATION

Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers (FMOs) 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 in the bioregion. Natural Heritage Trust (NHT) funding through South Coast Natural Resource Management Inc. has continued to fund a Volunteer and Education Activity Coordinator (VEAC) position in the bioregion.

Activities during 2006/07

Due to the variety of commercial and recreational fisheries, expanse of coastline and variable and seasonal weather conditions, FMOs employ a risk management driven approach to prioritise and plan compliance activities.

Overall, FMOs delivered a total of 2,985 hours of 'in-field' compliance activity during 2006/07 (South Coast Compliance Table 1), representing a decrease from the previous year. (South Coast Compliance Figure 1).

Officers made contact with a total of 213 commercial fishers in the field, with the majority of the commercial compliance effort directed towards 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. Officers from the southern region conducted joint investigations with other compliance units into organized unlicensed illegal abalone operations.

The remainder of the commercial fishery compliance effort was directed to the wide range of minor commercial fisheries operating in the bioregion. Particular attention was paid to the South Coast Estuarine Managed 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 South Coast Purse Seine Managed Fishery.

During the year, 4 infringement warnings and 8 infringement notices were issued and a further 6 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 2,857 recreational fishers. During 2006/07, 55 infringement warnings and 46 infringement notices were issued and 9 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, marine finfish and estuarine netting. There continues to be a growing awareness of the open season and availability of abalone on the south coast.

The education program in this bioregion is supported by Volunteer Fisheries Liaison Officers (VFLOs), who conduct education programs throughout the region.

In 2006/07 the VFLO program involved 12 volunteers in the Albany and Denmark areas and 8 in Esperance. Community education activities conducted in the bioregion included attendance and presentations by the Volunteer & Education Activity Coordinator and volunteers at primary and secondary schools, regional shows and festivals, community group meetings and fishing competitions.

Initiatives in 2007/08

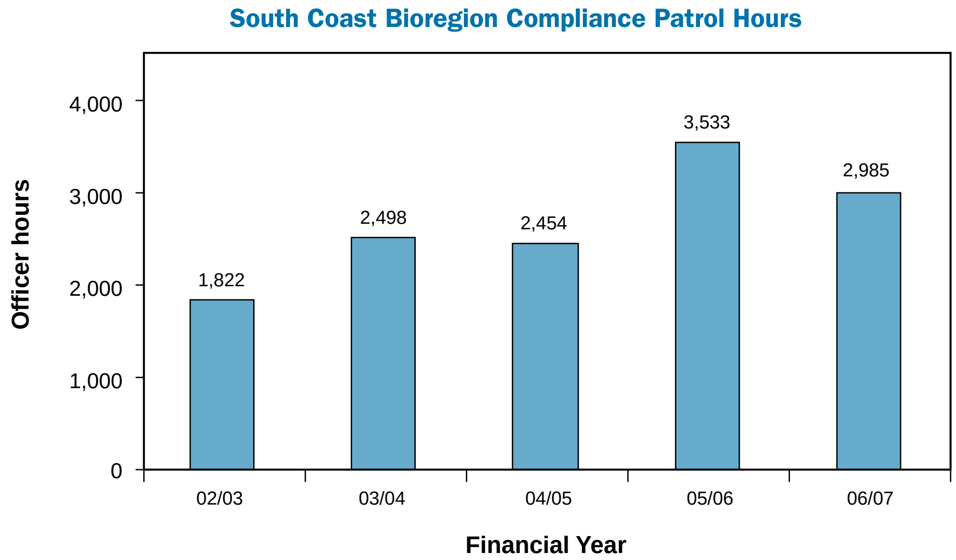
Compliance and management personnel continue to refine compliance planning to deliver greater efficiencies and outcomes through the use of risk assessments and intelligence processes. This has resulted in greater capacity to target specific offence types utilising risk analysis to deploy resources more efficiently.

A compliance plan will be developed to focus on the new management arrangements for the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF), which include effort restrictions and a 3-month whiskery shark pupping closure. Abalone compliance activities will continue to focus on targeted inspections of landings based on analysis of the existing intelligence.

FMOs will structure recreational fishing compliance programs to address a growing concern about increased catches of demersal scalefish by recreational fishers. The program will include operations aimed at ensuring compliance with possession limits, as well as investigations into suspected illegal fish sales.

The proposed development of the Walpole – Nornalup Inlets Marine Park will see the personnel in the South Coast bioregion engaged in a range of tasks, including delivery of marine park compliance services and education programs. Operational plans will be developed with the Department of Environment and Conservation, with a focus on joint operations to maximize the management presence in the marine park.

The VFLO program, with additional support from the Volunteer and Education Activity Coordinator position, will focus on a Marine Education Program for the South Coast that will incorporate the management initiatives for the Walpole – Nornalup Inlets Marine Park.



SOUTH COAST COMPLIANCE FIGURE 1

'On Patrol' Officer Hours showing the level of compliance patrol activity delivered to the South Coast bioregion over the previous 5 years. The 2006/07 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, etc.).

SOUTH COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2006/07 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,985 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	213
District Office contacts	555
Infringement warnings	4
Infringement notices	8
Prosecutions	6
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	2,857
District Office contacts	1,035
Infringement warnings	55
Infringement notices	46
Prosecutions	9
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	113
District Office contacts	673
Fishwatch reports**	21

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The 'Other' 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 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 Dam.

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 increased 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 Department's licensing and on-going arrangements, in conjunction with industry and TAFE.

The Department also has an approval process in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

The Department also has 'introduced aquatic organism incursion' and 'fish kill incident response' programs in place.

FISHERIES

Lake Argyle Silver Cobbler Fishery Status Report

S.J. Newman and C. Skepper
Management input from R. Green

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 'the *Lake Argyle Fishery Notice 1994*' (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
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

The LASCF is managed by input controls in the form of a set of licensing conditions. The LASCF is a limited entry fishery, with six current endorsement holders. Under the *Lake Argyle Fishery Notice 1994*, endorsement holders are allowed to use no more than 1,500 metres of gillnet at any one time, 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 159 mm (6¼ inches) and a drop length of no more than 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. This seasonal closure attempts to protect fish during the spawning season. Furthermore this time of the year water temperatures in the lake are high resulting in spoilage of fish in the nets. 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 2001, a voluntary industry Code of Practice was introduced to the LASCF, to implement sustainable fishing practices and to reduce conflict with other stakeholder groups in Lake Argyle. The code specifies the accepted means of operation in the fishery, and outlines contingency procedures for lost or abandoned fishing gear.

In response to concerns from charter operators, the general public and conservation groups of interactions between commercial fishers and protected species, a Bycatch Action Plan was developed for the LASCF. The Bycatch Action Plan aims to minimise the incidental capture of protected species in Lake Argyle (including freshwater crocodiles, tortoises, and birds) during commercial gillnetting targeting the silver cobbler.

Future management measures for the LASCF include (i) a review of the latent effort present within the fishery, (ii) a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species, and (iii) consideration of incorporating key elements of the LASCF Code of Practice into the formal management arrangements for the fishery in the future.

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. There is still a large amount of uncertainty around the biological parameters (e.g. longevity, growth rate) for silver cobbler.

Retained Species

Commercial landings (season 2007): 119 tonnes

This silver cobbler fishery first developed in 1979 with increasing catches reported until 1988 (138 t). Catch levels subsequently 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. Through voluntary reductions in effort, catches declined in both 2001 and 2002. From 2003 to 2005, the level of catch ranged from 131 to 165 t, but in 2006 the catch dropped to 78 t The catch in 2007 is 119 t and is within 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 2007 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 2007, four vessels were active in the fishery, and generated an effort of 5,823 units (100 m net days) – this level of effort is about 10% higher than the 5,279 units reported in 2006 (Lake Argyle Silver Cobbler Figure 1).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Adequate

The catch rates achieved in the fishery have varied substantially among years (Lake Argyle Silver Cobbler Figure 1). The catch rate in 2007 increased from the low level seen in 2006 to a level similar to 2005, which is within the range reported over the last decade.

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 over-fished. 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. These assessments indicated that the fishery was probably over-exploited and the breeding stock may not have been sufficient to maintain recruitment if fishing had continued at these levels.

Significant reductions in catch which occurred in 2001 and 2002 will have assisted in the recovery of the breeding stock. Nonetheless, the variable, but generally higher, CPUE observed since this time may be mostly related to variations in recruitment strength that are unrelated to fishing.

The demographic parameters (e.g. growth, longevity, mortality) for silver cobbler are highly uncertain. These parameters need to be resolved before a more robust assessment of the stock status could be made.

Non-Retained Species

Bycatch species impact: Low

As a result of the large mesh size used relative to the species present in the lake, there is minimal fish by-catch in this fishery.

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. Where practicable, freshwater crocodiles are released alive. Although Lake Argyle is an artificially-created aquatic environment it is now designated as a wetland of international importance under the Ramsar Convention. Based on the reports by fishers, only low levels of capture occur, therefore the incidental capture of crocodiles is considered to be of low risk to the crocodile stock.

In 2005, Lake Argyle Silver Cobbler Fishery endorsement holders' trialled the use of fish traps as a method of mitigating bycatch. However, this gear-type has proved to be ineffective for harvesting silver cobbler. The fishers are continuing attempts to reduce the incidental capture of non-target species using their endorsed Bycatch Action Plan.

Ecosystem Effects

Food chain effects: Not assessed

Habitat effects: Negligible

The gillnets used have minimal impact on the habitat.

Social Effects

During 2007, 4 vessels fished in the LASCF, with an average crew level of two people per vessel, indicating that 8 people were directly employed in the fishery. Additional employment occurs throughout the fish processing and distribution networks.

Economic Effects

Estimated annual value (to fishers) for year 2007: $316,000

The LASCF landed a total of 119 t of fish in 2007 for a catch value of over $316,000. This estimate is based on the landed weight of silver cobbler recorded in the Catch and Effort Statistics (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. Applying an autoregressive moving average control quality procedure to the annual catches from 1990 to 2002 has derived this range. 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 2007 catch was within the target range.

Current fishing (or effort) level; Acceptable

The levels of catch in the fishery increased in 2007 compared to 2006 due to increased levels of fishing effort within the fishery and also increased catch rates. The 2007 level of catch and effort was within the range reported over the past 5 years. As such, the current level of catch and effort are considered acceptable.

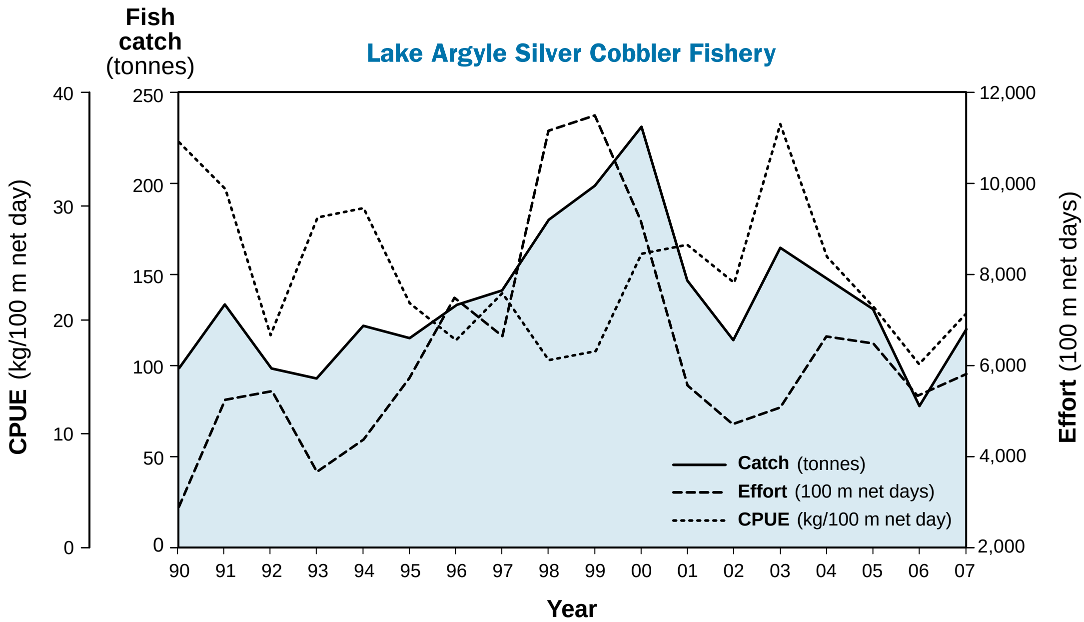
New management initiatives (2007/08)

The 2008 annual management meeting for the fishery is expected to focus on bycatch issues, particularly in relation to interactions with protected species (e.g. crocodiles, turtles) and their reporting requirements. It is expected that this meeting will lead to new management initiatives for the fishery including formalisation of current industry codes of practice into legislation and reviewing the seasonal closure period.

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 2007.

AQUACULTURE

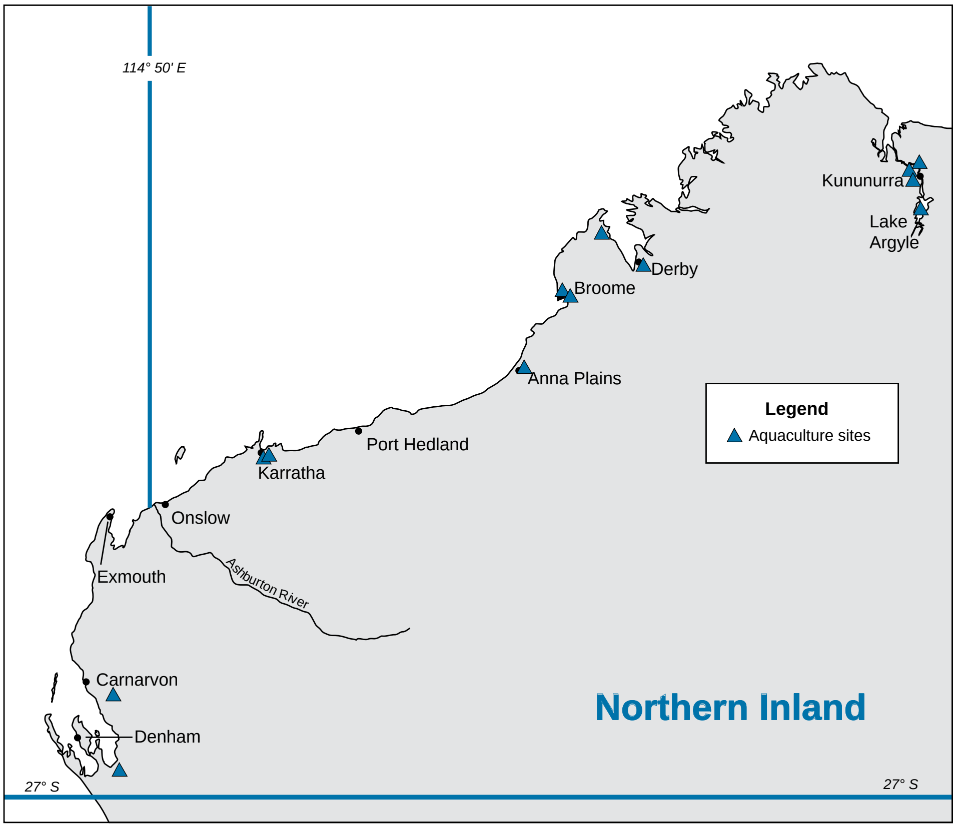
Regional Research and Development Overview

The Department of Fisheries has been involved in assessing a range of sites in areas occupied by local indigenous communities interested in aquaculture. Progress is being made to identify a site as part of the implementation of the Ord Stage II final agreement for providing land-based support facilities. An area in Lake Argyle has been vested in the Minister for aquaculture purposes. The process is under way to issue an aquaculture lease in Lake Argyle for the Mirriuwung Gajjerong Aboriginal Corporation, in accordance with requirements for the Ord Stage II final agreement. The lease is expected to be issued by the end of June 2008. The Department is in the final stages of issuing an Aquaculture Licence to allow the production of 500 tonnes per annum of barramundi in Lake Argyle.

The Department is working with local groups to assist in the development of an indigenous model farm for the aquaculture of barramundi and redclaw crayfish near Kununurra.

Two 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 initiatives aimed at improving the product quality, disease, feed and environmental management of barramundi cage farming in the Kimberley have been completed. Further work continues on improving sustainability of barramundi aquaculture across northern Australia. World leading feed designs being adopted by commercial feed companies both in Australia and overseas have arisen from this work. The development of feeding systems models and environmental impact assessment systems have also been widely-used 'outputs' from this work.



NORTHERN INLAND BIOREGION FIGURE 1

Map showing the major licensed aquaculture sites of the Northern Inland bioregion.

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 Northern 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 2006/07

During 2006/07, Fisheries and Marine Officers (FMOs) recorded 599 hours of active compliance patrol time in the Northern Inland bioregion – an increase compared to the previous year but aligned with historic levels of patrol activity (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland bioregion, personal contact was made with 2,253 fishers and non-fishers 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.

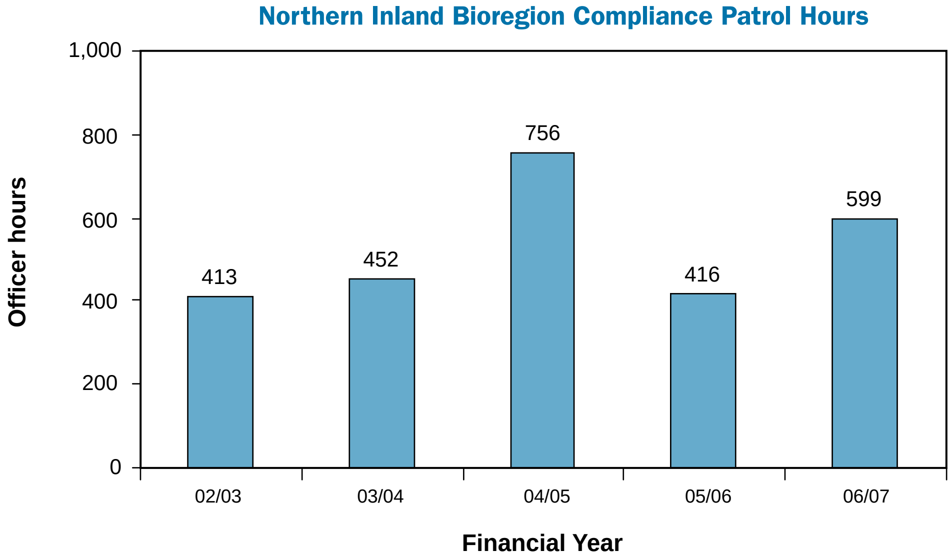
Compliance and education was also undertaken in the Lake Argyle area, where FMOs inspected commercial silver cobbler fishers and aquaculture sites to ensure that compliance with management, protected species interaction and environmental objectives were being met.

Initiatives in 2007/08

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 in WA, which targets the Lake Argyle silver cobbler, will continue. The operators in this fishery are inspected 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 five years. The 2006/07 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 2006/07 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	599 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries & Marine Officers	66
District Office contacts	30
Infringement warnings	0
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	1,030
District Office contacts	48
Infringement warnings	3
Infringement notices	16
Prosecutions	0
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1,157
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 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

Margaret River.

ABOUT THE BIOREGION

This region contains WA'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 grow-out 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.

Researchers from the Biodiversity and Biosecurity Branch are involved in several research projects related to freshwater biodiversity and conservation. One of these projects has been monitoring and assisting the restoration of hairy marron (freshwater crayfish) populations in the Margaret River. The critically endangered hairy marron (freshwater crayfish) is endemic to the Margaret River. However, the common, wide-spread smooth marron was accidentally introduced to the lower reaches of the river in the early 1980s. Over time, smooth marron have replaced hairy marron, first from the lower reaches (in the 1980s), then the middle reaches (in the 1990s) and at present hairy marron are only found in significant number in the upper reaches, but together with smooth marron.

Hairy crossed with smooth marron hybrids are common in the upper reaches of the Margaret River and the hybrids are fertile and appear to have similar ecological fitness. The displacement of hairy marron by smooth marron is most likely driven by hybridization of what appear to have been two geographically distinct sub-species. Maintaining populations of hairy marron in the upper reaches of the Margaret River is vital for the conservation of the sub-species and will require ongoing removal of smooth marron in combination with re-stocking pure hairy marron from the captive breeding program.

A different project funded by the Swan-Canning Research and Innovation Program (SCRIP) is aimed at determining the invasive potential of the feral cichlid (*Geophagus brasiliensis*) in Bennet Brook, a tributary of the Swan River. Recent salinity tolerance trails showed that this feral cichlid can easily cope with high salinities (>20 PPT). These results suggest that this feral cichlid could spread more widely throughout the Swan catchment in the future, posing a serious threat to native fish.

ENVIRONMENTAL MANAGEMENT

Regional Overview (Southern Inland)

The conservation of the 13 species of native fish in freshwater ecosystems in the south-west of WA is a growing issue for the Department of Fisheries. Many of these freshwater species are endemic to WA, and under pressure through increasing salinity, feral fish populations, 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 live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

The Department also has 'introduced aquatic organism incursion' and 'fish kill incident response' programs in place.

FISHERIES

Marron Fishery Status Report

Prepared by M. de Graaf and T. Baharthah
Management input by Nathan Harrison

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 (RFFSS) 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. The RFFSS 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 containing future management options for the fishery. The following adjustments to the existing management options of the recreational marron fishery were implemented from the 2007 season.

1) Minimum legal size increased from 76 mm to 80 mm rostrum carapace length.

2) Retention of the 10 (or 5 marron in 'trophy waters') marron per day bag limit, but the introduction of possession limit of 20 legal-size marron per licensed fisher.

3) Increased season from 16 to 23 days.

4) Hutt River managed as a 'trophy water', with a minimum size limit of 90 mm rostrum carapace length 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 so as 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.

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 12 January to 4 February 2007. Three types of legal gear exist – scoop nets, drop nets and snares. Only a single scoop net or snare, or six drop nets, may be used at any one time, and some waters, including all major public dams, have been declared 'snare-only'.

In most waters, there is a minimum size of 80 mm carapace length and a bag limit of 10 marron per day. However, Harvey Dam, Waroona Dam and Hutt River are managed as 'trophy waters', with a minimum legal size 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 logbook 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 Fisheries Research and Development Corporation (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; and
- development of a tagging program to provide information on long-term growth and mortality throughout the marron range.

Retained Species

Commercial component: Nil

Recreational catch estimate (season 2007): 69,800 marron

The total catch for the 2007 season was estimated at approximately 69,800 ± 6,900 standard error (SE) marron or

20.8 ± 2.1 t of marron (average weight marron 297 g, based on logbook data). This is an increase compared to the previous season (2006: 47,200 ± 7,780 marron or 10.8 ± 1.2 t). The increase in catch in numbers is due to an increase in effort.

Note that the change in minimum legal size from 76 to 80 mm rostrum carapace length during the 2007 season significantly increased the long-term, stable average weight of retained marron from 230g (1971 – 2006) to 300g in 2007.

Fishing effort/access level

Total effort for the 2007 season was estimated from phone surveys at around 20,300 days. Fishing effort significantly increased compared to the previous season (e.g. 2006: 10,700 days). This was due to a large increase in the number of participating licensed fishers (from 3,300 in 2006 to 7,400 in 2007) as the number of fishing days per fisher decreased from 3.2 in 2006 to 2.7 in the 2007 season. The season length increased in 2007 to 24 days from 16 days in 2006.

Stock Assessment

Assessment complete: **Yes**

Breeding stock levels: **Adequate**

Current assessment involves the research surveys of stock levels at several indicator sites before the summer fishing season, phone surveys of recreational licence holders and volunteer logbook 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 catch per unit effort (CPUE) recorded by fishers, based on phone surveys, was lower (~20%) in 2007 at approximately 3.4 marron per fisher per day compared to the previous season (2006: 4.4 marron per fisher per day). A decline in CPUE (in number) was to be expected after increasing the minimum legal size from 76 to 80 mm rostrum carapace length. Therefore the average weight of a retained marron increased significantly from 230 g (1971-2006) to 300 g in 2007 resulting in the catch rates, measured as g/day, being reasonably similar.

Fishery-dependent catch and effort data (e.g. CPUE as determined by logbook or phone survey) can often be a poor indicator of true stock abundance. Therefore, in 2006 a new fishery-independent, stock assessment program was conducted to generate data on the relative abundance of marron in 3 dams (Waroona Dam, Wellington Dam, Harvey Dam) and 6 rivers (Shannon, Warren, Blackwood, Preston, Murray and Moore River).

The fishery operates over a number of river and dams, which contain 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. size at which 50% of the females are mature) seems to be below the minimum legal size of 76 mm rostrum carapace length for the majority of marron stocks in the south-west (e.g. Warren River ±56 mm rostrum carapace length, Murray River ±54 mm rostrum carapace length, Collie River ±42 mm rostrum carapace length, Preston River ±60 mm rostrum carapace length, Waroona Dam ±63 mm rostrum carapace length, Drakesbrook Dam ±31mm rostrum carapace length, Wellington Dam ±54 mm rostrum carapace length). 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.

In the Harvey Dam, female size-at-maturity is about 85 mm, and a larger minimum legal size of 90 mm rostrum carapace length has been introduced to protect this 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 rostrum carapace length) than the minimum legal size of 76 mm rostrum carapace length. From 2007, the Hutt River has been managed as a ‘trophy water’ with an increased minimum legal size of 90 mm rostrum carapace length and a reduced bag limit of 5. An increase in the minimum legal size might also be required in the near future for the marron in the Moore River, where preliminary data show that size-at-maturity is large (± 79 mm rostrum carapace length).

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 type of marron has been identified (‘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 ‘hairy’ 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 the ‘hairy’ marron.

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 significantly impact 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 2007 season, a total of 21,452 licences were sold, including umbrella licences (14,342). This represents a considerable (35%) increase from the 15,918 licences in 2006. The marron fishery in the 2007 season involved approximately 7,400 licence holders undertaking about 20,300 fishing days, and provided a major recreational activity in regional areas of the south-west of the State.

Economic Effects

The value of the 2007 season recreational marron catch was in the approximate range of $499,000 (based on an average sale price of marron from aquaculture farms of approximately $24/kg, and a range of tonnage based on estimated total catch in numbers as calculated from the phone survey and estimated average size of marron captured as calculated from logbook returns). Revenue from licence sales was estimated at approximately $353,000, which is used to support recreational fishery management, research and compliance. In addition, the estimated 20,300 days of marroning in regional locations provided a significant economical boost to regional towns in the south-west.

Fishery Governance

Target catch (or effort) range:

maximum < 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.

Current fishing (or effort) level: Acceptable

Under recent management arrangements (short 16-day season since 2003) the average estimated recreational catch has been around 55,000 marron, with the current low annual catch not due to limited marron stocks but to this sharp reduction in effort (Recreational Marron Figure 1). In 2007 the marron season increased from 16 to 23 days – this should see a limited growth in the fishery while maintaining catches at a sustainable level.

New management initiatives (2007/08)

The marron season for 2008 is again scheduled to last for 23 days, from 12 noon, Friday 25 January 2008 to 12 noon, Sunday 17 February 2008.

Marron abundance (fishery-independent surveys) and catches (phone survey and logbook) will be examined following the 2007 season to determine the impact of the changes in season length and increase in legal minimum size. The management arrangements will, if necessary, be reviewed prior to the beginning of the 2008 season.

External Factors

The three main external factors that 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, reducing pre-season illegal fishing.

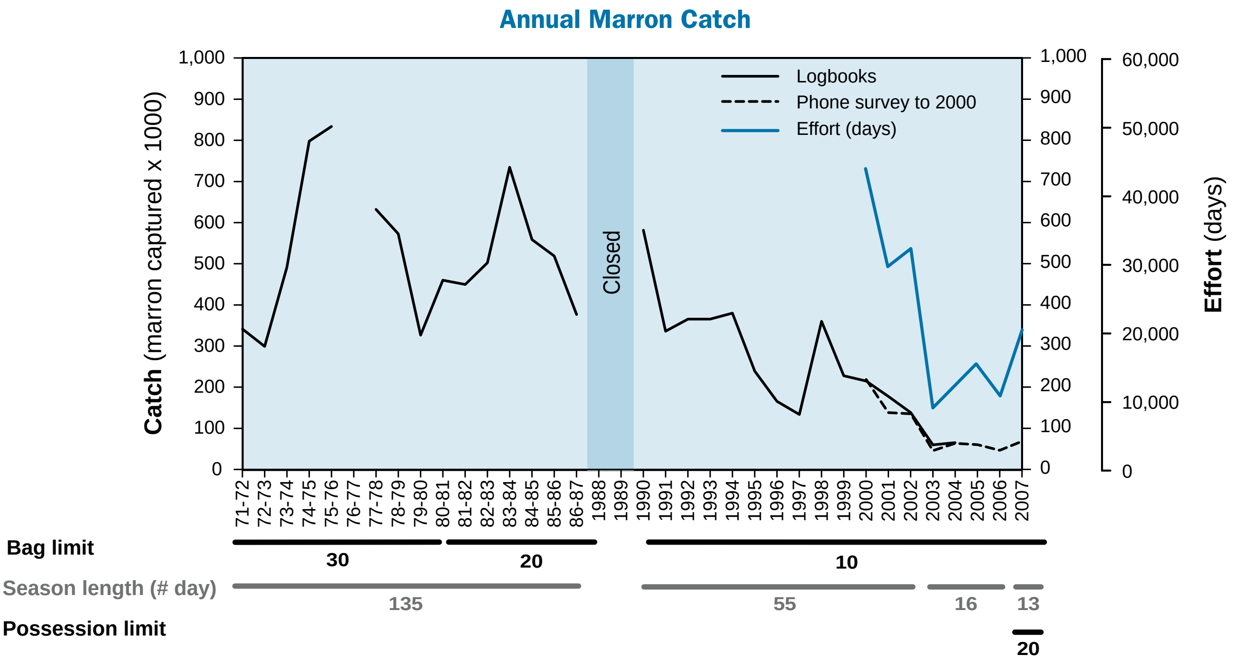
A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 and Logue Brook Dam in 2008 to divert the water to the Perth metropolitan water supply, and there is a strong possibility of limitations to fishing in Wellington Dam in the near future. Waroona Dam was closed for several seasons (2002 – 2005) for refurbishment, re-opening 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 to possibly 2012.

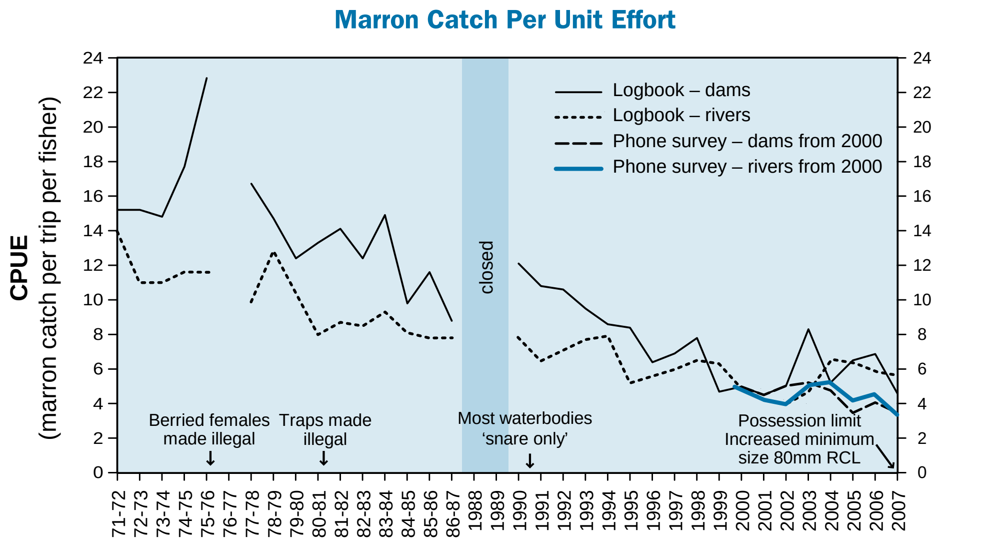
The Department of Fisheries is working closely with the Water Corporation to ensure the refurbished and refilled dams will provide a high-quality marron fishery by installing refuges, adding marron and controlling introduced species. Trials in Waroona Dam and Drakesbrook Dam showed that the artificial habitat (rock wall) provides an important refuge for juvenile marron and berried females. The Department of Fisheries secured funding from the Water Corporation to de-stock stock marron from Drakesbrook Dam before the complete drainage. The marron will be kept at the Department's hatchery facilities in Pemberton and will be re-stocked during the winter of 2009. Furthermore, in co-operation with RecFishwest and the Water Corporation, funding was secured from the Recreational Fishing Community Grants Program 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 2007.

South-West Freshwater Angling Fishery Status Report

Prepared by M. de Graaf and T. Baharthah
Management input by Nathan Harrison

Fishery Description

The south-west freshwater fishery is a recreational-only fishery that focuses primarily on angling for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*). These species are both the subject of an annual controlled stocking program undertaken by the Department of Fisheries. In addition, anglers catch the native freshwater cobbler (*Tandanus bostocki*) and an exotic species, redfin perch (*Perca fluviatilis*). Redfin perch was previously released in the south-west but now occurs 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 (RFFSS) of the Recreational Fishing Advisory Committee (RFAC)

Boundaries

The south-west freshwater angling license 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 licenses, seasonal closures, fish gear restrictions, minimum sizes, and bag limits. People under 16 years of age are not required to hold a license 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 is ‘artificial lure-only’ (no bait areas). A reduced bag limit (2 trout per day) also applies to this water. These measures are designed to improve the quality of the trout fishery over the spring period.

The trout stocking program administered by the Department of Fisheries in consultation with the 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 2007 approximately 527,000 rainbow and 40,000 brown trout fry, 23,700 rainbow and 220 brown trout yearlings and 2,680 rainbow and 450 brown trout broodstock were stocked in selected public waters.

The 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 2006/07): 26.8 tonnes

An estimated 26.8 ± 3.2 t of fish were landed in this fishery by recreational anglers in the 2006/07 season, including 18.9 t of retained fish (53,300 fish) and 7.9 t of captured and released fish (45,100 fish). The estimated catch was composed of 15,900 rainbow trout (4.3 t), 2,900 brown trout (0.8 t), 46,300 redfin perch (16.1 t), 600 native freshwater cobbler (0.2 t) and 32,600 black bream (5.4 t) (Freshwater Angling Figure 1).

The overall reported catch is similar to the previous season, which was 23.7 t. Landings of redfin perch (-4%; 1,800 fish) remained similar, while landings of native catfish (-85%; 3,300 fish) and rainbow trout (-15%; 2,700 fish) decreased significantly. Landings of black bream (275%; 24,000 fish) increased substantially and brown trout (120%; 1,500 fish) increased slightly compared to the previous season (Freshwater Angling Figure 1).

Fishing effort/access level

Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 23,800 days, similar to the previous season (23,400 days).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Not applicable

A catch rate of 4.1 fish of all species per day was estimated for the 2006/07 season. This included 2.2 retained fish and 1.9

released fish per angler per day. This is higher (~17%) than for the 2005/06 season, but well within the range of catch rates reported in the last seven years.

Phone survey data (Freshwater Angling Figure 1) indicate that overall, the stock levels of both rainbow and brown trout, as indicated by catch rates and catches, have remained reasonably stable over the past 7 years.

Both species of trout display little or no breeding in local waters, with the fishery supported through the stocking of fry, yearling and ex-broodstock trout by the Department of Fisheries. Redfin perch breed in, and dominate, the freshwater areas where they are located. The management arrangements (e.g. minimum legal size, bag limit) for 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, two species of south-west native fish are protected under the *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 has been raised, trout stocking has ceased [Margaret River 1998, Bancell Brook (Harvey River) 2004, Blackwood River downstream 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 captured 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 (~10%) and similar over the last 7 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 perch. Brown trout feeds on (non-) native fish, freshwater crayfish and, to a lesser extent, terrestrial insects. Rainbow trout on the other hand 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 2006/07 season, a total of 18,200 licences were sold, including umbrella licenses (14,342). This is a modest (10%) increase in comparison to the 16,500 licenses sold in 2005/06.

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 $275,000 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 (2007/08)

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.

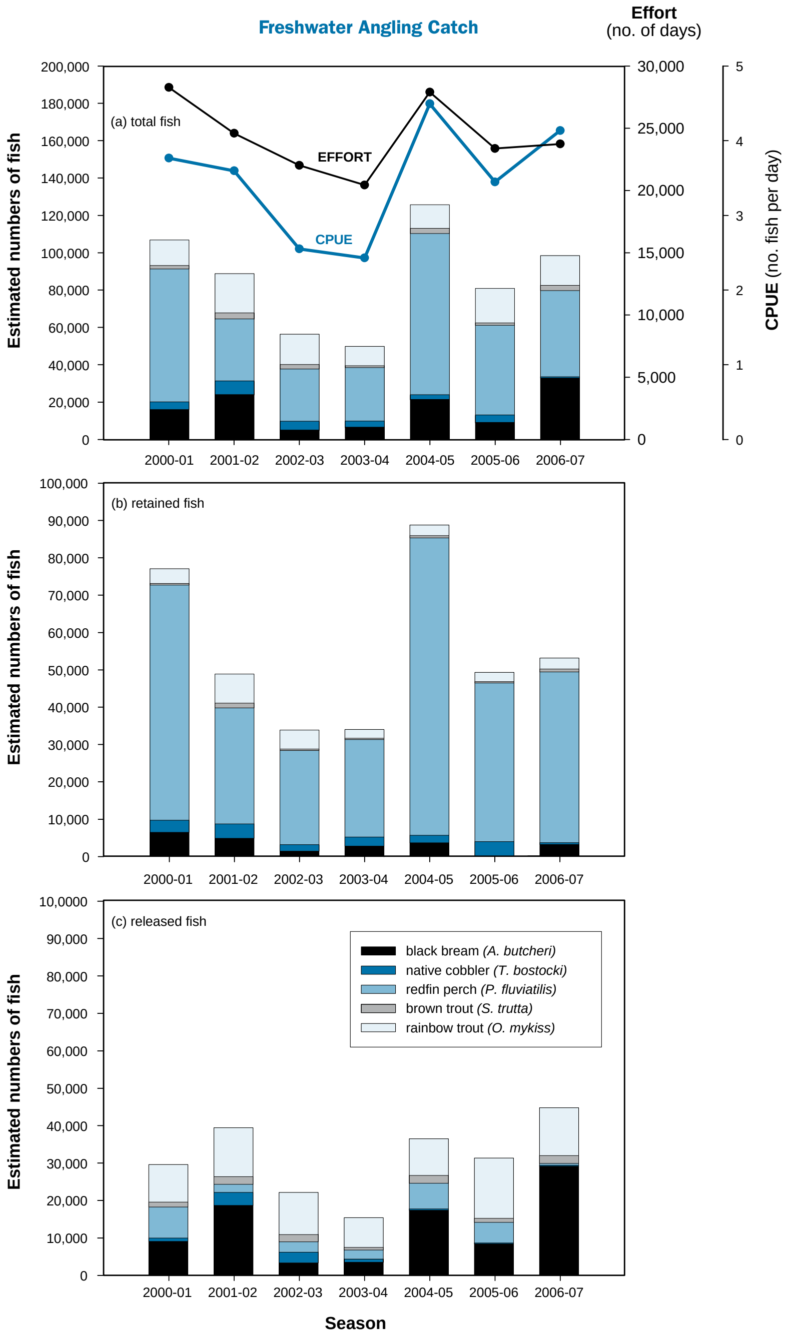
The RFFSS is currently reviewing the management arrangements for freshwater fisheries in the State's south-west. Part of the review will be the management arrangements (size limits, bag limits etc.) of the native cobbler based on the available historical and recent scientific data.

External Factors

The extent and success of the freshwater angling fishery in the south-west is dependent mainly upon availability of high-quality fresh waters 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 fishing. The availability of water 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 and Logue Brook Dam in 2008, owing to the diversion of this water to the Perth metropolitan water supply. 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.



FRESH WATER ANGLING FIGURE 1

Estimates of the development of total catch, effort and Catch Per Unit Effort (CPUE) (a) and total numbers of fishes retained (b) and released (c) by species in the south-west freshwater angling fishery since the 2000 – 01 season.

AQUACULTURE

Regional Research and Development Overview

Research undertaken over previous years at the Pemberton Freshwater Research Centre has focused on 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.

Industry sectors have now adopted and are applying the results of previous years' research to commercial operations.

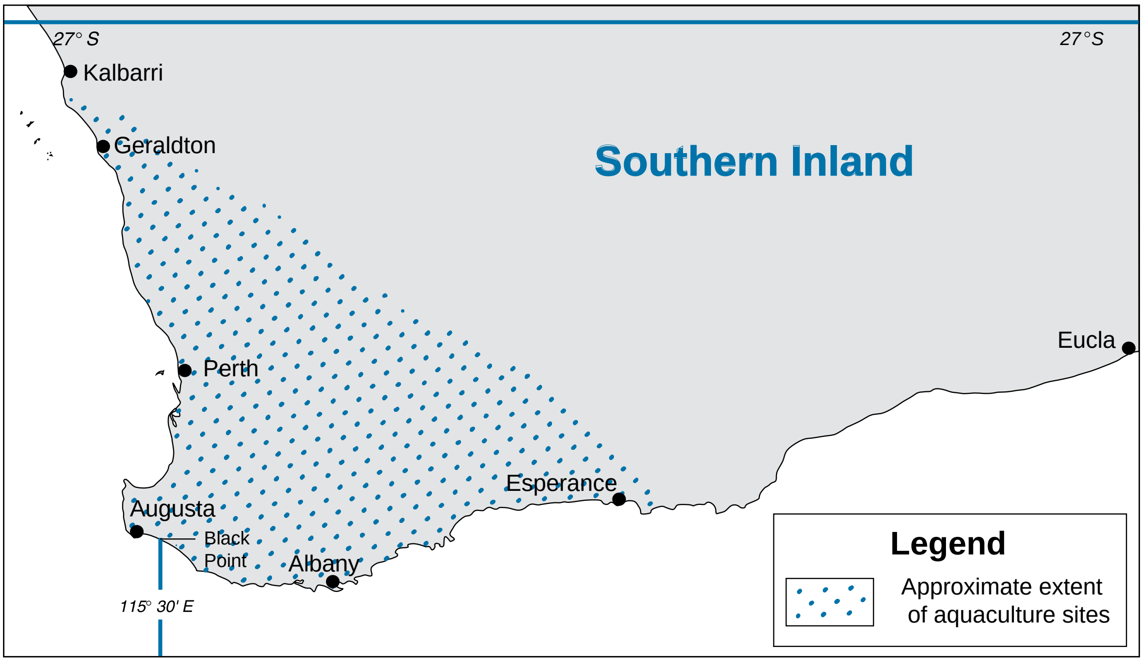
A major collaborative project was undertaken to assess the quality of local agricultural products, such as lupins and canola, in aquaculture feeds; the influence of feed grains on aquaculture feed manufacturing process; and their milling, storage and transport characteristics.

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 export market development has been restricted as a result of the drought.

A Ministerial Exemption has been issued to enable a commercial operator to collect marron from farm dams on a number of private properties. The purpose of the project is to provide information for a review of the current policy, which only allows one property on a licence. The trial project, which will run for three years, is at the end of its first year. It is being undertaken with the co-operation of local compliance officers in the south west.

The Aquaculture Development Council has developed a draft report identifying suitable sites for large-scale, inland aquaculture in Western Australia. The report is being finalized and is expected to become available in late 2008.



SOUTHERN INLAND AQUACULTURE FIGURE 1

Map showing the approximate extent of aquaculture sites in the Southern Inland bioregion.

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 23 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 the 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 Inland bioregion.

Commercial fishing activity in rivers is also included in the Southern Inland bioregion and some compliance patrols target fishing activity in the West Coast and South Coast estuarine fisheries.

Activities during 2006/07

During 2006/07, FMOs delivered 1721 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is a slight decrease from the compliance hours delivered in the previous year.

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 3,595 field contacts with recreational fishers and 89 contacts with commercial fishers. During the year, 36 infringement warnings and 32 infringement notices were issued with 58 prosecutions instigated (49 recreational, 9 commercial).

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The 2007 marron season was the second year of the five-year marron management strategy, public acceptance of the new rules is good and catches generally do not seem to have changed greatly in most areas. As was the case in 2006 the compliance activities for the 2007 marron season were developed from a risk assessment process, and targeted areas of high risk identified through that process. The marron season start date may need to be reviewed to permit better long-term planning for recreational fishers.

Aquaculture compliance activities are also a 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.

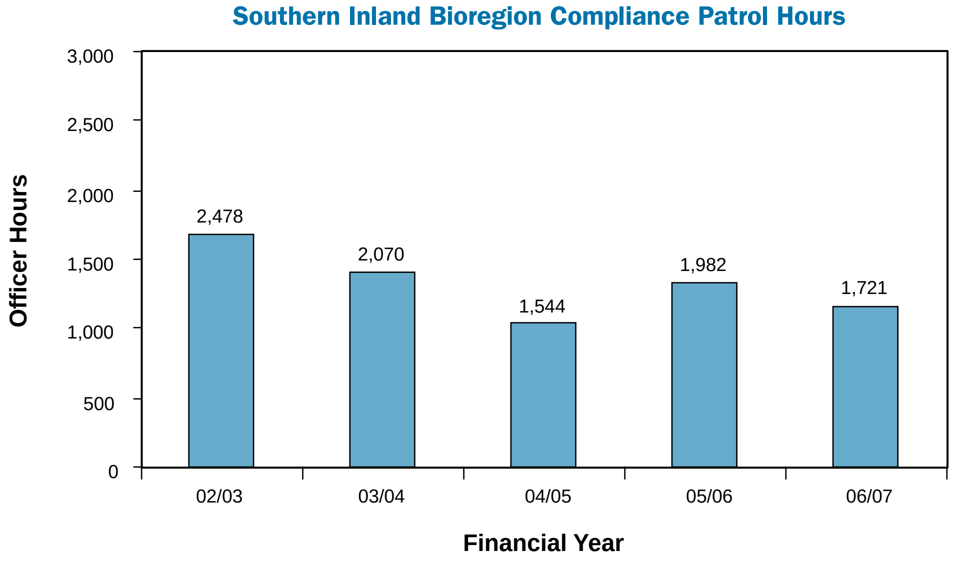
Initiatives for 2007/08

Joint operations with regional Water Corporation rangers will be increased during the 2008 season. These joint patrols increase the compliance presence in the marron fishery and the expert knowledge that Water Corporation rangers have of the dam areas and activities greatly assist in the compliance operations.

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 will also 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.

The southern regional Community Education Officer will again be conducting several 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 will be carried out in partnership with other agencies and natural resource management groups to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.



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 five years. The 2006/07 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 2006/07 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,721 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	89
District Office contacts	0
Infringement warnings	0
Infringement notices	0
Prosecutions	9
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,595
District Office contacts	3,100
Infringement warnings	36
Infringement notices	32
Prosecutions	49
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	1185
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 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

Hermit Crab at Moses Rock. Photo: Gilbert Stokman

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 the 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 metres 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, due to the small vessels used and the potentially hazardous conditions (e.g. waves and swell) encountered. In addition, human constraints (i.e. physiological effects of decompression) limit the amount of effort exerted in the fishery, the depth of water and the offshore extent as 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

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^2. 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 2007, 9 licenses operated in the fishery.

The fishery is permitted to operate in more general-purpose zones of marine parks for the collection of fish and some invertebrates (usually excluding coral and live rock). Licensees are not allowed to operate within any waters closed to fishing (e.g. Rowley Shoals, reef protected areas and sanctuary zones). 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 of 2004.

Retained Species

Commercial landings (season 2007): 37,000 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 2007 levels of catch is provided in Marine Aquarium Fish Table 1. The reported landings of aquarium fish for 2007 are similar to those reported in 2006.

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 809 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, licences 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 remote northern locations 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 many 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 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 over-fishing 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 his nominated operator) may fish with two 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 increased awareness of marine ecosystems through the provision of specimens for public and private aquariums.

Economic Effects

Estimated annual value (to fishers) for year 2007: 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 species targeted. Therefore the curent level of fishing activity is considered acceptable.

New management initiatives (2007/08)

The management arrangements for the MAF are currently under review. Among the changes under consideration is more equitable access for licensees to collect coral and 'live rock'.

The Australian Government's Department of Environment, Water, Heritage and the Arts 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 three years.

MARINE AQUARIUM FISH TABLE 1

Summary of the reported catch landed from the Marine Aquarium Managed Fishery and associated endorsements in 2007.

Common Name	Quantity (numbers)	Weight (kg)
Fish	35,580	
Syngnathidae (not included in 'Fish' category)	1,572	
Hermit crabs (land hermit crabs only -*Coenobita variabilis*)	76,877	
Invertebrates	84,072	
Algae/seagrasses		1,487
Hard coral		5,118
Soft coral		1,121
Living rock, living sand, sponge, other		2,824

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 operational limitations – 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 rare 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 2007): 23,000 shells

Recreational catch estimate (season 2007): Unknown

Landings

In 2007, the total number of specimen shells collected was 23,000, 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 13% of all shells collected in 2006 and 2007. Cypraeidae or cowries are noted for their localised variations in both shape and colour, making them attractive to collectors.

(Note reported total landings exclude *Trochus hanleyanus* taken for other purposes.)

Fishing effort/access level

Although there are 32 licences in the fishery, only about 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 2007, 1,135 days were fished.

Recreational component: 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 2007 season the catch rate was approximately 20 shells per day (excluding *Trochus hanleyanus*).

Ponder and Grayson (1998) 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. 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 59% (previously reported as 71%) in 2006 and 58% in 2007 of the shells sighted were not harvested.

The figures for 'sighted' versus 'taken' vulnerable shells continue to be poorly recorded by the majority of licensees.

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. However, licensees are not all reporting correctly and instead many continue to report using the 60 nm blocks.

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 2007, the catch level of approximately 23,000 shells and catch rate of 20 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 2007. 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 2007: 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 (2007/08)

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 (now) Department of Environment, Water Heritage and the Arts 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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Cocos (Keeling) Islands. Photo: Andrew Cribb

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APPENDIX 1

Stock Status and Catch Ranges for Major Commercial Fisheries

(Appendix 5 from Annual Report 2007/08[1])

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[1]	Season reported[1]	Catch (or effort) level acceptable	Comments on performance in reported season
West Coast Bioregion							
West coast rock lobster	Yes	Adequate	8,166 – 14,523	8,612 (Includes Windy Harbour and Augusta)	2006/07	Yes	The below-average catch is due to a low puerulus settlement three to four years previously. This low settlement is consistent with the environmental conditions.
Roe's abalone	Yes	Adequate	109.7 (Q) (620 – 750 days)	90.8 (585 days)	2007	Yes	The catch was taken using reduced effort levels, indicating higher abundances of Roe's abalone. Effort ranges are currently under review.
Abrolhos Islands and mid west trawl	Yes	Adequate	95 – 1,830	50	2007	Yes	The annual recruitment (and therefore catch) of scallops is highly variable and dependent upon favourable environmental conditions. The low catch in 2007 was anticipated, due to low recruitment.
South-west trawl	No	NA	Not available	Prawns 6 Scallops <3	2007	NA	
Cockburn Sound crab	Yes	Increasing	Not Applicable	1.5	2006/07	NA	The fishery was closed for most of the 2006/07 season, due to low breeding stock and low predicted catches. Monitoring of the stock to determine the level of recovery is underway.
Deep sea crab	Yes	Adequate	100 – 300 (crystal crabs)	227	2007	Yes	The introduction of a 140 t TAC for this fishery will begin in 2008.
Estuarine fisheries (west coast)	No	NA	75 – 220 (Peel-Harvey only)	165	2007	Yes	Catches have been stable since 2000, but are 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)	101	2007	Yes	Yearly fluctuations in whitebait stocks and catch levels 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[1]	Season reported[1]	Catch (or effort) level acceptable	Comments on performance in reported season
West Coast Bioregion (Continued)							
West coast purse seine	Yes	Adequate	3,000 (Q)	49	2007	NA	Quotas are adjusted annually. Target effort levels are not available. Continued low catches are due to a combination of market competition, irregular availability of market-sized fish and low activity levels by the fleet.
West coast demersal scalefish	Yes	Inadequate	558 – 798	725	2006/07	No	While the catch decreased to be within the previous target range, recent stock assessments indicate that two key indicator species are being overfished. Further reductions in catch are therefore required and new management arrangements are being developed.
Gascoyne Coast Bioregion							
Shark Bay prawn	Yes	Adequate	1,501 – 2,330	1,250	2007	Yes	Tiger prawns were within target catch limits. King prawns were below the target range; this was due to targeting of larger-sized prawns, less effort due to economics and targeting scallops during the early part of the season.
Exmouth Gulf prawn	Yes	Adequate	771 – 1,276	790	2007	Yes	While the total catch was in range, both king and tiger prawns were below their individual target catch limits. This was due to low recruitment of tiger prawns and the small size of king prawns early in the season.
Shark Bay scallop	Yes	Adequate	1,250 – 3,000	2273	2007	Yes	The scallop catch in 2007 was within the target catch range but below the catch prediction, due, in part, to reduced fishing effort.
Shark Bay beach seine and mesh net	Yes	Adequate	235 – 335	238	2007	Yes	The total catch increased slightly on 2006 level, mainly due to a large increase in the catch of mullet. The catch rates for whiting need monitoring.
Shark Bay snapper	Yes	Inadequate	297.3 t (Q) (410 – 580 days*) * June – July	286 t (547 days*)	2007	Yes	To assist stock recovery, the TACC for 2007/08 will be further reduced to 276.8 tonnes.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[1]	Season reported[1]	Catch (or effort) level acceptable	Comments on performance in reported season
North Coast Bioregion							
Onslow prawn	Yes	Adequate	60 – 180	4	2007	Yes	The very low catch was associated with minimal fishing effort. Environmental factors play a major role in the recruitment for these stocks and the acceptable range will be reviewed.
Nickol Bay prawn	Yes	Adequate	90 – 300	44	2007	Yes	The catches of banana prawns were below the predicted catch range. King prawn catches were low throughout the entire northern bioregion in 2007.
Broome prawn	Yes	Adequate	55 – 260	72	2007	Yes	
Kimberley prawn	Yes	Adequate	240 – 500	271	2007	Yes	
Kimberley gillnet and barramundi	Yes	Adequate	25 – 40 (barramundi)	26	2007	Yes	The barramundi catch was below that reported in 2006, but within range of the last 5 years.
Northern demersal scalefish	Yes	Adequate	Total 600 – 1,000 (goldband <382) (red emperor <186)	Total 908 (goldband 393) (red emperor 176)	2007	Yes	The catch of goldband snapper and red emperor increased from 2006. A stock assessment review for this fishery is in progress.
Pilbara fish trawl	Yes	Adequate	2,000 – 2,800	1,704	2007	Yes	Reduced catch levels were due to a combination of unused effort (vessels were trialling net modifications) and the natural cycles in catch rates of some shorter-lived species.
Pilbara demersal trap and line	Yes	Adequate	160 – 360 (trap) 50 – 115 (line)	460 (trap) 102 (line)	2007	Yes	Trap catches were again above the upper limit, due to increased stock sizes of target species where this sector operates. Acceptable catch ranges are therefore to be reviewed. The line catch was reduced to acceptable levels, following management changes for this sector.
Mackerel	Yes	Adequate	246 – 410 (all except grey mackerel)	324	2007	Yes	Catches remain relatively low In the Pilbara.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[1]	Season reported[1]	Catch (or effort) level acceptable	Comments on performance in reported season
North Coast Bioregion (Continued)							
Northern shark	Yes	Depleted	< 20 (sandbar only)	NA	2006/07	Yes	The shift to daily log sheets has delayed analysis of these data so catch estimates are incomplete, but are likely to be consistent with acceptable range.
Pearl oyster	Yes	Adequate	603,000 oysters (Q) (14,071 – 20,551 dive hours)	600,658 oysters (14,652 dive hours)	2007	Yes	Effort was below-average historical range, despite increase in quota, indicating stocks are higher than historical levels. With the predicted high abundance levels, the TAC has been increased to 694,800 in 2008.
Beche-de-mer	Yes	Uncertain	50 – 150	92.2	2007	Yes	Total catch was within targeted range, however it was dominated by a new species (redfish), with sandfish being a minor component. Species-specific indicators are under development for this fishery.
South Coast Bioregion							
South coast crustacean	Yes	Uncertain	50 – 80 (southern rock lobster)	53	2006/07	Yes	The upturn in this season follows a series of years of declining catches. The management arrangements are currently being reviewed to address latent effort issues.
Abalone (greenlip/ brownlip)	Yes	Adequate	211.5 (Q) (907 – 1,339 days)	205 (1,137 days)	2007	Yes	No Issues
Estuarine fisheries (south coast)	Yes	Adequate	200 – 500	251	2007	Yes	The total catch was approximately equal to the 10-year average. The stock levels of key species are considered adequate.
WA salmon	Yes	Adequate	1,200 – 2,800	871	2007	Yes	Recent catches are very low relative to historic levels, due to the low effort from limited market demand. In addition, recent oceanographic conditions made fish less accessible to fishers on the south coast.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[1]	Season reported[1]	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)	192	2007	Yes	Stock levels may have declined during the previous decade as a result of poor recruitment. However, the current commercial catch and effort levels are still acceptable because they are at historically-low levels due to markets.
Albany/King George Sound purse seine	Yes	Adequate	2,722 (Q)	1,445	2006/07	NA	Target effort levels are not available.
Bremer Bay purse seine	Yes	Adequate	1,500 (Q)	167	2006/07	NA	Target effort levels are not available. Low catch and effort are due to lack of local labour and competition for markets.
Esperance purse seine	Yes	Adequate	1,500 (Q)	11	2006/07	NA	Target effort levels not available. Low catch and effort are due to lack of local labour, competition for markets and availability of market-sized fish.
Southern and west coast demersal gillnet and longline	Yes	Gummy and whiskery increasing. Dusky and sandbar depleted.	725 – 1,095	NA	2005/06	NA	The shift to daily log sheets has delayed analysis of these data, so catch estimates are not available. Stock status is likely to be unchanged from last year. Management will be shifting to the use of daily gear units to more explicitly control fishing effort.
Northern Inland Bioregion							
Lake Argyle catfish	Yes	Adequate	95 – 155	119	2007	Yes	

Notes:

1 Catch figures supplied for latest year/season available.
NA Not assessed.
Q Quota management.
TAC Total Allowable Catch
TACC Total Allowable Commercial Catch

APPENDIX 2

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APPENDIX 3

Table of catches from fishers' statutory monthly returns for 2007/08

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*	7,978	7,978
Anchovy	*Engraulis australis*	1,614	1,614
Barramundi (giant perch)	*Lates calcarifer*	23,035	33,609
Bass grouper	*Polyprion americanus*	6,485	6,485
Bigeye (not tuna)	Priacanthidae	27,105	27,105
Boarfish	Pentacerotidae	4,524	5,429
Bonito	*Sarda australis*	1,499	1,506
Bream, black	*Acanthopagrus butcheri*	39,336	39,336
Bream, monocle	*Scolopsis spp.*	12,666	12,666
Bream, Robinson's	*Gymnocranius grandoculis*	40,939	40,939
Bream, sea	*Gymnocranius spp.*	11,042	11,126
Bream, silver (tarwhine)	*Rhabdosargus sarba*	5,241	5,241
Bream, western yellowfin	*Acanthopagrus latus*	20,235	20,235
Catfish, sea (golden cobbler)	Ariidae	22,238	22,267
Chinaman fish (not cod)	*Symphorus nematophorus*	11,856	11,856
Cobbler	*Cnidoglanis macrocephalus*	41,976	59,846
Cobbler, silver	*Arius midgleyi*	58,541	87,511
Cod	Serranidae	60,869	61,502
Cod, bar (grey-banded, eight-bar)	*Epinephelus octofasciatus*	32,503	32,503
Cod, breaksea	*Epinephelides armatus*	6,656	6,826
Cod, chinaman	*Epinephelus rivulatus*	2,070	2,090
Cod, radiant/comet	*Epinephelus radiatus/morrhua*	1,344	1,344
Cod, Rankin	*Epinephelus multinotatus*	189,957	189,957
Cod, spotted	*Epinephelus microdon, E.areolatus, E. bilobatus*	60,126	60,126
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	159,726	165,901
Emperor, blue-lined (grass, black snapper)	*Lethrinus laticaudis*	3,494	3,494
Emperor, blue-spot	*Lethrinus hutchinsi*	419,134	419,134
Emperor, red	*Lutjanus sebae*	372,294	372,444
Emperor, red-spot (snapper)	*Lethrinus lentjan*	61,457	61,457
Emperor, spangled	*Lethrinus nebulosus*	98,720	98,848
Emperor, sweetlip	*Lethrinus miniatus*	124,994	125,016
Emperor, yellow-tailed	*Lethrinus atkinsoni*	2,023	2,023

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (continued)			
Flagfish (Spanish flag)	*Lutjanus vitta, L. quinquelineatus, L. carponotatus, L. lutjanus*	148,697	148,697
Flathead	Platycephalidae	11,169	11,184
Flounder	Bothidae	3,058	3,111
Garfish, sea	*Hyporhamphus melanochir*	31,089	31,089
Groper, baldchin	*Choerodon rubescens*	28,269	32,058
Groper, blue	*Achoerodus gouldii*	34,785	41,080
Groper (wrasses)	Labridae	1,848	1,851
Halibut	*Psettodes erumei*	1,693	1,693
Hapuku	*Polyprion oxygeneios*	18,896	18,919
Herring, Australian	*Arripis georgianus*	230,592	230,592
Herring, Perth	*Nematalosa vlaminghi*	4,617	4,617
Javelin fish	*Pomadasys spp.*	47,702	47,702
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper)			
Kingfish, black (cobia)	*Rachycentron canadum*	15,479	15,666
Kingfish, yellowtail	*Seriola lalandi*	855	948
Knifejaw	*Oplegnathus woodwardi*	1,824	1,919
Leather jacket	Monacanthidae	21,948	32,192
Mackerel, blue	*Scomber australasicus*	541	541
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	17,641	17,642
Mackerel, scaly	*Sardinella lemuru*	598,632	598,632
Mackerel, shark (salmon)	*Grammatorcynus bicarinatus*	847	851
Mackerel, Spanish	*Scomberomorus commerson*	204,466	297,415
Mangrove jack	*Lutjanus argentimaculatus*	13,568	13,606
Morwong	Cheilodactylidae	653	654
Mullet, other	Mugilidae	1,440	1,440
Mullet, red	Mullidae	23,232	23,232
Mullet, sea	*Mugil cephalus*	220,153	220,153
Mullet, yellow-eye	*Aldrichetta forsteri*	34,965	34,965
Mulloway	*Argyrosomus hololepidotus*	27,497	28,752
Mulloway, northern (black jew)	*Protonibea diacanthus*	879	1,224
Parrot fish	Scaridae	10,183	10,273
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	50,289	50,306
Perch, red (maroon sea perch)	*Lutjanus spp. (large)*	3,213	3,213
Perch, scarlet sea (saddletail sea perch) –see snapper, saddletail	*Lutjanus malabaricus*	165,018	165,137
Perch, yellowtail	*Amniataba caudavittatus*	1,863	1,863
Perches, other	Lutjanidae	4,806	4,834
Pike, sea	*Sphyraena novaehollandiae*	1,777	1,777
Pilchard (the name 'Australian sardine' is used by ABARE)	*Sardinops sagax ocellatus*	1,873,226	1,873,226

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (continued)			
Pomfret, black	*Parastromateus niger*	3,221	3,227
Redfish	*Centroberyx spp.*	2,565	2,598
Redfish, bight	*Centroberyx gerrardi*	53,828	54,723
Redfish, yelloweye	*Centroberyx australis*	29,190	29,725
Rockcod, blackspotted	*Epinephelus malabaricus*	17,360	17,376
Rockcod, goldspotted	*Epinephelus coioides*	3,187	3,187
Salmon, Western Australian	*Arripis truttaceus*	1,027,468	1,047,969
Samson fish (sea kingfish)	*Seriola hippos*	60,430	63,072
Scad, yellowtail	*Trachurus novaezelandiae*	8,419	8,419
Scorpionfishes	Scorpaenidae	2,935	2,935
Shark, blacktip	*Carcharhinus spp.*	28,132	68,075
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	112,266	178,468
Shark, common saw	*Pristiphorus cirratus*	1,335	3,112
Shark, eastern school	*Galeorhinus galeus*	830	1,321
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	28,854	45,881
Shark, gummy	*Mustelus antarcticus*	358,555	570,075
Shark, hammerhead	Sphyrnidae	49,110	84,380
Shark, mako (shortfin)	*Isurus oxyrinchus*	10,872	17,288
Shark, pencil	*Hypogaleus hyugaensis*	1,205	1,915
Shark, saw	*Pristiphorus spp.*	1,749	4,077
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	18,154	29,180
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	81,610	131,187
Shark, tiger	*Galeocerdo cuvier*	10,658	26,707
Shark, whiskery	*Furgaleus macki*	96,754	145,218
Shark, wobbegong	Orectolobidae	54,080	85,837
Shark, other		9,893	15,541
Shovelnose (fiddler rays)	*Rhinobatidae & Rhynchobatidae*	2,742	11,181
Skates and rays, other		9,490	18,300
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	2,511	2,511
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	303,770	303,770
Snapper, fingermark (golden)	*Lutjanus johnii*	530	876
Snapper, frypan	*Argyrops spinifer*	69,476	69,476
Snapper, goldband	*Pristipomoides multidens*	560,127	560,127
Snapper, long nose	*Lethrinus olivaceus*	16,623	16,623
Snapper, maroon (formerly maroon sea perch)	*Lutjanus lemniscatus*	19,030	19,030
Snapper, Moses (formerly Moses Perch)	*Lutjanus russelli*	52,141	52,141
Snapper, nor-west	Lethrinidae	18,897	18,908
Snapper, pink	*Pagrus auratus*	573,596	585,600
Snapper, queen	*Nemadactylus valenciennesi*	53,538	58,485
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy	*Pristipomoides filamentosus*	29,537	29,558
Snapper, ruby	*Etelis spp.*	50,266	50,266
Snapper, saddletail sea (formerly scarlet sea perch)	*Lutjanus malabaricus*	165,018	165,137
Snapper, sharptooth	*Pristipomoides typus*	3,647	3,647
Sprat, blue	*Spratelloides robustus*	15,220	15,220

Common Name	Scientific Name	Landed weight (kg)	Live weight (kg)
Fish (continued)			
Sweep	*Scorpis aequipinnis*	1,249	1,381
Sweetlip	Haemulidae	80,382	80,847
Tailor	*Pomatomus saltatrix*	22,921	22,921
Threadfin	Polynemidae	9,444	9,990
Threadfin bream (butterfish)	Nemipteridae	292,477	292,477
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	70,907	73,540
Trevalla, deepsea	*Hyperoglyphe antarctica*	12,660	12,660
Trevally, golden	*Gnathanodon speciosus*	5,527	5,585
Trevally, other (skippy)	Carangidae	190,252	190,449
Trevally, skipjack	*Pseudocaranx dentex*	8,057	8,386
Tripletail	*Lobotes surinamensis*	2,339	2,493
Trout, coral	*Plectropomus maculatus*	17,959	18,335
Trout, spotted (duskytail grouper)	*Epinephelus bleekeri*	7,687	7,687
Trumpeters	Terapontidae	4,009	4,009
Tuna, yellowfin	*Thunnus albacares*	645	726
Tuna, other	Scombridae	38,505	38,536
Tuskfish, bluebone	*Choerodon spp.*	11,134	11,207
Whitebait	*Hyperlophus vittatus*	87,397	87,397
Whiting, King George	*Sillaginodes punctata*	10,478	10,480
Whiting, western sand	*Sillago schomburgkii*	123,564	123,793
Whiting, other	Sillaginidae	1,293	1,293
Other fish varieties		116,953	163,274
Total Fish		**10,758,724**	**11,595,143**
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	955,133	955,133
Crab, champagne (spiny)	*Hypothalassia acerba*	7,626	7,626
Crab, crystal (snow)	*Chaceon bicolor*	220,825	220,825
Crab, giant (king)	*Pseudocarcinus gigas*	4,476	4,476
Crab, mud	*Scylla serrata*	8,051	8,051
Total crabs		**1,196,111**	**1,196,111**
PRAWNS			
Prawn, banana	*Penaeus merguiensis*	172,354	172,354
Prawn, brown tiger	*Penaeus esculentus*	739,329	739,329
Prawn, coral	*Metapenaeopsis spp.*	179,453	179,453
Prawn, endeavour	*Metapenaeus endeavouri*	189,040	189,040
Prawn, western king	*Penaeus latisulcatus*	1,317,944	1,317,944
Prawn, other		2,566	2,566
Total prawns		**2,600,686**	**2,600,686**
LOBSTERS			
Bugs	Scyllaridae	12,122	12,201
Rock lobster, southern	*Jasus edwardsii*	53,711	53,711
Rock lobster, western	*Panulirus cygnus*	8,612,970	8,612,970
Total lobsters		**8,678,803**	**8,678,882**

MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	15,488	36,418
Abalone, greenlip	*Haliotis laevigata*	61,264	162,065
Abalone, Roe's	*Haliotis roei*	73,076	85,710
Cuttlefish	Sepiidae	34,402	34,444
Octopus	*Octopus spp.* (mainly *O. tetricus*)	113,111	217,534
Scallop, saucer	*Amusium balloti*	472,894	2,361,390
Squid	*Sepioteuthis spp., Loligo spp.*	59,318	59,318
Total molluscs		**829,552**	**2,956,878**
OTHER CLASSES			
Beche-de-mer	Holothuridae	26,752	80,256
Total other classes		26,752	80,256
GRAND TOTAL		**24,090,628**	**27,107,957**

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

Research Division – Other Activities

PEMBERTON FRESHWATER RESEARCH CENTRE ACTIVITIES 2007/08

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 two 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 Thomson's 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, the 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 four key areas – of conservation, recreational fishing, aquaculture and freshwater fisheries.

Key PFRC projects in 2007/08 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. Two species of trout are produced at PFRC – brown trout (*Salmo trutta*) for recreational fishing and rainbow trout (*Oncorhynchus mykiss*) for both aquaculture and recreational fishing.

In 2007/08 the PFRC produced 700,00 trout fry. These consisted of 660,000 rainbow trout fry and 40,000 brown trout fry, representing a decrease in production of 1% and increase of 20% respectively, compared with 2006/07. The majority of production (81%) consisting of 527,000 rainbow trout fry and 40,000 brown trout fry were stocked into public waterways to support recreational fishing.

A further 78,000 rainbow trout (11%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism. Included in the 78,000 trout fry sold to the recreational groups were 22,750 rainbow triploid fry. All the triploids were sold to private waters for recreational fishing. The acquisition of new equipment to produce triploids using a high-pressure chamber will, in the future, increase the production of triploids compared to the present heat-shock method that is used.

The PFRC has established a reputation amongst commercial trout farmers for consistent hatchery production of quality fry and eyed ova. PFRC also provides vital support to the aquaculture industry by providing fry to supplement commercial production in years of private hatchery failures. In 2007/08, commercial farmers purchased 7,500 fry from the PFRC, representing 1% of PFRC trout production.

The remaining 7% of trout produced were retained for future brood stock for the PFRC, yearling stocking, trout nutrition research and sales for private waters.

During the winter-spring months in 2007/08, some 32,750 rainbow trout yearlings, as well as 2,670 rainbow and 450 brown trout ex-brood stock, were released to public waters for recreational fishing.

Also during 2007/08, 2,000 rainbow yearlings were sold to individuals for private recreational fishing. 5,000 rainbow yearlings were sold to Challenger TAFE to evaluate commercial production using SIFTS (Semi Intensive Floating Tank System) in inland saline waters.

Trout research for recreational fishing and aquaculture

In late 2006 the Department of Fisheries commenced a review of trout production at PFRC to consider two key factors – brown trout embryo survival and rainbow trout brood stock selection strategies. In 2007 the Department commenced research to evaluate hatchery production techniques for producing sterile triploid trout and develop improved protocols using hydrostatic pressure and tetraploids.

Brown trout embryo survival

In 2005, brown trout embryo survival was sub-optimal, but prior to disposing of this valuable line that is highly regarded by recreational fishers, Department of Fisheries' Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. 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 C. 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 and a further 20% improvement in 2007/08. Sperm motility assessment has been postponed until the purchase of computing equipment and software.

Rainbow trout brood stock selection

The current breeding strategy for both rainbow and brown trout at the PFRC focuses upon random selection of brood stock. However, trout production at PFRC has two key client groups with different objectives – recreational fishing and aquaculture.

Therefore, it is likely that breeding objectives for these two groups may be different. Accordingly, Department of Fisheries' Research Division staff commenced discussions with both major client groups to establish and prioritise breeding objectives. This will ensure that, in 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 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.

Sterile triploid trout production

Triploids are valuable for stocking as they cannot reproduce and continue to grow after reaching sexual maturity. The PFRC hatchery has produced triploids for many years using temperature shock to retain the first polar body of fertilised eggs. However, temperature shocking is known to have considerable variability in triploidy rates. To address this in 2006 the PFRC obtained the first hydrostatic pressure chamber for manipulating chromosome numbers to produce triploids and tetraploids in WA.

Protocols for the production of triploids and tetraploids using hydrostatic pressure were developed. Juveniles were produced, however resource limitations prevented the percentage of triploids and tetraploids to be analysed in 2007/08. These samples have been frozen and will be analysed when finances permit.

Although tissue samples are awaiting analysis, it was clear that protocols are heading in the correct direction as juveniles were produced, and triploid and tetraploid fingerlings were larger than the control diploid fingerlings. This is to be expected as triploids contain an extra chromosome, so every cell is 50% larger – and tetraploids contain an extra 2 chromosomes, so every cell is 100% larger.

The tetraploid progeny have been tagged and placed into ponds with diploid siblings. They are being reared at the PFRC to sexual maturity and will be spawned in 2008/09.

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*). The aim of this research project is to develop large-scale pond 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 broodstock population of pygmy perch (*Edelia vittata*) established at the PFRC were weaned onto a commercially-available formulated pellet. These broodstock subsequently spawned in concrete tanks, 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, broodstock populations of two 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 waterbodies 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) to identify 'pure' marron from hybrids in collaboration with the University of Western Australia. This resulted in the establishment of the only 'pure' brood stock population of the rare Margaret River marron at the PFRC. This brood stock produced over 1,200 juveniles in the first year of this project. These juveniles have been reared to sexual maturity at the PFRC and their progeny will be available for restocking the Margaret River catchment in 2008/09.

In addition, captive breeding populations from three other river systems were established at the PFRC. These brood stock represent the genetic biodiversity of the northern, central and eastern marron populations found in Western Australia. 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 (FRDC) 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 three regions.

Marron aquaculture research and development

In 2006 the FRDC 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, the Research Division staff initiated a selective breeding program that resulted in a 100% improvement in growth rate. In 2007 the PFRC produced around 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.

ACTIVITIES OF THE FISH HEALTH UNIT DURING 2007/08

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, 1 research scientist, 1 laboratory manager and 1 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 2007/08 were as follows:

- The fish health laboratory received a total of 185 diagnostic cases during the 2007 calendar year – a decrease on the previous year. This was due to a fall of about 50% in the fish diagnostic cases submitted – mainly due to a reduction in submissions from barramundi farmers.
- The provision of export health certificates for yabbies and marron has continued its downward trend since 2002, when 55 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.
- A case of the endemic notifiable disease *Bonamia sp.* in the flat oyster *Ostrea angasi* was diagnosed in April 2007. This disease is considered established in wild populations and is monitored for international reporting purposes only. No other notifiable diseases were reported.
- A continuing mortality of pearl oyster (*Pinctada maxima*) has resulted in a considerable extra workload for the Fish Health staff, and an additional technical officer was employed from January 2007 using Development and Better Interest Funds. 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 Department of Water and the Water and Rivers Commission, 23 reports of 'fish kills' throughout the State were investigated. This was down from the 25 investigated last year. Most 'fish kills' were due to poor water quality or toxic algal blooms.
- 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 provides executive support to the chair of the National Aquatic Animal Health Technical Working Group and the Subcommittee on Animal Health Laboratory Standards. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues under the national AQUAPLAN 2005 – 2010 biosecurity strategy.
- The Fish Health Unit participated in national proficiency testing for the aquatic pathogens white spot syndrome virus (WSSV) and nervous necrosis virus (NNV). Only two laboratories, including the Fish Health Unit, were 100% proficient in the detection of WSSV. This is the second consecutive year that the Fish Health Unit was 100% proficient in WSSV testing, putting it at the top of the list for proficiency in WSSV detection. Testing for NNV by Polymerase Chain Reaction (PCR) at various laboratories has highlighted detection inconsistencies, which have been well documented in the literature and were confirmed by the national proficiency testing program.
- 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. Assistance was provided to the Republic of the Maldives to determine the cause of mass mortalities of trigger fishes on coral reefs.
- The laboratory staff participated in a joint Australia-French study tour and conference on non-maxima pearl oyster biosecurity issues at Geraldton. This was organized by AMWING (the non-maxima pearl oyster farmers association) and funded by the French Australia Science and Technology Program and the Fisheries Research Development Corporation. A reciprocal conference was held in Tahiti during May 2008, at which two Fish Health staff attended.

INDIAN OCEAN TERRITORIES FISHERY STATUS REPORT

S.J. Newman, M. Pember, C. Skepper and L. Bellchambers
Management input from R. Green

Fishery Description

In November 2002, the territorial seas (out to 12 nautical miles) of the Cocos (Keeling) Islands and Christmas Island were declared as 'excepted waters' from the *Fisheries Management Act 1991.* Management responsibilities for these waters were transferred from the Australian Fisheries Management Authority (AFMA) to the Department of Transport and Regional Services.

The Government of Western Australia's Department of Fisheries (the Department) has now taken on management responsibilities for the marine waters of the Indian Ocean Territories out to 12 nautical miles (nm), under a Service Delivery Arrangement with the Commonwealth Attorney General's Department (AGD), and the AFMA continues to manage the waters from 12nm to AFZ. The location of the Indian Ocean Territories and their proximity to the Western Australian coast are illustrated in Indian Ocean Territories Figure 1.

Under the Service Delivery Arrangement with the AGD, the Department now manages commercial, recreational, charter and aquaculture activities at the Cocos (Keeling) Islands and Christmas Island, in addition to providing fish health diagnostic services, biosecurity, fish habitat protection advice, fish pathology and licensing services. The Commonwealth Minister for Home Affairs currently holds responsibility for these excepted waters under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Act').

The commercial Christmas Island Line Fishery primarily targets pelagic species, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, limited demersal fishing activities are also undertaken, targeting deepwater snappers and groupers.

The Cocos (Keeling) Islands Marine Fish Fishery primarily targets the endemic Cocos angelfish or yellowheaded angelfish (*Centropyge joculator*) and, to a lesser extent, the lemonpeel angelfish (*Centropyge flavissima*).

Large amounts of recreational/customary fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island, targeting both finfish and invertebrate species.

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995(WA) (CKI/CI) and subsidiary legislation

Fishing Boat Licences with conditions

Cocos (Keeling) Islands Marine Aquarium Fish Fishery – Commonwealth Government Environment Protection and Biodiversity Conservation Act 1999 (Export Exemption)

Recreational

Fish Resources Management Act 1994 (WA) (CI/CKI) (the 'Applied Act')

Fish Resources Management Regulations 1995 (WA) (CKI/CI) and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries and industry, and community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational

Community consultation – Cocos (Keeling) Islands and Christmas Island

Boundaries

The territorial seas from the shoreline out to a distance of 12 nautical miles around the Cocos (Keeling) Islands and Christmas Island.

Management arrangements

Under the Service Delivery Arrangement with the AGD, the Department of Fisheries (Government of Western Australia) now manages commercial, recreational, charter and aquaculture activities, in addition to providing fish health diagnostic services, fish habitat protection advice, biosecurity, fish pathology and licensing services at the Cocos (Keeling) Islands and Christmas Island under the *Fish Resources Management Act 1994 (WA) (CI/CKI)* (the 'Applied Act').

The Christmas Island Line Fishery (CILF) is managed primarily through input controls in the form of limited entry to the fishery, gear restrictions and closed areas. There are 3 licenses in the fishery. In 2007, 2 licenses operated in the fishery. The CILF also has output controls in the form of quota limits on both demersal and pelagic species to be harvested.

The commercial Cocos (Keeling) Islands Marine Aquarium Fish Fishery (CKIMAFF) is managed through input controls in the form of a limited entry fishery (there is only 1 license in the fishery), gear and area restrictions. The fishery also has a number of output controls in the form of limits on the species permitted to be harvested, limits on the total number of individuals of all species combined that can be harvested in a year, and limits of the number of individuals within a family that can be harvested within a year.

Research summary

Risk assessment workshops were undertaken in August 2006 and September 2007 to identify and refine fisheries research and management priorities at the Indian Ocean Territories. Following these workshops, finfish fisheries research has focused on collecting biological material to assess the wahoo stocks and on collecting tissue samples from a suite of species at the Cocos (Keeling) Islands and Christmas Island to examine their connectivity with other sites along the Western Australian coast and locations to the north. Invertebrate fisheries research has focussed on surveys to assess the abundance and biology of gong gong (*Lambis lambis*) and also to understand the abundance and distribution of bêche-de-mer (Holothurians) and clams (*Tridacna* spp.).

Retained Species

Commercial landings (season 2007): Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the Christmas Island Line Fishery. Other pelagic species targeted during trolling operations include yellowfin tuna (*Thunnus albacares*) and, to a lesser extent, mahi mahi (*Coryphaena hippurus*). Some commercial fishing activities are also undertaken for demersal fish, mainly deep slope species such as ruby snapper (*Etelis* spp.). The commercial catch for Christmas Island consists of catch data from only 2 vessels and thus the catch data is not reportable due to confidentiality provisions.

Recreational catch: Not assessed

There are large recreational/customary fishing fleets operating around the Cocos (Keeling) Islands and Christmas Island. The amount and magnitude of the recreational fishing catch and effort at these islands has not been assessed. Recreational bag limits, area closures, and gear restrictions have been proposed.

Fishing effort/access level

Effort in the CILF has been relatively stable over the past two years. Effort in the fishery is weather-dependent and limited by access to the water through the principal boat ramp at Flying Fish Cove and, to a lesser extent, the Ethel Beach boat ramp.

Stock Assessment

Assessment complete: Preliminary

Breeding stock levels: Not Assessed

In 2006/07 a large-scale assessment of the bêche-de-mer communities inhabiting the lagoon and outer reef at the Cocos (Keeling) Islands was undertaken to determine the status of key holothurian stocks and enable recommendations to be made regarding the feasibility of a commercial bêche-de-mer fishery being developed in the region. Analysis of abundance and distribution data found that the bêche-de-mer community is strongly influenced by habitat and, although some species are wide-ranging and found in relatively high densities, they tend to be of low economic value. In contrast, species of moderate-to-high value were recorded at densities too low to support commercial fisheries and typically had very restricted distributions.

The bêche-de-mer community found at the Cocos (Keeling) Islands is near to pristine, due to a lack of historical fishing pressure, and has high conservation value as holothurians are integral to key ecosystem processes including maintenance of water quality within the lagoon. Bêche-de-mer stocks are very sensitive to fishing pressure and have been heavily over-exploited in other areas of the Indian and Pacific Oceans.

Research has also focused on the common spider conch or gong gong (*Lambis lambis*), a heavily recreationally targeted gastropod inhabiting shallow waters of the lagoon. This species is vulnerable to over-fishing as it is highly accessible and presumably shares biological traits with other exploited conch species, including slow growth and late maturity. Monitoring data collected in 2007 and 2008 indicate that the current abundance of gong gong is substantially lower than that recorded historically. While heavy fishing pressure has presumably contributed to the reduction in gong gong numbers, further monitoring is required to determine the role of recruitment variability in maintaining gong gong populations at the Cocos (Keeling) Islands and changes in the lagoon system.

The sustainability of giant clam (*Tridacna* spp.) and coral species were identified as potential concerns during recent risk assessments undertaken for the marine resources of the Cocos (Keeling) Islands by the Department of Fisheries. To address these concerns, biodiversity research efforts have now expanded to assess the status of *Tridacna* clams at the islands. In addition, an on-going reef monitoring program is currently being established. The implementation of these initiatives will enable the Department of Fisheries to access the health of the coral reef ecosystems at the Cocos (Keeling) Islands and effectively detect change, both spatially and temporally, resulting in better management of the natural resources of the atoll.

Data on the abundance of finfish species is being collated and collected to determine changes over time. A number of recent surveys have been undertaken at both localities (Hobbs, Choat pers. comm.). Some species appear to have exhibited marked declines in abundance. For example, Lincoln Smith *et al.* (1995) reported that the squaretail coral trout (*Plectropomus areolatus*) was abundant on shallow reefs (<10m) and was one of the species most commonly recorded on deep reefs (15 – 20m). Cocos Malay community members have advised that these species were targeted in the waters of the lagoon using lines. This species is now extremely low in abundance at the Cocos (Keeling) Islands (Choat pers. comm.), suggesting local depletion and/or overexploitation of the stock (presently very little is known about the stock structure of species in the Indian Ocean Territories, in particular gene flow and linkages with other populations elsewhere in the Indian Ocean).

The CKIMAFF principally targets the Cocos angelfish (*Centropyge joculator)* and, to a lesser extent, the lemonpeel angelfish (*Centropyge flavissima). Centropyge joculator* is endemic to the Cocos and Christmas Islands and inhabits fringing reefs from 15 to 70 m. Little is known about the biology of *C. joculator*, although Allen *et al.* (2007) describe this species as being abundant on Christmas Island. The catch in 2006 was over 800 individuals of *C. joculator*, with less than 600 reported in 2007. Few *C. flavissima* (<10) were reported in the catch.

Non-Retained Species

Bycatch species impact: Negligible

Fishing in the CILF for pelagic species such as wahoo uses specialised trolling gear to target the fish and involves limited discarding. Species occasionally caught, and sometimes retained but generally discarded, include billfish, barracuda, shark, mackerel, tuna 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 pelagic fishery has a negligible impact on stocks of discarded species. Fishing for demersal species in the CILF, particularly those in the deep slope waters, involves limited discarding, as most species are retained for processing.

The fishing techniques used to capture fish in the CKIMAFF involve using hand or scoop nets, or a small seine net of specific dimensions (the seine net cannot exceed 16 metres in length, must have a mesh of less than or equal to 28mm and a drop of not more than 3 metres) and may use SCUBA equipment. Thus, the CKIMAFF has negligible bycatch due to the highly selective nature of fishing activities.

Protected species interaction: Negligible

The line fishing methods used in CILF are not known to catch any protected species. However, there is some potential for lines to inadvertently catch curious seabirds at Christmas Island. No interactions have been reported for the CKIMAFF.

Ecosystem Effects

Food chain effects: Not assessed

Habitat effects: Negligible

The line fishing methods and hand collection methods used in this fishery have minimal impact on the habitat.

Social Effects

At least 2 people were employed in the CILF around Christmas Island during 2007. This estimate is based on the number of vessels reporting catches and the average number of crew on each boat.

At least 2 people were employed in the CKIMAFF around Cocos (Keeling) Islands during 2007.

Due to their sport fishing and eating qualities, wahoo and other pelagic species are a popular target of recreational anglers and fishing charter (tourism) operators around both island groups. They are usually captured from small boats, although shore-based fishing is also undertaken.

A large variety of demersal and lagoon finfish and invertebrate species are caught by recreational/customary fishers at Cocos (Keeling) Islands, involving a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from a number of small vessels and the shore, catching a large variety of finfish species.

Economic Effects

Estimated annual value (to fishers) for year 2007: **Not assessed**

The value of the CILF is not known. The value of the CKIMAFF is also unknown, although *C. joculator* commands a high price on the international market.

Fishery Governance

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

Current fishing (or effort) level: **Not assessed**

The amount of fishing effort available to catch both pelagic and demersal fish species at both the Cocos (Keeling) Islands and Christmas Island, in terms of the number of vessels available for fishing, is high and they have the capacity to operate over the extent of the fishable area at each island group. Given the restricted amount of habitat and fishing area available, it is expected that fishing pressure on some species at Cocos (Keeling) Islands or Christmas Island will be above optimum levels.

The catch of the CKIMAFF has been less than 1,000 individuals since its inception in 1993. There is little incentive for the single licensee to increase catch or effort since market viability and high prices are maintained by only having small numbers of fish available for sale.

New management initiatives (2007/08)

The Department of Fisheries conducted risk assessment workshops in August 2006 and September 2007 to identify and refine fisheries research and management priorities at the Indian Ocean Territories. Following extensive community consultation, initial research surveys and observation of fishing practices, the need for increased protection to ensure sustainability has been identified for a number of species.

The cultural and subsistence fishing requirements of the community members must also be taken into consideration in the development of any fisheries management strategies for the Indian Ocean Territories. The Department notes that the individuals in both islands groups often fish for their extended family groups, and that catch is often shared. However, the practice of sharing fish with extended family groups on mainland Australia could impact on the sustainability of fish resources at both the Cocos (Keeling) Islands and Christmas Island.

Following initial community and stakeholder consultation, the Department released the Cocos (Keeling) Islands recreational fishing guidelines for public comment in December 2006, and the Christmas Island Fisheries Management Strategy for public comment in May 2007. The Cocos (Keeling) Islands guidelines were solely focused on the recreational fishing sector, while the Christmas Island fisheries management strategy included recreational guidelines, commercial fishing models and charter fishing concepts for community feedback.

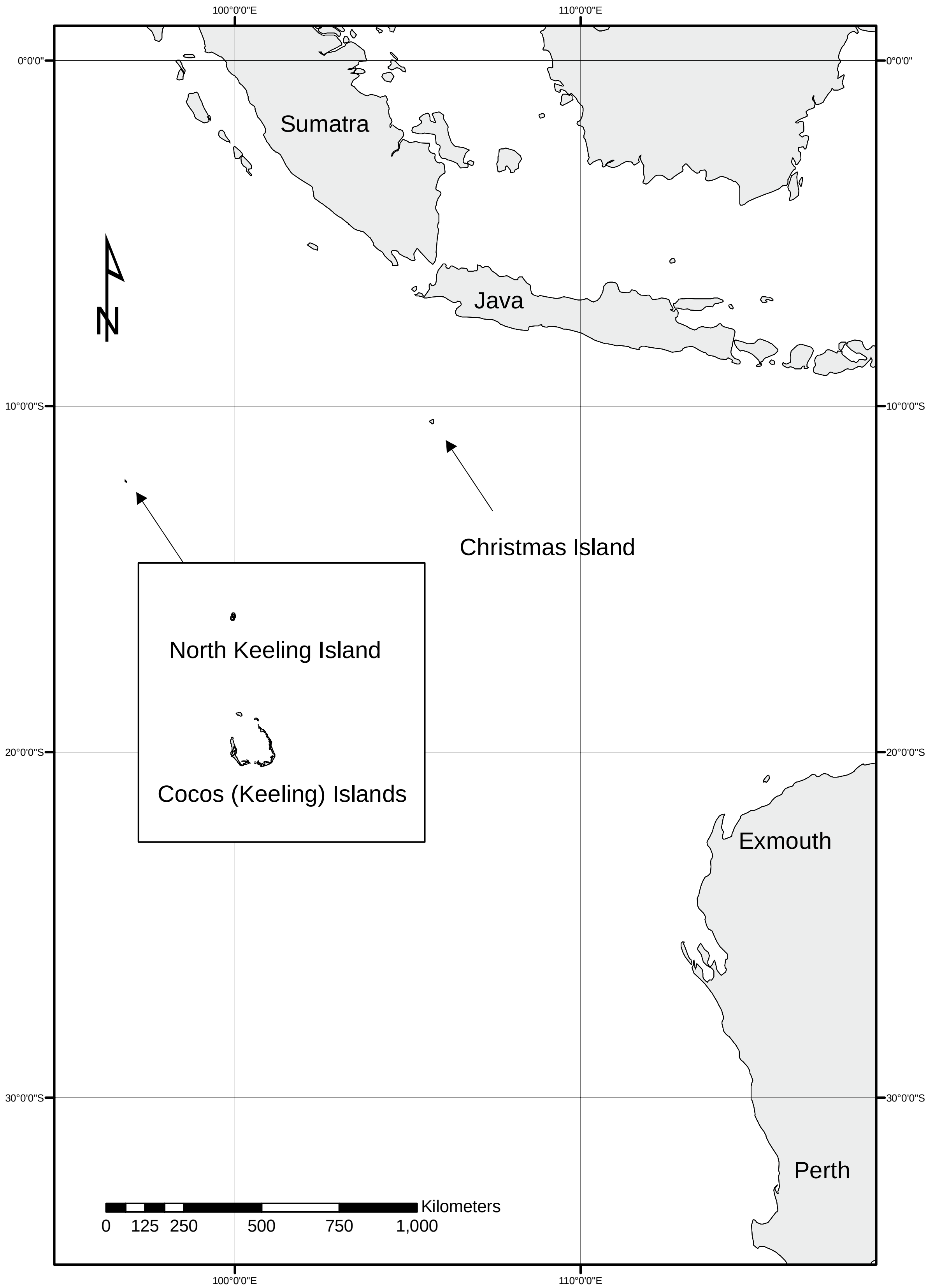
Christmas Island has three current commercial fishing licenses (Fishing Boat Licenses initially issued by the Australian Fisheries Management Authority), whereas there are currently no edible finfish commercial fishing licenses on the Cocos (Keeling) Islands. The only commercial fishing activities currently licensed at the Cocos (Keeling) Islands, is the Cocos (Keeling) Islands Marine Aquarium Fish Fishery, which target small demersal fish species for the aquarium trade. A draft paper is currently being developed for the Cocos (Keeling) Islands, outlining the development of a community-based commercial fishing-licensing framework that would ensure that the commercial license would remain on the islands for the benefit of the Cocos (Keeling) Island communities.

The Department of Fisheries is reviewing the management arrangements for the Christmas Island Line Fishery and the Cocos (Keeling) Islands Marine Aquarium Fish Fishery.

The effective implementation of any future fisheries management legislation at the Indian Ocean Territories will require the development of community education and compliance enforcement programs.

External Factors

The demersal fish and invertebrate populations of Cocos (Keeling) Islands and Christmas Island are likely to consist of small, isolated populations that are expected to experience highly variable recruitment due to environmental fluctuations.



INDIAN OCEAN TERRITORIES FIGURE 1

Location of the Cocos (Keeling) Islands and Christmas Island comprising the Indian Ocean Territories within the Indian Ocean and illustrating their proximity to the Western Australian coast.

COMMERCIAL DAILY/TRIP RETURNS REPORT

R. Marriott and C. Bird

Management input from T. Nicholas

Greater detail is now required in the commercial fishing catch and effort data in order to better monitor and manage Western Australia's finfish fisheries. Daily/trip logbooks have been developed as a new form of statutory fishing return to facilitate the recording of commercial catches and effort on a finer scale. In these new fishing returns, the area over which catch data are recorded is smaller (grids of 10 x 10 nautical miles are used compared with the previous grids of 60 x 60 nautical miles in the catch and effort statistics [CAES] system) and the time over which data are recorded is shorter (information is broken down by day rather than being provided as a monthly total). Thus, the daily/trip logbooks result in higher resolution data, which is more useful to monitoring and management.

In 2006, daily/trip fishing returns were developed as an approved form of reporting catches of finfish in four commercial WA fisheries and two Joint Authority fisheries: the Mackerel Fishery; the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery; Joint Authority Northern Shark Fishery; WA North Coast Shark Fishery; West Coast Demersal Gillnet and Demersal Longline Fishery; and the Wetline fishery. The daily/trip fishing returns were introduced to the Wetline fishery on an informal basis, whereas they became a formal legislative requirement for the other three WA commercial fisheries.

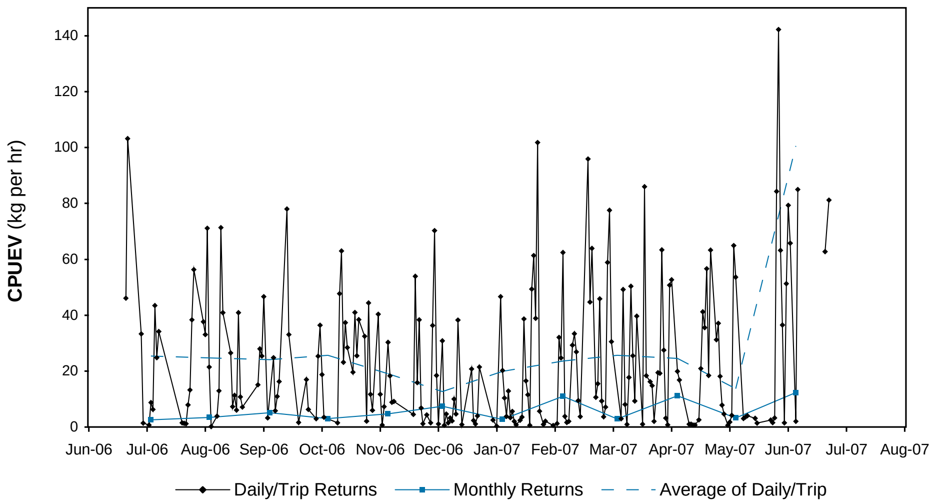
The informal trialling of daily/trip fishing returns by commercial wetline fishers in the West Coast bioregion was continued until the West Coast Demersal Scalefish Interim Managed Fishery commenced in January 2008, when use of the new daily/trip statutory fishing returns became compulsory. The former commercial 'wetline' fleet comprised a diverse range of vessels and operations, with many vessels also authorised to operate in other (often managed) fisheries, such as for western rock lobster (Crowe *et al.,* 1999). It was therefore critical that wetline fishers who primarily targeted demersal scalefish in the West Coast bioregion were involved in this trial.

Twenty-one wetline operators participated in the trial use of daily/trip fishing returns in 2006/07. Catch rates of demersal scalefish, such as pink snapper, reported by wetliners using daily/trip fishing returns were generally higher than were reported by wetliners using the compulsory Catch and Effort Monthly Returns (Commercial Daily/Trip Returns Figure 1). This is because most of the participants in the trial primarily targeted demersal scalefish.

High fluctuations in daily catch rates could be attributed to many factors such as the type of line fishing gear and equipment used, the number of lines used, the number of people fishing, the vessel used, the experience of the skipper, differences in habitats and areas fished, weather and seasonal influences, and/or the relative abundance of fish. Information on all of these variables is recorded in the daily/trip fishing returns. The analysis of all of these different types of information on a daily basis and at a much smaller spatial scale (10 x 10 nautical miles) will help researchers distinguish between the influence of these factors and fish abundance on the catch rates. This will greatly improve the Department of Fisheries' capability to monitor trends in fish abundance and manage these fisheries in a sustainable manner.

Current Status

Daily/trip fishing returns are now employed by the Department of Fisheries on a statutory basis for the reporting of catches for the Mackerel Fishery; the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery; the West Coast Demersal Gillnet and Demersal Longline Fishery; the Joint Authority Northern Shark Fishery, the WA North Coast Shark Fishery, the West Coast Demersal Scalefish Fishery; the Shark Bay Snapper Fishery and the Northern Demersal Scalefish Fishery.



COMMERCIAL DAILY/TRIP RETURNS FIGURE 1

Average catch rates per vessel (kg per hour) of pink snapper caught by commercial wetliners using hydraulic reels in the West Coast Bioregion recorded in daily/trip fishing returns (8 vessels) and monthly catch returns (12 vessels).

APPENDIX 5

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 2006/07 season or the calendar year 2007.

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 2006/07 or 2007	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 g greenlip, 160 g 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	80% 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	Not met	
	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 9,000 kg recommended for 2008 in Area 8
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch12,000 kg	Not met	
Fishery: **Abrolhos Islands and Mid West Trawl** *Date of certification:* 17 March 2005 *Approval type:* Wildlife Trade Order *Expiry date*: March 2013	Scallops (spawning stock)	The residual stock index determines a predicted catch that sets the length of the next season	Acceptable	
Fishery: **Beche-de-mer** *Date of certification:* December 2004 *Approval type:* Wildlife Trade Order *Expiry date*: December 2010	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 2006/07 or 2007	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 one 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 and restricted size of area fished.
Fishery: **Exmouth Gulf Prawn** *Date of certification:* March 2003 *Approval Type:* Export exemption *Expiry date*: February 2013	Tiger prawn (spawning stock)	Catch rate above 8–10 kg/hr	Acceptable	
	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 0–2 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)	< 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 BRDs	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	
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	
	Black tiger prawn (spawning stock)	Total catch within acceptable range of 0–1 t	Acceptable	
	Squid (spawning stock)	Total catch within acceptable range of 1–50 t	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2006/07 or 2007	Comment
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 > 40% of virgin spawning biomass with lower limit of 30%; total annual catches should not increase > 20% above 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 >20% above average catch 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	Catches were low due to consecutive low rainfall years and the decision not to fish to protect breeding stock.
		Onslow: total catch within acceptable range of 2–90 t	Below but acceptable	
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Below but acceptable	Due to very low effort and limited targeting
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Below but acceptable	Due to very low effort and limited targeting.
	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 0–2 t	Acceptable	
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 < 60% of species distribution; catch rates should not decrease by > 50% from historical averages of 29.5 oysters/hr (Zone 2) and 34.8 oysters/hr (Zone 3); > 30% of Zone 1 catch should be > 150 mm shell length	Acceptable	Catch rates in Zones 2 and 3 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 details	Issue/species	Performance measure	Current performance in 2006/07 or 2007	Comment
Fishery: **Pilbara Trap** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: December 2007 Under review by DEWHA	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 > 20% above average catch of previous 4 years No decrease in annual trap catch rates in > 2 consecutive years	Acceptable	The age structured model was updated in 2007.
Fishery: **Pilbara Trawl** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: October 2009	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 > 20% above average catch of previous 4 years; no decrease in annual trawl catch rates in > 2 consecutive years	Acceptable	The age structured model was updated in 2007
	Short-lived target species (spawning stock)	Median spawning biomass of blue-spot emperor should be > 40% of the 1993 spawning biomass in Area 1; annual catch of each short-lived target species should not increase > 20% above the average annual catch of the previous 4 years; annual catch rate of each short-lived target species should not decrease in two consecutive years	Acceptable	
	Bycatch of protected species – dolphins	Number of dolphins caught by the fishery should be < 75/yr, assuming 100% catch mortality; all skippers to maintain records of the time, date, shot duration and location of each incidental capture	Acceptable	
	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	

Fishery details	Issue/species	Performance measure	Current performance in 2006/07 or 2007	Comment
	Bycatch of protected species – syngnathids	Number of pipefish caught and released alive should be < 500/yr; number of seahorses caught and released alive should be < 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 < 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	Catch below target level due to limited targeting and low Catchability along the South Coast. West Coast catch historically high, so overall acceptable.
Fishery: **Shark Bay Experimental Crab Fishery** *Date of certification:* November 2004 *Approval type:* Wildlife Trade Order *Expiry date*: November 2010	Blue swimmer crab (breeding stock)	CPUE to remain above 1 kg/trap lift	Acceptable	
Fishery: **Shark Bay Prawn** *Date of certification:* February 2003 *Approval type:* Export exemption *Expiry date*: February 2013	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

Fishery details	Issue/species	Performance measure	Current performance in 2006/07 or 2007	Comment
	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-BRD 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)	< 40% of sand/shell habitat in Shark Bay trawled	Acceptable	
	Impact to coral/ sponge (habitat)	<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*: February 2013	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-BRD 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	Acceptable	Catch rates fell but were above the trigger. There is a need to review the current ESD trigger level of 500 kg/standard boat day.
Fishery: **South Coast Crustacean** *Date of certification:* September 2004 *Approval type:* Wildlife Trade Order *Expiry date*: February 2009	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*: 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 details	Issue/species	Performance measure	Current performance in 2006/07 or 2007	Comment
Fishery: **Western Rock Lobster** *Date of certification:* August 2002 *Approval Type:* Export exemption *Expiry date*: September 2012	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 > 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	Acceptable	Indicator requires revision as whale populations are increasing hence 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 2014	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	

APPENDIX 6

Fisheries Research Division staff adjunct positions and supervisions

Staff Member	Position
Rod Lenanton	Adjunct Associate Professor, School of Biological Sciences and Biotechnology, Murdoch University.
Brian Jones	Adjunct Professor, Murdoch University
	PhD co-supervision, Murdoch University, supervises Susan Kueh – "Diseases of Asian seabass or barramundi"
David Fairclough	Adjunct Lecturer, Centre for Fish and Fisheries Research, Murdoch University
	PhD co-supervision, Murdoch University, supervises Elaine Lek – "Comparisons of the biology of three sympatric species of wrasse (Labridae) in Western Australia".
	Honours student supervision, Murdoch University, supervised Alexia Bivoltsis – "A baited video study of the fish faunas in the main habitat types and management zones of the Jurien Bay Marine Park".
Brett Glencross	Adjunct Associate Professor, University of Western Australia
Sagiv Kolkovski	MSc co-supervision, Edith Cowan University, supervises Justin King – "Artemia production".
Martin de Graaf	Honours student co-supervision, Murdoch University, supervises Renea Larsen – "Octopus biology"
Craig Lawrence	Adjunct Associate Professor – The University of Western Australia
Danielle Johnston	Adjunct Senior Lecturer – School of Animal Biology, University of Western Australia
	PhD co-supervision, University of Western Australia, supervises Andrew Limbourn – "Nutritional condition of *Panulirus cygnus* post-puerulus".
Fred Wells	Editorial board: *Journal of Science, Technology, and Humanities*. Burapha University, Thailand.
	Research Associate, Field Museum of Natural History, Chicago, Illinois, USA.
	President, Australian Marine Sciences Association

GLOSSARY OF ACRONYMS

AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AGD	(Australian Government) Attorney General's Department
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
CDR	Catch and disposal record
CI/CKI	Christmas Island and Cocos (Keeling) Island
CILF	Christmas Island Line Fishery
CKIMAFF	Cocos (Keeling) Islands Marine Aquarium Fish Fishery
CPUE	catch per unit effort
CW	carapace width
DEC	Department of Environment and Conservation (formerly Department of Conservation and Land Management)
DEWHA	(Australian Government) Department of Environment, Water, Heritage and the Arts
DVI	digital video imagery
EPBC	(Commonwealth) Environment Protection and Biodiversity Conservation (Act 1999)
ENA	Extended Nursery Area
ERLF	Esperance Rock Lobster Managed Fishery
ESD	ecologically sustainable development
FED	fish escape device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
GAB	Great Australian Bight
GDSF	Gascoyne Demersal Scalefish Fishery
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
MBP	Marine Bioregional Plan
MOP	Mother-of-Pearl
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MPP	Management Planning Panel
MSC	Marine Stewardship Council
MSY	maximum sustainable yield
NBPF	Nickol Bay Prawn Managed Fishery
NDSF	Northern Demersal Scalefish Managed Fishery
NHT	Natural Heritage Trust
NPF	Northern Prawn Fishery
PER	Public Environmental Review
PFRC	Pemberton Freshwater Research Centre
PFTF	Pilbara Fish Trawl (Interim) Managed Fishery
RAP	Research Angler Program
RCL	Rostrum Carapace Length
RFAC	Recreational Fishing Advisory Committee
RFFSS	Recreational Freshwater Fisheries Stakeholder Subcommittee
RLIAC	Rock Lobster Industry Advisory Committee
ROA	Reef Observation Area
SBBSMNF	Shark Bay Beach Seine and Mesh Net Managed Fishery
SBSF	Shark Bay Snapper Managed Fishery
SCEF	South Coast Estuarine 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
SWBS	South West Beach Seine Fishery
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TAE	Total Allowable Effort
TL	Total Length
TPSA	Tiger Prawn Spawning Area
VFLO	Volunteer Fisheries Liaison Officer
VMS	Vessel Monitoring System
WADNHFMAC	WA Demersal Net and Hook Fisheries Management Advisory Committee
WAFIC	WA Fishing Industry Council
WAFMRL	WA Fisheries and Marine Research Laboratories
WAMSI	WA Marine Science Institute
WANCSF	WA North Coast Shark Fishery
WCBBF	West Coast Beach Bait Managed Fishery
WCDGDLF	West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery
WCDSF	West Coast Demersal Scalefish Fishery
WCEF	West Coast Estuarine Managed Fishery
WCRLF	West Coast Rock Lobster Managed Fishery
WDWTF	Western Deepwater Trawl Fishery
WTO	Wildlife Trade Operation