2009

State of the Fisheries Report 2008/09

W.J Fletcher

K. Santoro

STATE OF THE FISHERIES REPORT

2008/09

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

Fish for the future

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CONTENTS

OVERVIEW FROM THE CHIEF EXECUTIVE OFFICER

The *State of the Fisheries Report* is published annually to provide a detailed review of the management of fisheries resources 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 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 2008/09 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 status of Western Australian fisheries of major importance to the commercial and recreational sectors, the aquaculture industry and for those interested in aquatic management.

The report 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. The first of our bioregional assessments using the West Coast as a Case Study is presented in this edition.

These bioregional reports indicate that fishing generally does not present an unacceptable risk to most of the targeted stocks or the marine, estuarine and freshwater ecosystems underpinning them. 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 high risk to one or more elements, they have 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 where the abundance is considered to above the level where additional management is required. Of those not at acceptable levels, additional management has previously been implemented to rectify the situation for Cockburn Sound Crabs, southern shark and northern shark. Management measures aimed at reducing the catch and effort by all sectors for west coast demersal finfish (including snapper and dhufish) have also recently been implemented. Furthermore, the proposed intensive monitoring program for these stocks is underway.

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 2008/09* follows a fully bioregional format reflecting the Department of Fisheries' ongoing commitment to ecosystem-based management of Western Australia's aquatic resources. This includes a section at the beginning of each bioregion that outlines the key natural assets for the region and summarises the status of the key fish stocks. In this context, individual fish stocks are now formally used as general indicators of the health of the aquatic environment and the West Coast Bioregion has the current outputs from the bioregional assessments that have been completed as part of Ecosystem Based Fisheries management initiative that has been running for the past few years. These comprehensive bioregional reports will be extended to other bioregions in coming years

Each of the Individual fishery reports is based upon the now well-established Ecologically Sustainable Development (ESD) reporting approach and contains both the commercial and recreational activities within the one report. This ensures that the aggregate catch harvested from each stock is clear and shows 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.

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 Research Angler Program and the provision of biological samples. 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.

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.

A summary version of this document is now also available from the same website.

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 and undertook the editing and formatting.

Dr Rick Fletcher
Director – Fisheries Research

September 2009

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* 2008/09 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.

Breeding stock status

Adequate: reflects levels of parental biomass of a stock where annual variability in recruitment of new individuals (recruits) to the stock is a function only of environmental effects or recruit survival, not the level of the stock.

Recovering: 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 at an acceptable rate 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.

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.

Assessment Method

The report now clearly identifies what type of assessment method(s) have been used to determine the status of stocks. The main methods vary from the relatively simple analysis of catch levels and catch rates, through to more sophisticated analyses that involve sampling of the catch (fishing mortality), direct surveys and age structured simulation models.

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.

INTRODUCTION FIGURE 1

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

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 2007/08 or the calendar year 2008, whichever is more appropriate.

Similarly, the statistics on compliance and educational activities are also for 2007/08, 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 2009.

Performance measures

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

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

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 southward along the continental shelf. 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 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.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

The principal commercial fishery in this region targets the western rock lobster which is Australia's most valuable single-species wild capture fishery. There are also significant commercial fisheries for other invertebrates including scallops, abalone and blue swimmer crabs. Commercial fishers take a range of finfish species including sharks, dhufish, snapper, baldchin groper and emperors using demersal line and net methods. Beach based methods such as beach seining and near-shore gillnetting, and hand-hauled nets are used to capture whitebait, mullet and whiting.

The West Coast bioregion, which contains the state's major population centres, is the most heavily used bioregion for recreational fishing (including charter based fishing). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic/game species often around islands and out to the edge of the continental shelf.

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.

ECOSYSTEM MANAGEMENT

The marine benthic habitats along the west coast are 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 Ecosystem Management, Figure 1).

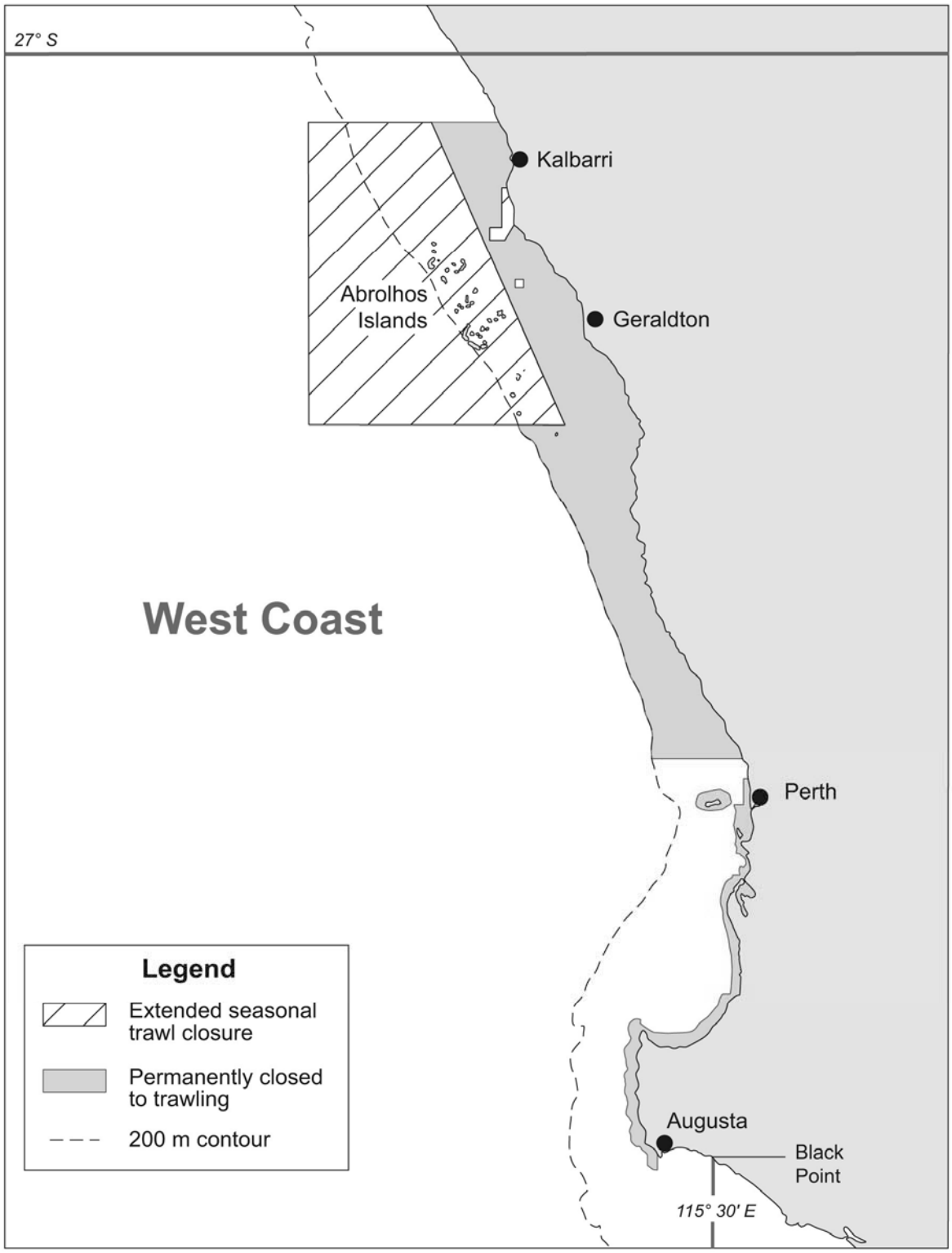
Fish habitat and biodiversity protection is also provided within individual marine protected areas along the west coast including:

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 s.43 of the Fish Resources Management Act 1994 at Yallingup Reef, Cowaramup Bay, the Busselton Underwater Observatory, and around the wrecks of the Saxon Ranger (Shoalwater Bay) and Swan (Geographe Bay); and

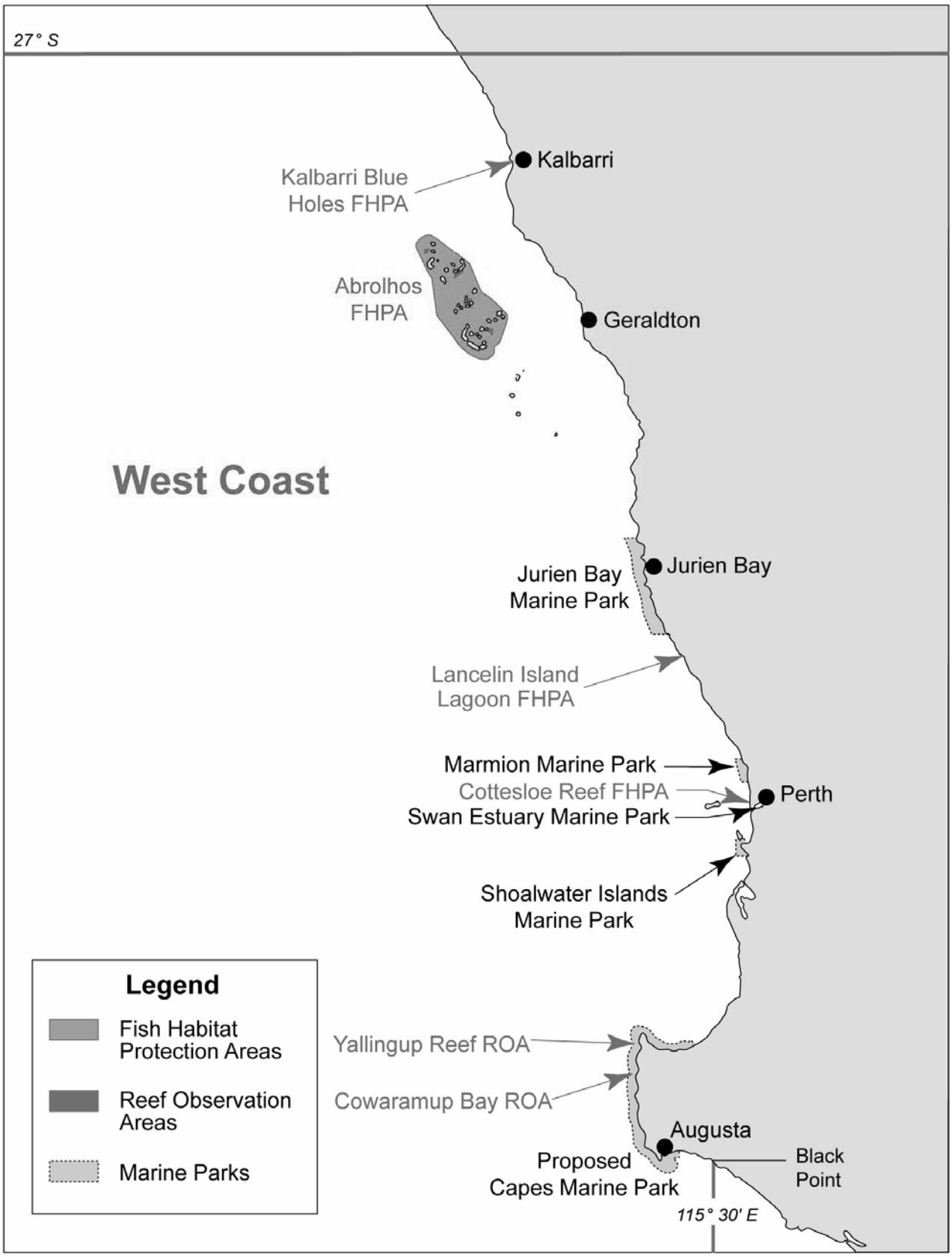
marine conservation areas proclaimed under the Conservation and Land Management Act 1984 at Jurien Bay, Marmion, Swan Estuary, Shoalwater Islands, and the proposed Capes Marine Park between Cape Leeuwin and Cape Naturaliste (West Coast Ecosystem Management, Figure 2).

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 draft South West Marine Bioregional Plan (MBP) is due for release in late 2009, and will include proposed marine protected areas within the Commonwealth waters.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas of permanent and extended seasonal closures to trawl fishing in the west coast bioregion.



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed marine protected areas in the west coast bioregion.

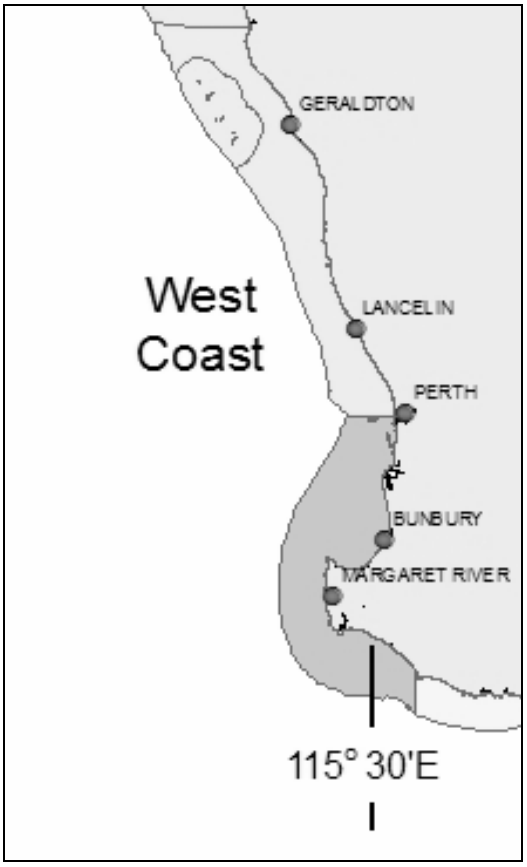
ECOSYSTEM BASED FISHERIES MANAGEMENT

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

This sub-regional scale of management has been used in the

.

Department's Ecosystem Based Fisheries Management (EBFM) framework. EBFM is a risk based management approach, which recognizes the social, economic and ecological values at a regional level and links between exploited fish stocks and the broader marine ecosystem, to ensure the sustainable management of all fisheries resources into the future. EBFM identifies these individual ('lower level') values, and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. The West Coast was the first bioregion where the EBFM process, including the risk assessment (see Table 1), has been applied. This process will be applied in the other bioregions in the near future



WEST COAST ECOSYSTEM MANAGEMENT FIGURE 3

Map showing the three main IMCRA ecosystems in the west coast bioregion: the Abrolhos Is.; the Central West Coast; the Leeuwin-Naturaliste.

Note- This is IMCRA v3.0.

Ecological Assets

In terms of ecological assets, the Department has recognised the following ecological values for the three IMCRA regions within West Coast Bioregion:

- Ecosystem structure and biodiversity (on a meso-scale basis – marine, estuarine/embayments);
- Captured fish species (stock sustainability);
- Protected species (direct impact – capture or interaction);
- Benthic habitat; and
- General environmental impacts.

For some issues a finer level of division of the IMCRA ecosystems is used by the Department. This relates to recent management initiatives necessary to recognise different suites of exploited fish and invertebrates across the continental shelf. These sub-components are defined by depth contours (Nearshore 0-20m; Inshore 20-250m; Offshore >250m).

WEST COAST ECOSYSTEM MANAGEMENT TABLE 1 RISK LEVELS FOR EACH ASSET.

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Severe risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Aquatic zone	Risk	Status and Current Activities
Abrolhos Islands	Marine	LOW - MEDIUM	The Abrolhos Islands are protected within a 'Fish Habitat Protection Area', and are not considered to be at unacceptable risk from fisheries related activities. There are a number of research programs Including monitoring of the health of coral communities at the Abrolhos Islands. This program, which utilises permanent 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. Surveys of the community structure of finfish are also underway within and outside of non-fishing areas..
Central West Coast	Marine	LOW - MEDIUM	An assessment of the community structure and trophic level of all commercially caught fish species over the past 30 years through an FRDC project found no evidence of systematic changes that could be evidence of an unacceptable impact on this ecosystem 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, and 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.

Ecosystem	Aquatic zone	Risk	Status and Current Activities
	Estuaries	SEVERE (non-fishing)	The estuaries and embayments within this area have been identified as being at severe risk, due to external factors (water quality issues due to high nutrient runoff from surrounding catchment) which have the potential to affect fish and other communities. Poor water quality within the Peel – Harvey and Swan-Canning estuaries, and Cockburn Sound are of particular concern. The Port of Fremantle provided funding to the Department to assess the potential impacts of a proposed new outer port development in Cockburn Sound on important aspects of the biology of the native fauna, and user groups in the vicinity. A final report was prepared and combined with associated studies undertaken by other organisations on other aspects of the proposed development, such as modelled changes to circulation patterns in Cockburn Sound, and potential impacts to penguin and dolphin populations, to allow for a full risk assessment of the proposed development.
Leeuwin Naturaliste	Marine	LOW	The impacts on the marine communities are relatively low in this region.
	Estuaries	HIGH (non-fishing)	External factors such as water quality issues in the Blackwood Estuary, due to high nutrient run-off from surrounding land, as well as acid-sulphate soil contamination are of concern to sustainable fish stocks and the ecosystem in general.

Captured fish species

Fish species	Aquatic zone	Risk	Status and Current Activities
Finfish	Estuarine	SEVERE (non-fishing)	There is extreme concern for some indicator fish stocks within estuaries in the west coast bioregion mainly due to external (non-fishing) factors (poor water quality).
	Inshore demersal (20-250m depth)	SEVERE	Major concerns for specific demersal species (dhufish, pink snapper, baldchin groper, sharks, western blue groper) were confirmed following a number of stock assessments and recent reviews. Strong management actions have been taken for the commercial and plans for the recreational sectors have been developd. Determining catch shares for commercial and recreational users is now a major focus for management.
	Nearshore demersal (0-20m depth)	HIGH	There are increasing concerns for Australian Herring, tailor and skipjack trevally and King George whiting in the nearshore region given the potential for fishing levels to increase on these stocks once the increased management of the inshore demersal stocks commences. New research projects have begun to assess these stocks.
	Offshore demersal (>250m depth)	MEDIUM - HIGH	Some of the key indicator species in this deepwater location are vulnerable to overfishing. Management arrangements for fishing in these depths, especially for recreational sector are still being finalised.
	Pelagic	LOW	There is now minimal capture of pelagic fish in this bioregion.
Crustaceans	Estuarine	HIGH	The stocks of crabs in Cockburn Sound have been at depleted levels for the past few years but are now in the process of recovery since the closure of fishing occurred in 2007. The other stocks of crabs are being Investigated.
	Offshore demersal	MEDIUM	The stock levels of key crustaceans in this region, western rock lobsters and prawns, are both currently at appropriate levels. The strong management that is being applied to the rock lobster fishery should ensure that its spawning stock remains at acceptable levels.
Molluscs	Nearshore	MEDIUM	The stocks of abalone are conservatively managed with strong management controls on both commercial and recreational fishers. Allocations of access to all sectors through the IFM process were determined in 2009.

Protected species

Protected fish species	Species	Risk	Status and Current Activities
Protected non 'Fish' species	Turtles	LOW	There is minimal impact from fishing activities on any turtle species within this bioregion
	Seabirds	MEDIUM	Little Penguins are considered at risk from fishing and boating in this region, mostly from boat strikes. Few other Issues Identified.
	Mammals	LOW	Sea lion exclusion devices required for rock lobster pots near sea lion breeding islands has reduced the level of risk to low levels.
Protected 'Fish' Species	Fish	MEDIUM	Blue groper (Rottnest Island), Cobbler (Swan Canning) and Great White Sharks are within this category. already closed to fishing.
	Crustaceans	LOW	No Issues
	Molluscs	LOW	No Issues

Benthic habitat

Benthic Habitat	Category	Risk	Status and Current Activities
Estuaries and Embayments	Sand	SEVERE (non–fishing)	Estuarine and embayment habitats are threatened by various non-fishing factors (poor water quality, direct loss of habitat through coastal infrastructure and physical disturbance eg dredging), sedimentation and smothering by algae. There are minimal impacts of fishing on these habitats
	Seagrass	MEDIUM (non-fishing)	Seagrass habitat threatened from non-fishing related activities (coastal infrastructure and associated dredging (direct habitat loss, turbidity), eutrophication. Strong controls exist for destruction of seagrass.
Nearshore (0-20 m depth)	Sand	LOW	Minimal direct impacts and high recovery rates.
	Seagrass	LOW	No destructive fishing methods allowed in these areas.
	Mangroves	MEDIUM (non-fishing)	Mangrove communities at the Abrolhos under threat due to decreasing rainfall.
	Rocky Reef	LOW	Minimal direct impacts and high recovery rates.
	Coral Reef	LOW	Minimal direct impacts.
Inshore demersal (20-250 m depth)	Sand Seagrass Rocky Reef Coral Reef Sponge	LOW LOW LOW LOW LOW	Minimal direct impacts.
Offshore demersal (>250 m depth)	Sand Rocky Reef Sponge	LOW LOW LOW	Minimal direct impacts.

The Biodiversity and Biosecurity Branch were involved in 'Marine Futures', which was a Natural Heritage Trust (NHT) funded collaborative project, managed by the University of Western Australia, to collect baseline scientific data to develop marine resource indicators for marine habitats, biodiversity and human use patterns in south-western Australia. The focus of the project was 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 mostly by other agencies (e.g. UWA, ECU, CSIRO) 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). This work is being coordinated through the WAMSI Node 4 project 4.1

The Department continues to undertake research to assess the impacts on fisheries, from other activities and determine appropriate management responses, and input into the Western Australian Environmental Protection Authority's environmental impact assessment process when a development proposal has the potential, if implemented, to impact on the aquatic environment.

The Department also continues to actively engage with the natural resource management groups within 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.

FISHERIES
West Coast Rock Lobster Fishery Status Report

S. de Lestang, A. Thomson and M. Rossbach.
Management input from J. Kennedy and G.Baudains

Main Features

Status		Current Landings (Season 2007/08)	
Stock level	- Acceptable	Commercial catch	8920 t
Fishing Level	- Acceptable	Recreational catch	206 t

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 about 11,000 t, this is Australia's most valuable single species wild capture 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; Western Rock Lobster Council

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 meters 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 three 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 included the protection of females in breeding condition, a minimum size limit of 77 mm carapace length applied from 15 November to 31 January, and a minimum of 76 mm from 1 February to 30 June. A maximum size limit for female lobsters was re-imposed in 2002/03 that prohibits the take of female lobsters larger than 105 mm from waters between 21º44′ S and 30º S (northern region) and those larger than 115 mm between 30º S and 34º24′ S (southern region), excluding waters east of 115º08′. Gear controls, including escape gaps and a limit on the size of pots, also play a significant role in controlling exploitation rates. The season was open from 15 November to 30 June, 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 ESD assessment of this fishery has been undertaken to identify any potential sustainability risks requiring direct management. The issues identified through this process were lobster breeding stock levels, by-products (octopus) and interactions with protected species. Boxed text in this status report provides 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.

In 2007/08 a daily bag limit of 8 lobsters per fisher per day was 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 provided 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.

Integrated 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 logbook 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 has recently 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. This research is supported by the Western Australian Marine Research Institution and a new FRDC project starting in 2009. The aims of this project include negotiating a suitable closed area in deep water to assess the ecological impacts of fishing, developing cost effective methods to monitor benthic communities in deep water and the collection of baseline information on lobster stocks, habitats 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 second project examining lobster populations between fished and unfished zones is ongoing at Rottnest Island. This project consists of annual sampling using pots and underwater dive surveys at Armstrong Bay and Parker Point sanctuary zones. Results from the first two years after the no-take regions were implemented have shown a rapid increase in lobster numbers within the protected areas. This study also aims to provide additional information on growth and natural mortality. Further funding will be sought to continue this monitoring into the future.

A risk assessment workshop to examine the low puerulus settlement was held in April 2009. The workshop focused on examining the 'likelihood' of factors that could have caused the decline in puerulus settlement. The workshop concluded that the decline in settlement could have been caused by changes in environmental conditions and productivity in the eastern Indian Ocean, or a decline in the abundance of the rock lobster breeding stock, particularly in the northern region of the fishery, or a combination of these two factors. A report on this workshop was released to stakeholders for comment in July 2009.

The five projects listed below were submitted to the Fisheries Research and Development Corporation (FRDC) and were successful in securing funding. The objectives of the projects are to investigate various aspects of the possible causes and factors associated with the low puerulus settlements of 2007-08 and 2008-09.

Project 1 (FRDC 2009/018) Identifying factors affecting the low western rock lobster puerulus settlement in recent years.

Project 2 (FRDC 2008/087) Evaluating source-sink relationships of the Western Rock Lobster Fishery using oceanographic modelling.

Project 3 (FRDC 2009) Evaluating the use of novel statistical techniques for determining harvest rates and efficiency increases in the Western Rock Lobster Fishery.

Project 4 (FRDC 2009) Evaluation of population genetic structure in the western rock lobster.

Project 5 (FRDC 2008) Assessing possible environmental causes behind the reduced colonization of puerulus collectors by a wide suite of species.

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. Phone diary surveys are considered to be more accurate than those from mail surveys because they 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.

Research will commence that aims to identify those parameters derived from mail surveys that are to be adjusted to lead to a catch estimate that is comparable to the diary survey estimates. Thus, mail survey effort estimates may be altered in the future. The comparison between effort levels from one season to the next season should, however, not be affected.

Retained Species

Commercial landings (season 2007/08):

8920 tonnes

Trends in the annual catches from the West Coast Rock Lobster Managed Fishery are shown in West Coast Rock Lobster Figure 1. The 2007/08 catch in the WCRLF was forecast from puerulus settlement 3 to 4 years previously to be 8940 t. The actual catch from the WCRLF for the 2007/08 season was 8,920 t, which was 19.5% lower than the long-term average catch (1980/81 to 2005/06) of 11,083 t and 4.0% higher than the previous season's 8,577 t. In 2007/08, the catches in A, B and C Zones were 1,881, 3087 and 3,952 t, respectively, with A Zone 6% lower, B Zone 4% up and C Zone 9.5% higher 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 2007/08 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 6,480, 95,311, and 62,107, 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 2007/08):

206 tonnes

Based on the first 2 phone diary surveys (2000/01 and 2001/02), catch estimates from previous mail surveys going back to the 1986/87 season were adjusted downwards by the average ratio of 1.9. A fourth phone diary survey undertaken in the 2005/06 season produced a different ratio between the mail and phone diary recreational catch estimates. In the interests of maintaining consistency from year to year, however, 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 2007/08 was estimated at 206 t based on the adjusted mail survey, with 147 t taken by potting and 59 t by diving. Comparative catch estimates for 2006/07 were 117 t by potting and 57 t by diving. The estimated recreational catch in 2007/08 was 18.4% above the 2006/07 catch. The 2007/08 season catch estimate was within the catch prediction confidence limits (i.e. 115 – 468 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 2007/08 the numbers of vessels fishing for lobster were 126 in A Zone, 106 in B Zone and 228 in C Zone. Thus, in comparison to the 491 active boats in 2006/07, a fleet of 460 vessels fished in 2007/08, which was a reduction of 6.3%.

The nominal fishing effort was 7.9 million pot lifts in 2007/08 – 4.5% lower than the 8.3 million pot lifts for 2006/07 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 2007/08 nominal effort for A, B and C Zones was 1.1, 2.7 and 4.2 million pot lifts respectively, which was 8.1, 3.6 and 4.2% lower than the previous season's pot lifts.

Recreational

A total of 40,611 licenses were sold that permitted fishing for lobsters during some part of the 2007/08 season (made up of specific rock lobster licenses plus umbrella licenses), with an estimated 22,800 (56%) utilized for lobster fishing. License usage was forecasted to be 24,400 but came in below that prediction at around 22,800. 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 2007/08 was 4% higher than the number of active licenses (22,000) for the 2006/07 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 14 and 6 days respectively during the 2007/08 fishing season. These rates were similar in the 2005/06 fishing season.

Finally, the average catch taken by active pot and diving fishers were 36 and 20 lobsters respectively during the 2007/08 fishing season. In the 2006/07 season the average number of lobsters caught by pot and dive fishers was 32 and 22 respectively.

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

Assessment method: Size-structured model

Breeding stock levels: Adequate

Projected commercial catch next season (2008/09):

7,800 tonnes

Projected recreational catch next season (2008/09):

265 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 egg production are the main indicators for assessing the health of this fishery. Traditionally these have been empirical measures, and have been presented as the north and south coastal fishery-dependent breeding stock indices, based on commercial monitoring data, and the fishery-independent breeding stock survey (IBSS) indices. With the development of a fully integrated stock-assessment model, that incorporates information from both of these surveys as well as other data sources, estimates of egg production derived from this model are considered to be more representative. The use of model derived egg production estimates was also a key recommendation from a recent stock assessment review of this fishery.

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, 4 and 5).

A performance measure for the fishery is that the egg production index for the coastal zones remains above that estimated to be the 1980 level (22% of virgin biomass). The breeding stock levels at the end of the 2007/08 season in B and C Zones were clearly above this threshold value. 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 increase in CPUE to 1.12 kg/pot lift in 2007/08 (around 9.0% higher 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 1.3 and 1.9 lobsters per person per fishing day in the 2007/08 fishing season. These catch rates are slightly higher compared to the 0.9 lobsters for potting but slightly lower compared to the 2.2 lobsters for diving in the 2006/07 fishing.

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 2008/09 were at record low levels at nearly all sampling sites (West Coast Rock Lobster Figure 7). This low settlement has been particularly unusual in that it occurred during a year that the Leeuwin Current was strong which means other environmental factors and/or breeding stock may be contributing to this decline. This low 2008/09 settlement will first impact on catches during the 'reds' of 20011/12 and the 'whites' throughout the fishery in 2012/13.

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 87,435 fish and invertebrates other than rock lobster and octopus were captured during the 2006/07 fishing season, of which most were released (Table 1).

Protected species interaction: Low

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

In order to eliminate these accidental drownings, from November 15, 2006 all pots fished in waters less than 20m 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. 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 2007/08 showed that over 95% of pots checked had an approved SLED.

The performance measure for this fishery is that no increase in the rate of capture of sea lions occurs. During the 2007/08 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.

The 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 two and five 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; however, with the increasing population of whales, more interactions are likely to occur in the future.

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

The 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 four whale/dolphin interactions per season. Four whale entanglements were recorded during the 2007/08 lobster season, which were all 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 FRDC, almost completed and a second FRDC 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 3 and a half months of the year.

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

Social Effects

Commercial

The western rock lobster fishery is an important sector of Western Australia's economy, with the commercial catch from the current reporting season valued ex-vessel at $217 million. Employment is seasonal, the fishing season covering seven and a half months from 15 November to 30 June.

A total of 460 vessels and 1,274 people were engaged directly in fishing for rock lobsters in 2007/08. This equates to 1 skipper and an average of about 1.76 deckhands per vessel, which is very similar to that recorded during the 2006/07 season. During the year, 5 processing establishments, located in the Perth metropolitan area (3) and Geraldton (2), serviced practically every location where 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 2007/08: $217 million

The price that commercial fishers received for the western rock lobster in 2007/08 was an estimated average of $24.30/kg in all zones of the fishery. This was 14.7% decrease on the $28.50/kg paid in 2006/07. The overall value of the fishery declined marginally from the previous season's value of $245 million as a result of the lower beach price 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 2007/08 commercial catches have averaged 10,951 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. However with the record low puerulus settlement in 2008/09 (which will be reported in next years report) and the consequential significant effort reductions that were instigated for the whites (ca. 35%) and reds (ca. 60%) portions of the season to ensure carryover into the predicted low catch years of 2010/11 and 2011/12, the catch in 2008/09 will fall below the normal commercial target catch range and be lower again in 2009/10.

Recreational

Current Fishing (or Effort) Level: Acceptable

Target recreational catch range: 197 – 354 tonnes

Between 1986/87 and 2007/08 recreational catches have varied between 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.

The recreational catch estimate for the 2006/07 season is 206 ± 23 t (95% confidence interval of the mean).

New management initiatives (2008/9)

A new management package, currently being developed by the Department and the Rock Lobster Industry Advisory Committee, will be implemented by the start of the 2009/10 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 over the following five seasons given the current poor recruitment period.

A revised decision rules framework for the West Coast Rock Lobster Fishery was presented at the coastal tour 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) recertification of the fishery.

The Minister requested advice on a business case for quota management in 2008. A RLIAC working group developed a possible management framework and this was released in 2009. The incoming Minister then requested RLIAC's advice on an optimised Quota Management System. RLIAC convened a panel of independent experts to develop models for an optimised quota management system and input control; system. These papers have been released for information.

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 Nino* or neutral conditions, which has generally resulted in average or below average puerulus settlement due to the weaker Leeuwin current strength. However the low settlement of 2008/09 has been particularly unusual in that it occurred during a year that the Leeuwin Current was strong (*la Nina* year) which means other environmental factors and/or breeding stock may be contributing to this decline. The possible effect of the Indian Ocean Dipole (IOD), which has had three years (2006-2008) of positive IOD, is being examined as historically the puerulus settlement has never been above average in a year with a positive IOD.

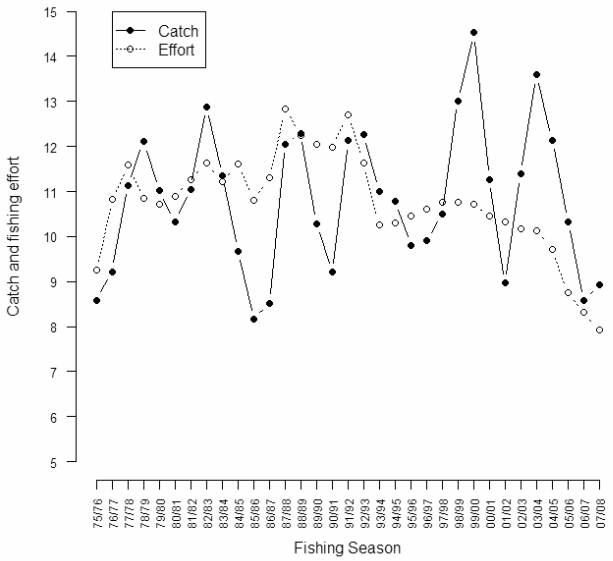
Increases in water temperatures over the last 30-40 years appear to be affecting some of the biological parameters such as size at maturity and size of migrating lobsters. These changes are being taken into account in future stock assessments.

The economic performance of the fishery is being strongly affected by the value of the Australian dollar (affecting the price of lobsters), fuel and labour costs.

WEST COAST ROCK LOBSTER TABLE 1.

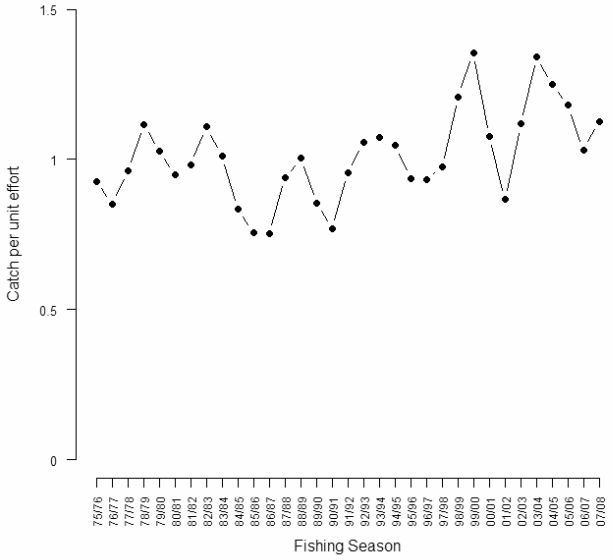
Catch rate of bycatch in lobster pots recorded during observer monitoring programs in 2007/08. The total number caught is an estimate based on the catch rate and the total number of pot lifts in 2007/08 fishing season.

Bycatch Species	Catch/1000 Pot Lifts	Estimated Total Number Caught (whole fishery)
Baldchin Groper (*Choerodon rubescens*)	0.76	6025
Break Sea Cod (*Epinephelides armatus*)	1.40	11,098
Cuttlefish (*Sepia* sp.)	0.41	3250
Dhufish (*Glaucosoma hebraicum*)	0.29	2299
Eel (Muraenidae)	0.58	4598
Leatherjacket (Monocanthidae)	0.12	951
Pink Snapper (*Pagrus auratus*)	0.12	951
Port Jackson Shark (*Heterodontus portusjacksoni*)	0.82	6500
Scorpion Fish (Scorpaenidae)	0.29	2299
Unknown fish	4.26	33,769
Wobbegong shark (*Orectolobus* spp.)	1.34	10,622
Wrasse (Labridae)	0.64	5073
Total		**87,435**



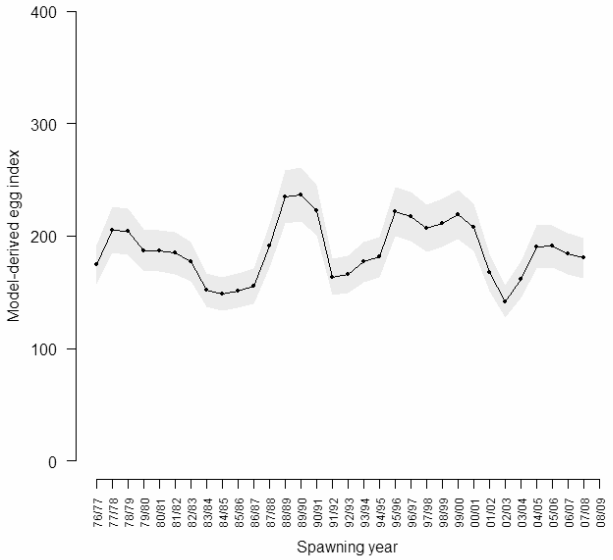
WEST COAST ROCK LOBSTER FIGURE 1

Annual catch and nominal fishing effort from fishers' compulsory monthly returns for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2007/08.



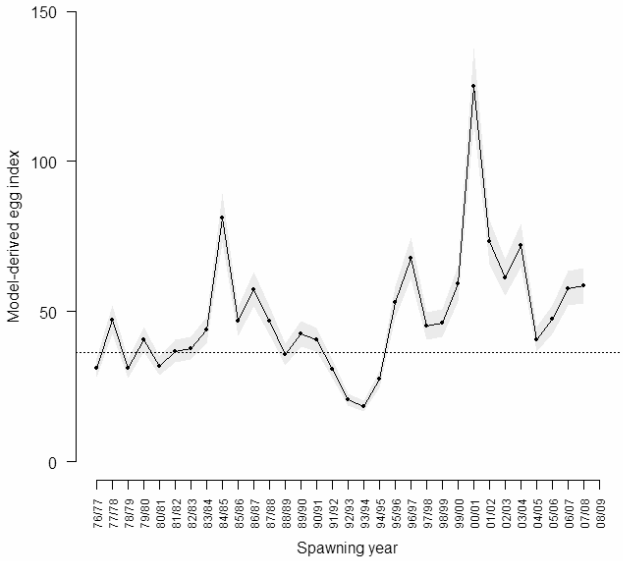
WEST COAST ROCK LOBSTER FIGURE 2

Annual catch rate (kg/pot lift) for the West Coast Rock Lobster Managed Fishery from 1944/45 to 2007/08.



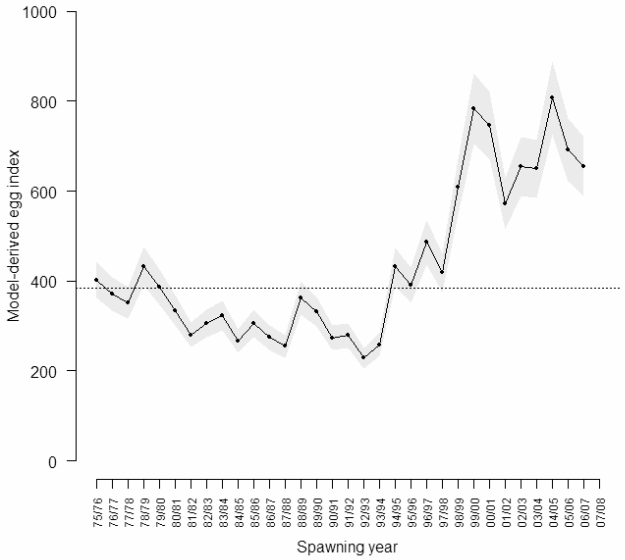
WEST COAST ROCK LOBSTER FIGURE 3

Mean ± 1 SE (in grey) model-derived egg production index for the Abrolhos zone of the fishery (A zone).



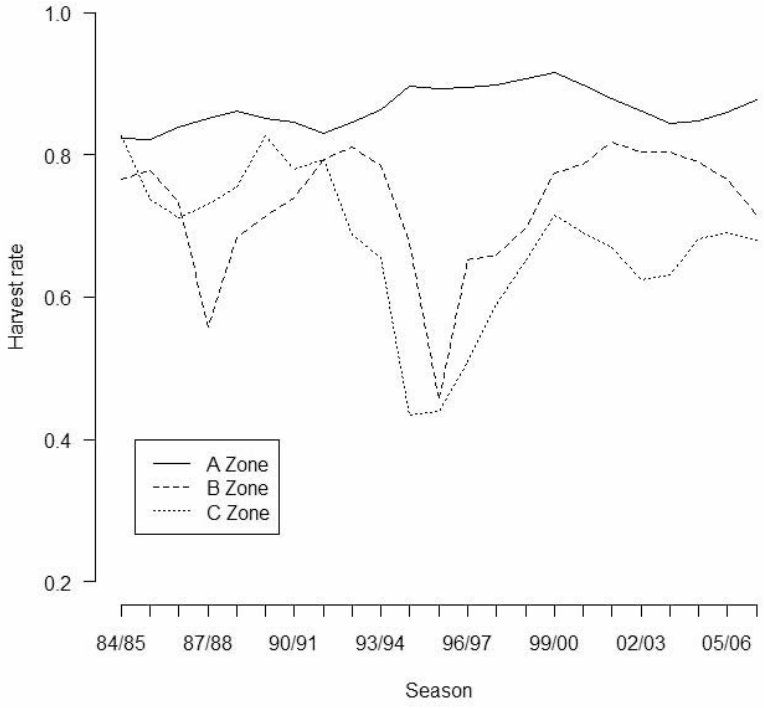
WEST COAST ROCK LOBSTER FIGURE 4

Mean ± 1 SE (in grey) model-derived egg production index for the northern coastal zone of the fishery (B zone). The horizontal dotted line represents the 1980's threshold.



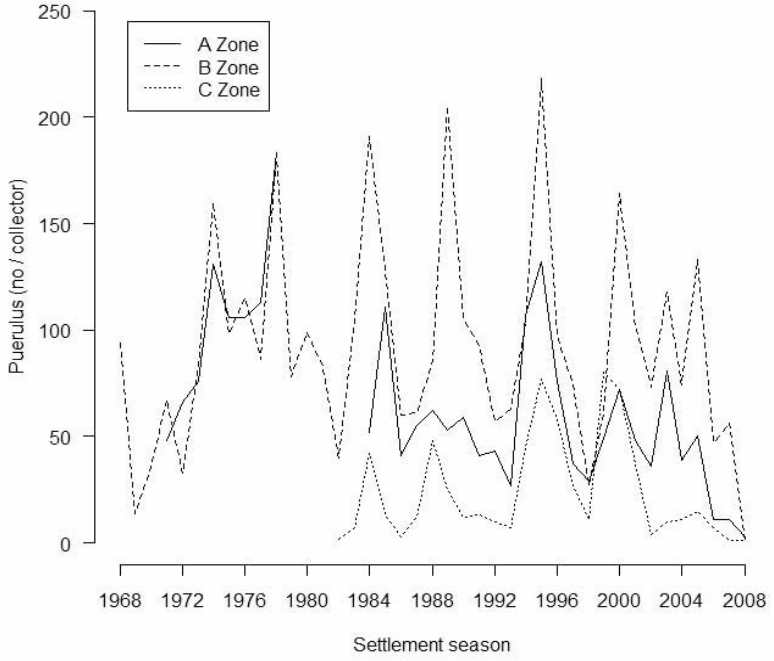
WEST COAST ROCK LOBSTER FIGURE 5

Mean ± 1 SE (in grey) model-derived egg production index for the southern coastal zone of the fishery (C zone). The horizontal dotted line represents the 1980's threshold.



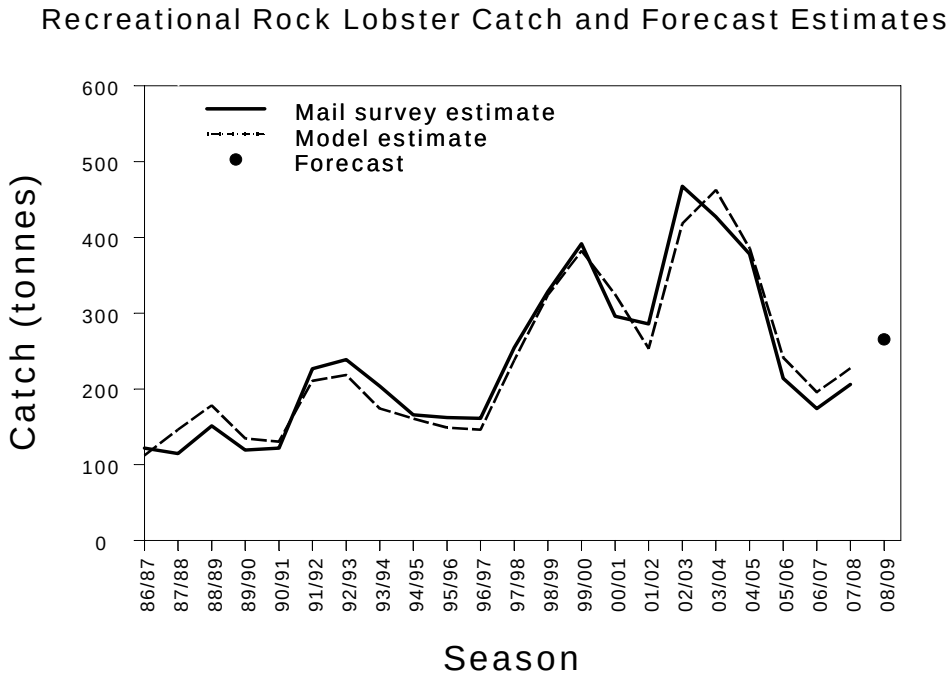
WEST COAST ROCK LOBSTER FIGURE 6

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 2008/09 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

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings

Commercial Roe's Abalone Catch - Total (All Zones) - 93 t

Recreational Roe's Abalone Catch - Total (All Zones) - 58 t (38% of total)

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

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

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

Meetings between the Department of Fisheries and commercial abalone 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 and includes the metropolitan 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 2008 was 106.7 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. 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.

A comprehensive Ecologically Sustainable Development assessment of the commercial 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.

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, commencing on the first

Sunday in November, and the daily allowed fishing time is 60 minutes (between 7.00 a.m. and 8.00 a.m.). Prior to 2006, daily fishing time was 90 minutes.

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.

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, sub-area and month of fishing, as well as technological improvements that aid fishing efficiency. The standardized CPUE data are being used to develop a decision-rule framework for quota setting for each area of the fishery.

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 an annual field survey (West Coast Zone / Perth metropolitan fishery), and an occasional telephone diary survey covering the entire state (2007 was the last year of a state-wide survey).

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 1,200 interviews in 2008), 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, however is not completed every year. 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 2008):	93.2 tonnes whole weight
Metro only	35.9 tonnes whole weight

The TACC for the 2008 quota year was 106.7 t whole weight for Roe's abalone. The catch of 93.2 t whole weight for 2008 (Roe's Abalone Table 1) was 3% higher than in 2007 and 13.5 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) where an exploratory quota is set, and catches below the TACC in Area 5 (85% 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 2008):	Roe's Metro Fishery 44 tonnes
(season 2007):	Roe's rest of state 14 tonnes
	(38% of total catch)

The recreational catch for Roe's abalone from the Perth metropolitan area in 2008, as estimated from the field survey, was 44.4 t (Roe's Abalone Table 2). This is an increase of about 30% from 2007 and the highest catch weight since this time series was started in 1999. This has probably been caused by a combination of increases in catch rates and meat weight as a result of good weather conditions, and an 8% increase in license numbers (Roe's Abalone Figure 3).

Based on the Perth recreational fishery for 2008 (44 t), and using the 2007 phone diary estimate for the rest of the state (14 t), recreational fishing represented about 38% of the total (commercial and recreational) Roe's abalone catch (151 t) across the state in 2008. This is slightly higher than the 2006 and 2007 estimates of 21 – 36%, and the increase was caused by the increased catch in the Perth fishery.

Fishing effort/access level

Commercial

Total effort for dedicated Roe's abalone divers in 2008 was 580 diver days (similar to last year's effort of 585 diver days), which was the lowest effort on record (Roe's Abalone Table 1). The low effort in recent years is a combination of high abundance, lower quota being set and improved fishing efficiency and only 87% of TACC being caught.

Recreational

For the 2008 season, around 25,000 licences were issued. This was an 8% increase over the 2007 figure of 22,500 licenses (Roe's Abalone Figure 4). Overall license numbers were stable for 6 years between 2001 and 2006, but have increased by 15% in the last 2 years, primarily due to an increase in abalone specific licenses (Roe's Abalone Figure 4). The vast majority of these new licenses have been issued to fishers targeting the Perth metropolitan roe's abalone fishery

Effort in the Perth fishery for 2008 was of 14,490 hours, a 17% increase on 2007 effort of 12,433 hours (Roe's Abalone Table 2) and reflects improved weather for fishing in 2008. This was still at the lower end of the historical range. Since 2006, daily season length has been shortened from 1.5 hours to 1 hour and is likely to affect overall effort, but catch rates and meat weights 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

Assessment method: Catch Rates / Direct Survey

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 2008 was 143 kg/day, which was similar to the 2006 catch rate of 142 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 are at higher than historically average levels. However, market preferences for large-sized abalone have impacted on Area 8, where there is only a limited area of habitat able to produce large-sized animals, and the TACC has been reduced from 12 to 9 t in 2008. Also, the exploratory quota in Area 1 (previously 9.9 t) has been reduced to 5 t in 2009 because environmental factors (loss of habitat due to sand encroachment) have reduced the available stock. These changes have resulted in an overall TACC reduction to 101.8 t for 2009 (Roe's Abalone Table 1).

A standardised catch per unit effort (CPUE) analysis was also undertaken. This methodology is still under development and will eventually be used as one of the performance indicators to set the TACC. A report that reviewed performance indicators for the abalone fishery was completed in 2008 and from 2009 onwards, the standardised CPUE information will be the principal indicator of the abundance of legal-sized abalone

The catch rate of recreational fishers in the Perth metropolitan fishery of 29 abalone/hour in 2008 was the equal highest since surveys began in 1999 (Roe's Abalone Table 2). A correlation analysis between catch and weather conditions (swell, tides, wind, rain) during the 6 hours of the fishery detected a high positive correlation. This suggests that weather conditions are the principal cause of the annual catch variability.

Stock surveys: Densities of sub-legal animals (less than 60 mm in size) on the platform habitat of the fished stocks increased from 42 in 2008 to 51 abalone m-2 in 2009 (Roe's Abalone Table 4). This is the highest level since surveys began in 1997, and was primarily due to increases in 0+ (1 -16 mm) and 1+ (17 - 32 mm) animals, which relates to higher settlement levels in 2008 and 2009. These animals will reach legal size in three to four years time. On the subtidal habitat, densities of sub-legal animals increased from 7.2 to 9.4 abalone m-2, which is also the highest density since the survey began in 1997.

Densities of legal-sized animals (60+ mm) on the platform habitat were slightly lower in 2009 (19 m-2), compared to 21 m-2 in 2008 (Roe's Abalone Table 4). Overall, however, legal-sized densities have been stable since 2004.

In the subtidal habitat, legal-sized densities remained at 15 abalone m-2 in 2009, which was the same as 2008. These are the highest level recorded (Roe's Abalone Table 4). With the increased abundance of sub-legal animals from 2007 to 2009, densities of legal-sized animals are expected to increase in the next two to five years.

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 (Roes Abalone Table 4). However, the difference is less evident for sub-legal animals, although density of sub-legal animals has also increased in the MPA, indicating there has been an environmental cause of increased settlement.

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 2008, 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 (85% of TAC caught). A reduction in Area 1 TAC (9.9 t to 5.0 t) was recommended for 2009 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.

Around 25,000 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 2008: $2.6 million

The estimated average price for Roe's abalone in 2008 was $26/kg, an increase from $24/kg in 2007. On the basis of the average price, the fishery was worth approximately $2.6 million – an increase from the 2007 value of $2.2 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 increased from $US0.58 in 2000 to >US$0.90 in mid-2008, although dropped back to $US0.7 to $US0.8 in the later part of 2008. The decline in prices is also due to competition from abalone produced by aquaculture.

Fishery Governance

Target effort range: 620 – 750 diver days

To assess whether the catch quota set 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 580 diver days in 2008 (Roes Abalone Table 1) falls below the expected effort range, suggesting stocks are at historically-high levels, however not all quota was caught (87% of the quota was taken), so a lower effort is expected.

New management initiatives (2008/09)

The main new management initiative in 2008/09 was the development of performance indicators and TACC decision rules for the abalone fishery. A report has been published, and TACC setting for 2009/10 was undertaken with the new decision rules. These will be included in the 2009/10 state of fisheries review.

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 commercial 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. In the recreational fishery, weather conditions have a significant effect on catch rates and total catch of recreational fishers.

ROE'S ABALONE TABLE 1

Roe's abalone catch and effort1 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	93,197	580	143
2009	**101,800**			

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
2008	**14,490**	**29**	**420,000**	**44.4**	**106**

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 may vary from 2007.

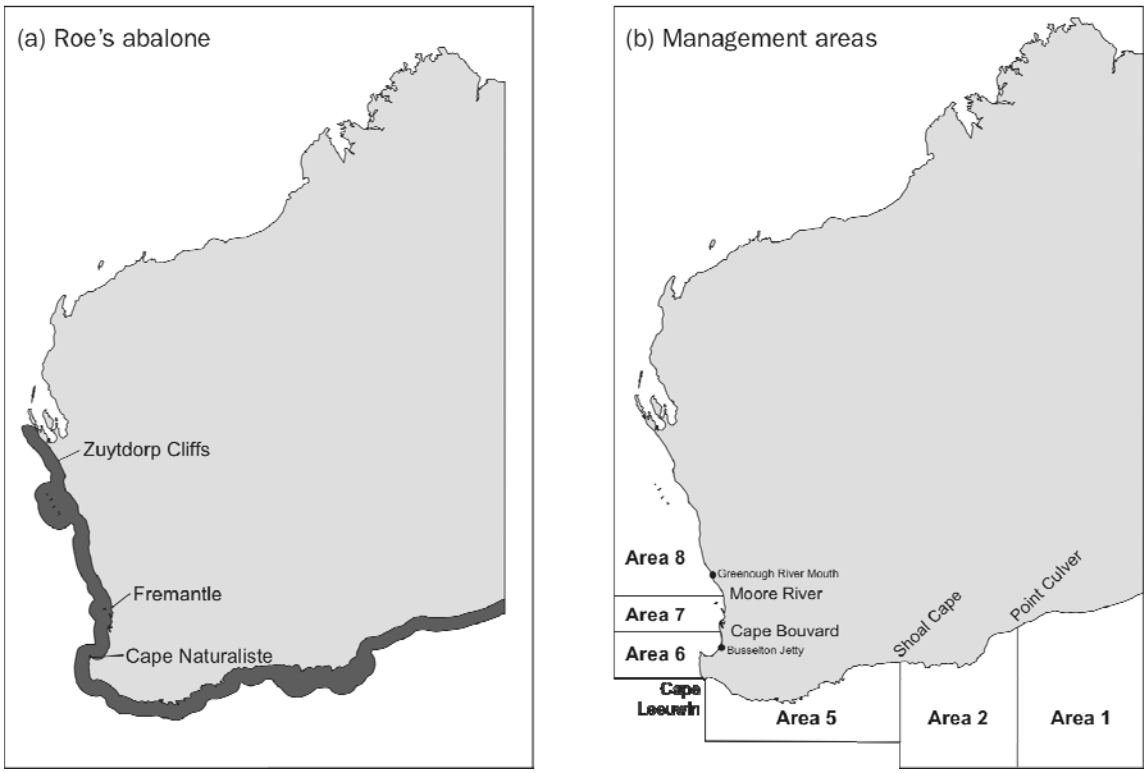
Year	Platform habitat				Sub-tidal habitat			
	Fished stocks		Waterman's Reserve (MPA)		Fished stocks		Waterman's Reserve (MPA)	
	<60	60+	<60	60+	<60	60+	<60	60+
1997	32	29	44	26	4.2	12	9	21
1998	42	27	51	37	5.2	13	11	29
1999	47	26	52	26	3.8	7	12	27
2000	45	24	29	35	2.7	10	8	31
2001	44	25	38	34	3.7	10	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
2009	**51**	**19**	**67**	**38**	**9.4**	**15**	**11**	**24**

ROE'S ABALONE TABLE 5

Assessment against agreed performance measures for 2008.

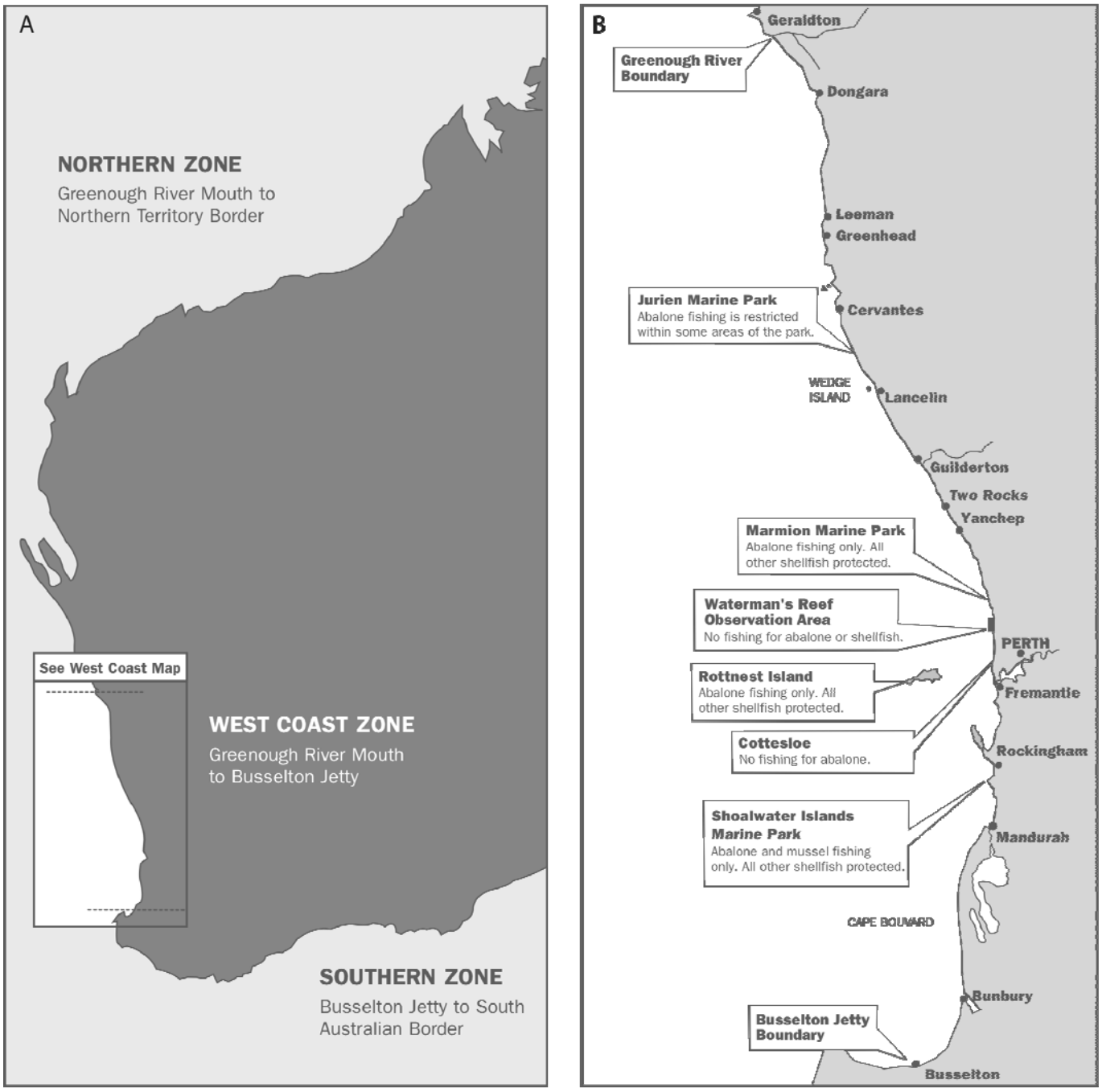
Performance Indicator	Performance Measure[1]	2008 Values	Assessment/Comments
Area 1			
Total catch (TACC)	9,900 kg	508	Exploratory quota – only a small percentage caught due to poor weather.
Total effort (diver days)	14 – 43	5	See above.
Area 2			
Total catch (TACC)	19,800 kg	19,729	Met – 99% of quota caught.
Total effort (diver days)	80 – 106	73	Met – quicker than agreed level.
Area 5			
Total catch (TACC)	20,000 kg	17,050	Met – 85% of quota caught.
Total effort (diver days)	100 – 140	91	Met – below agreed level, but due to lower-than-average catch.
Area 6			
Total catch (TACC)	12,000 kg	11,386	Met – 95% of quota caught.
Total effort (diver days)	80 – 127	99	Met – within agreed level.
Area 7			
Total catch (TACC)	36,000 kg	35,995	Met – 99% of quota caught.
Total effort (diver days)	175 – 215	199	Met – within agreed level.
Area 8			
Total catch (TACC)	9,000 kg	8,531	Met – 95% of quota caught.
Total effort (diver days)	140 – 200	115	Met – below agreed level, but due to lower TACC

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.



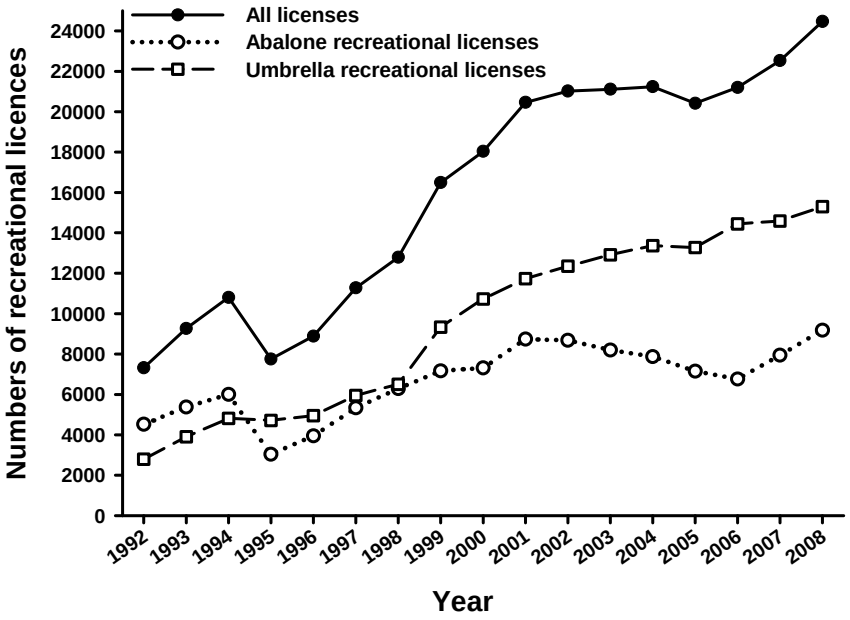
ROE'S ABALONE FIGURE 1

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.



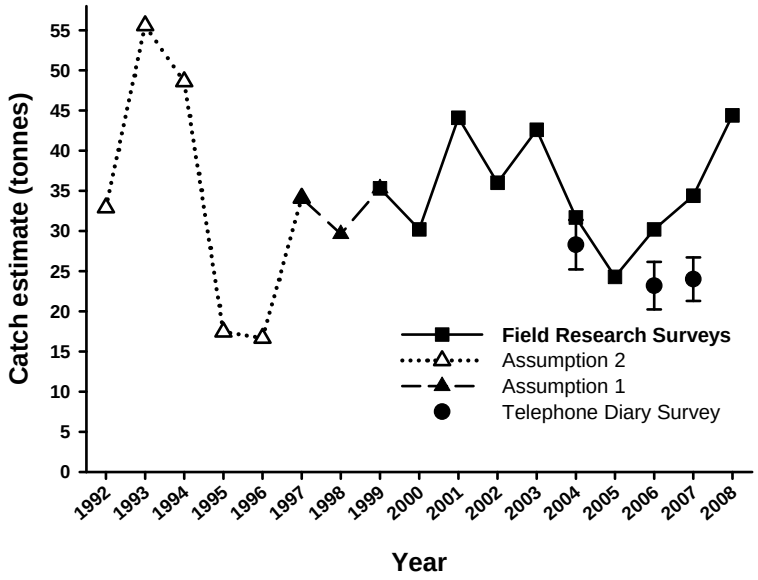
ROE'S ABALONE FIGURE 2

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 2008.



ROE'S ABALONE FIGURE 4

Catch estimates for the Perth recreational abalone fishery for the period 1992 to 2008, 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 - 2008, permissible fishing time per season day was 1 hour.

Abrolhos Islands and Mid West, South West Trawl Managed Fisheries and South Coast Trawl Fishery

E. Sporer, M Kangas and S. Brown
Management input from R Gould

Main Features

Status	Current Landings
	AIMWTMF:
Stock level – Acceptable	Scallops 1216 t (whole weight)
	SWTMF:
	Scallops 7 t (whole weight)
Fishing level - Acceptable	Prawns 8 t
	SCTF:
	Scallops, 23 t (whole weight)

Fishery Description

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

The South West Trawl (SWTMF) 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*).

The South Coast Trawl Fishery (SCTF) 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. Scallop landings for the fishery have varied dramatically over the years, depending primarily on the strength of recruitment. While the managed fishery area covers a large section of the coastal waters, the operations of the fleet are effectively restricted to very small areas of higher scallop abundance.

The catches in all fisheries are 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) for AIMWTMF.

South West Trawl Management Plan 1989

South West Trawl Managed Fishery Licence (MFL)

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 process

Meetings between the Department of Fisheries and industry.

Boundaries

AIMWTMF 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*'.

SWTMF 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 MFL's)
Zone B	from 32°16′ S to 115°08′ E	(12 MFL's)
Zone C	north-east of Cape Naturaliste	(0 MFL's)
Zone D	Comet Bay off Mandurah	(3 MFL's)

SCTF: 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. Four fishing boat licences have both conditions.

The Australian Fisheries Management Authority has proposed that a new set of co-ordinates be used under the Offshore Constitutional Settlement to define the 200 m isobath and if this proposal is adopted the westward or seaward side boundary of the fishery would be moved slightly eastward and the area of the fishery reduced slightly. However, scallop fishing operations do not normally occur near the 200 m depth boundary and accordingly there would be little impact on the

productivity of the fishery.

Management arrangements

AIMWTMF 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 principle of fishing ceasing at a threshold level also reduces conflict with the rock lobster industry that operates in this region. 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 336.5 metres (184 fathoms).

In 2008, the scallop season opened on 1 May and closed on 15 July. However fishing commenced on 15 May and ceased 5 June because the catches of scallops reached the voluntary threshold catch level of 250 kg per day (fleet average). The Port Gregory prawn trawl area was only fished by one boat on one day.

Bycatch reduction devices to release large and protected species (e.g. turtles) are fully implemented in the AIMWTMF as a license condition. The Department of Fisheries' vessel monitoring system (VMS) continues to monitor the activities of all boats.

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 accredited the fishery for a period of five years, allowing product from the fishery to be exported from Australia. The comprehensive Ecologically Sustainable Development assessment of this fishery has also identified that the breeding stock levels of the target scallop species is the issue for management. Boxed text in this status report provides the annual assessment of performance against this indicator for this issue.

SWTMF is managed under an input control system that limits boat numbers, gear sizes and fishing areas. Although a total of 18 MFL's only 14 boats are licensed to operate in this fishery, some in more than one zone. The fishing season operates between 1 January and 15 November in Zones A and B. Zone D season is open to fishing all-year-round and access to Zone C ceased in 2002. The management plan also includes large closures to protect sensitive coastal habitats (including seagrass beds) and nursery areas such as Cockburn Sound, Warnbro Sound and inshore Geographe Bay.

SCTF 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 SCTF under the provisions of the Environment Protection and Biodiversity Conservation Act 1999 and has granted a Wildlife Trade Order, 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.

Research summary

Research monitoring of the scallop stocks in the AIMWTMF fishery is undertaken using daily logbooks. The logbooks are 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. In the SWTMF and the SCTF fishers' monthly return data, which is used to assess the stocks with some skippers filling in daily logbooks that provide improved spatial catch and effort information.

Retained Species

Commercial landings (season 2008)

AIMWTMF:	Scallops, 1216 tonnes whole weight
SWTMF:	Prawns 8 tonnes
	Scallops 7 tonnes whole weight
SCTF:	Scallops, 23 tonnes whole weight

The total landings for the 2008 season were 1216 t (whole weight) of scallops (West and South Coast Scallop Figure 1). The predicted catch range for the 2008 season, based on a pre-season survey, indicated a high season total catch of scallops between 2300 and 3400 t whole weight. The total landings were below the predicted catch range. There were two main contributing factors for the lower catches, firstly the areas where high abundance of scallops were evident in the survey provided small size scallop meat and therefore these areas were not fished to their potential catch expectations. The other factor was ceasing fishing at a catch level to provide carry over of stock for spawning, which is a recent development in this fishery.

The total recorded landings in the SWTMF for the season were 8 t of western king prawns and 7 t whole weight of scallops. The catch of king prawns was low, representing only about 60% of the average catch over the last five years, with scallop catches also being 80% of the 10 year average but up on 2005 to 2007. The fishery also lands a mixture of by-product species of which the most abundant species recorded was 3 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.

The scallop catch In the SCTF was 23 tonnes (whole weight) and is due to low effort expended in the fishery and variable recruitment (West and South Coast Scallop Figure 2). By-product species landings were negligible.

Recreational catch: Nil

Fishing effort/access level

For the 2008 season, 15 of the 16 licensed boats operated in the AIMWTMF fishery resulting in 172 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 48.4 square nautical miles.

A total of 2348 trawl hours (nominal effort) were recorded for the 2008 season (West and South Coast Scallop Figure 1). This season's effort for the catch taken indicates an efficient fleet because they are ceasing at a catch level rather than continuing fishing at low levels to a closure date. Comparing the 2008 season's effort to years of similar total landings (1993, 1995, 1996 and 2001) the effort is markedly reduced. Since 1997, fishing effort is more in line with the available stock. The aim to cease fishing at a threshold level has been to reduce ineffective fishing effort. Also 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 overall effort in the fishery.

A total of 128 days were fished in the SWTMF which is the lowest effort recorded in the fishery since 2002. This low level of effort reflects the availability of boats to fish in this fishery and inclement weather conditions restricting fishing time for the 2008 season.

The annual effort expended in the SCTF is mostly affected by scallop recruitment levels. Exploratory fishing is undertaken 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 2008 season only one boat fished for scallops between June and September recording a total of 71 scallop fishing days. This boat also spent 20 days fish trawling in April.

Stock Assessment

Assessment complete:

AIMWTMF:	Yes
SWTMF and SCTF:	Not assessed

Assessment method:

AIMWTMF:	Direct survey, catch rate

Breeding stock levels:

AIMWTMF:	Adequate
SWTMF and SCTF:	Not assessed

Projected catch range next season (2009)

AIMWTMF:	Scallops 350 – 500 tonnes

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

Specified areas were closed to scallop fishing towards the end of the season because of the high numbers of small scallops observed. This initiative was 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.

This fishery is highly variable, being dependent on sporadic recruitment, which appears to be strongly influenced by environmental conditions, e.g. the Leeuwin Current. A pre-season survey is undertaken annually. The survey index provided a catch prediction of 425 tonnes whole weight providing a catch range 350 to 500 tonnes whole weight for the 2009 season.

The main performance measure for the AIMWTMF 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 2008 fishing season was set at six weeks, consistent with the low yield predicted from the survey in November 2007. Also, fishing ceased at the catch rate threshold level of 250 kg /24 hr. Hence the breeding stock indicator was met.

Non-Retained Species

Bycatch species impact: Low

The AIMWTF trawl fleet operates over a small portion of the licensed fishing area, focusing on scallop aggregations in several different areas or fish grounds and fishing activity is dependent on how widespread settlement is each season. Scallops settle on relatively bare sand habitats. In 2008, the total area of the fishery fished was approximately 5% (West and South Coast Scallop Figure 3). 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 2008 and the large mesh size (100 mm), little bycatch was taken during the fishing season.

In the SWTMF 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. 1993) of the environmental effects of this fishery has shown that the fishery has minimal impact on bycatch species' populations.

The large-mesh (100 mm) trawl gear used in the SCTF takes minimal bycatch. The areas trawled by the boats 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: 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 negligible. No records of turtle captures were made in 2008. Few other protected species occur in this area. For the SWTMF and SCTF protected species that are susceptible to capture by trawling do not occur regularly in the fishing areas.

Ecosystem Effects

Food chain effects: Low

The total biomass taken by these fisheries 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:

The fishers generally operate over a very small proportion of the licensed area and therefore the total area impacted by trawling is small. Trawling is not extensive and confined to trawl grounds where fishable scallop abundance is significant (West and South Coast Scallops Figure 3).

The areas associated with scallops are sandy habitats and trawling activity does not impact these significantly.

Social Effects

The estimated employment for the year 2008 was 110 skippers and crew in the AIMWTMF, nine in the SWTMF and three in the SCTF.

Economic Effects

Estimated annual value (to fishers) for year 2008:

AIMWTMF	$4.7million
SWTMF:	$0.2 million
SCTF:	$0.1 million

The estimated value of the catch for the AIMWTMF has been based on the average wholesale price per kilogram obtained in the Shark Bay fishery, that is $3.90/kg whole weight or $19.50/kg meat weight.

For the SWTMF and the SCTF the estimated value of the scallop catch is based on wholesale price per kilogram obtained from these fisheries, which is $4.40/kg whole weight or $22.00/kg meat weight. Meat weight is approximately 20% of the whole weight. For the SWTMF the prawn price is estimated at $18.00/kg.

Fishery Governance

Target catch range:

AIMWTMF: 95 – 1,830 tonnes whole weight

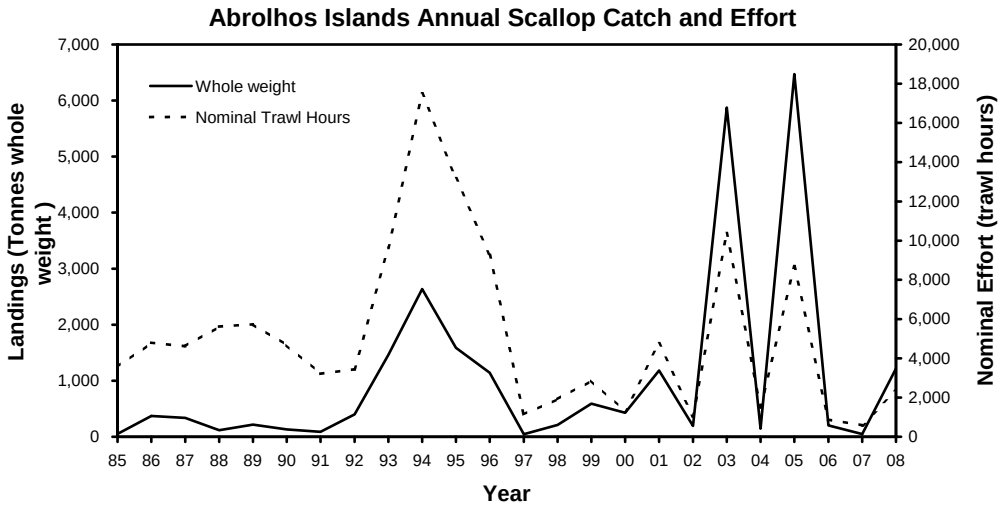
Current fishing level: Acceptable

Apart from the exceptional catches of the mid-1990s, 2003 and 2005 in the AIMWTMF, 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 2008 was predicted to be above this range, due to a survey showing good pre-season recruitment.

New management initiatives (2009) Nil

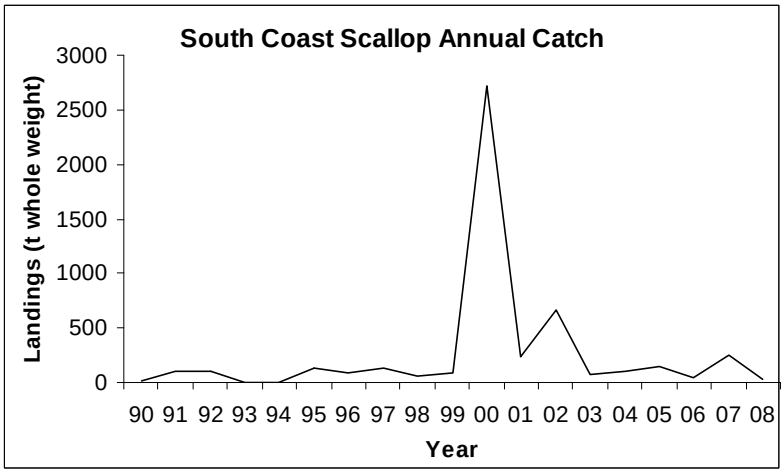
External Factors

High variability in the level of recruitment highlights the dependence of recruitment success upon environmental conditions, such as the Leeuwin Current, rather than spawning stock levels. The relationship between environmental factors and recruitment success is being evaluated for all these regions. This high variability in recruitment results in the level of fishing activity and quantity of catch within these fisheries to be variable and in addition, in recent times, the cost of fishing has affected fishing levels.



WEST AND SOUTH COAST SCALLOP FIGURE 1

Annual Scallop Landings And Nominal Effort For The Abrolhos Islands And Mid West Trawl Managed Fishery, 1985 – 2008.



WEST AND SOUTH COAST SCALLOP FIGURE 2

South coast scallop annual catch from 1990 – 2008

WEST AND SOUTH COAST SCALLOP FIGURE 3

Boundaries of the Abrolhos Islands and Mid West Trawl Managed Fishery and trawl area in 2008.

West Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from J. Pezzaniti, N. Moore

Main Features

Status

Stock level	Cockburn Sound – Recovering
	Peel-Harvey Estuary – Acceptable
Fishing Level	Cockburn Sound - Fishery closed
	Peel-Harvey – Under review

Current Landings

Commercial catch	126 t
	Cockburn Sound – Fishery closed
	Peel-Harvey Estuary – 90 t
	Catch by other commercial fisheries – 36 t
Recreational catch	Approximately 75% of total catch
	Peel-Harvey Estuary (Nov 07 to Oct 08) – TBA

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).

The commercial blue swimmer crab fisheries in the West Coast bioregion are the Cockburn Sound Crab Managed Fishery, the Warnbro Sound Crab Managed Fishery, Area I (the Swan and Canning Rivers) and Area II (the Peel-Harvey Estuary) of the West Coast Estuarine Managed Fishery, Area I (Comet Bay) and Area II (Mandurah to Bunbury) of the Mandurah to Bunbury Experimental Crab Fishery. Blue swimmer crabs are also retained by trawlers operating in Comet Bay (Area D of the South West Trawl Managed Fishery).

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.

Recreational crabbing in the West Coast bioregion is centred largely on the estuaries and coastal embayments from Geographe Bay north to the Swan River and Cockburn Sound. 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

South West Trawl Management Plan 1989

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 Developing Crab Fishery covers the waters south of the Shoalwater Islands Marine Park (32°22′40″ S) to Point McKenna near Bunbury (33□18′ S), and offshore to 115°30′ E. The fishery is further divided into

two zones. A single northern zone (Area 1) 80-pot exemption (valid as at 30 June 2008) authorises crab fishing in a specified area of Comet Bay between 32°22´40″ S and 32o30' S. Historically, four 60-pot exemptions were permitted to be operated In the southern zone (Area 2) (in the waters between Cape Bouvard and the southern boundary of the fishery). However, as at 30 June 2008, only two 60-pot exemptions were valid. The area separating the 2 zones (waters between 32o30' S and Cape Bouvard) is closed to commercial crab fishing.

The Geographe Bay fishery was officially closed on 21 January 2005 to reduce conflict between the recreational and commercial fishing sectors and 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 (86-98 mm carapace width).

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. However, from 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 2007/08 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. A further licence was removed from the fishery in early 2008, and the final licence is expected to be resumed in 2009.

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.

Annual trawl programs conducted in Cockburn Sound provide information on the status of the spawning stock and subsequent strength of recruitment, along with data on the general crab population.

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, a stock-recruitment-environment model has been developed which correlates 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 Cockburn Sound crab stock. From this data the recruitment index that drives a catch prediction model for the Cockburn Sound commercial blue swimmer crab fishery has been revised to more accurately estimate recruitment strength and the residual stock from the previous year and which determines the potential catch during the stock recovery;

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 survey in the Peel-Harvey Estuary between November 2007 and October 2008 to provide an estimate of total recreational catch and effort. Data collection during this study has been completed and the data is currently being analysed.

Retained Species

Commercial landings (season 2007/08): 126 tonnes

The total commercial catch of blue swimmer crabs taken in Western Australian waters during 2007/08 (July to June) was 888 t (West Coast Blue Swimmer Crab Figure 1) – a 6% decrease on the 947 t taken in 2006/07. Total landings from the West Coast bioregion declined 10% over the same period from 140 t in 2006/07 to 126 t in 2007/08.

The commercial catch from the Peel/Harvey Estuary (Area 2 of the West Coast Estuarine Fishery) for 2007/08 was 90 t. This represents a 4% decrease on the 'fishery high' level of 95 t reported in 2006/07 (West Coast Blue Swimmer Crab Figure 3).

The Mandurah to Bunbury Inshore Experimental Crab Fishery reported an annual catch for 2007/08 of 20 t, close to a 30% decrease on the 28 t reported for the 2006/07 financial year (West Coast Blue Swimmer Crab Figure 4).

Recreational catch estimate (season 2007/08):

Recreational catch: approximately 75% 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 recreational catch and effort survey in the Peel Harvey Region was completed in October 2008. Preliminary analysis have been undertaken, final figures are currently being generated based on updated procedures. This survey covered fishing from boats, shore, canals, and houseboats.

Recent surveys produced relatively consistent 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 catch 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 in December 2006, south of a line between Woodman Point and the northern end of Garden Island. The closure remained in effect during the 2007/08 financial year. A recreational survey quantifying catch and effort in the West Coast bioregion has been conducted during 2007/08. While data collection covering this period had been completed, the survey has been extended to include the 2008/09 financial year. Consequently, analysis of the 2007/08 data will be delayed until the second half of 2009.

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.

The Geographe Bay fishery is now exclusively for recreational use – previous surveys have found their catch was between 7 – 11 t per year.

Fishing effort/access level

No commercial fishing was undertaken In the Cockburn Sound crab fishery during the 2007/08 financial year as the fishery remained closed over this period.

Commercial fishers in the Peel-Harvey Estuary reported 57,940 trap lifts during the 2007/08 season – a 12% decrease on the 66,114 trap lifts reported the previous year which is probably due to the closure in September and October (West Coast Blue Swimmer Crab Figure 3).

Commercial effort in the Mandurah to Bunbury Inshore Experimental Crab Fishery also fell in 2007/08, with a total of 17,306 trap lifts reported compared to 24,006 trap lifts the previous year (West Coast Blue Swimmer Crab Figure 4). The annual fishing effort in both of these fisheries has been found to follow variations in the abundance of the resident crab stock.

Stock Assessment

Assessment complete: Yes

Assessment method: Cockburn Sound - Direct survey

Other West Coast fisheries – Catch rate

Breeding stock levels: Cockburn Sound – Recovering

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. Direct surveys of recruitment and breeding stock have been conducted in Cockburn Sound for about 10 years and are now being assessed for Peel-Harvey.

Cockburn Sound: No commercial fishing for blue swimmer crabs took place in Cockburn Sound during 2007/08 as the fishery remained closed. 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 were 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 as part of the investigation into the causes of the decline in crab stocks in Cockburn Sound. 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 (86-98mmcarapace width), allowing crabs to spawn at least once before entering the fishery. 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 demonstrated that catches in these months were predominantly female, which decreased egg production levels by removing these individuals before their second year of spawning.

It appears that the 4 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 level of egg production.

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 and the residuals from the previous year 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. Despite no fishing pressure, the recovery of the breeding stock and subsequent recruitment has been slow and the closure has been continued to December 2008. The abundance of recruits and residuals in recent years indicate that the predicted catch for recent seasons would have been 37 t, 64 t and 11 t for the 2006/07, 2007/08 and 2008/09 seasons, respectively, if the fishery had been opened as normal. These reflect a slow improvement in the stocks but are well below the historic catch range experienced.

The experience gained from this stock collapse will add considerable value to the understanding of blue swimmer crab stock management, helping to guide future direction In the sustainable management of both the Cockburn Sound crab fishery and crab fisheries elsewhere in the State.

Peel Harvey: The mean catch rate for 2007/08 in the Peel-Harvey estuary was 1.56 kg/trap lift – a steady increase on the 1.43 kg/trap lift recorded the previous year (West Coast Blue Swimmer Crab Figure 3). The 2007/08 catch rate was the highest on record since the conversion to hourglass traps, and represents the first real increase in mean annual catch rate this decade (West Coast Blue Swimmer Crab Figure 3). This may be due to the 2-month closure during the low catch period.

Data collected during catch monitoring surveys in the Peel-Harvey estuary has revealed that a large number of undersize crabs appear in commercial traps at the start of the season in November and into December. As the residual crabs moult over the warmer summer months, the proportion of undersize crabs in the catch diminishes and the catch becomes predominantly male through to March. Significant quantities of female crabs first appear in commercial traps towards the end of March, with the catch mainly female by the end of April. Females then dominate the catch until the winter rains flush most of the residual crab stock out of the estuary.

A recreational survey conducted in the Peel-Harvey estuary during 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. Data collection for this comprehensive recreational survey was completed in October 2008. A preliminary analysis has revealed an increase in boat-based catch by recreational fishers, but significant drops in both shore-based scoop net and drop-net catches, since a survey a decade ago.

Mandurah-Bunbury: Mean annual 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 the region crab stocks as the commercial operators' knowledge of the spatial and temporal distribution of resident stocks and localized environmental influences increased over time. The mean catch rate for 2007/08 in the Mandurah to Bunbury fishery was 1.10 kg/trap lift – a marginal increase on the 2006/07 catch rate of 1.05 kg/trap lift (West Coast Blue Swimmer Crab Figure 4).

Monthly monitoring surveys conducted aboard commercial vessels In the Mandurah to Bunbury fishery have indicated a high percentage of female crabs in the catch from this fishery, especially during the peak period of commercial fishing from March to August.

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 2007/08, approximately 23 people were employed as skippers and crew on vessels targeting blue swimmer crabs in the West Coast bioregion. Employment numbers have 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. Recreational fishing in this region has also been affected by the closure of the Cockburn Sound crab fishery.

Economic Effects

Estimated annual value
(to fishers) for year 2007/08: $0.94 million

The economic value of commercial blue swimmer crab fishing to the State of Western Australia for the 2007/08 season was estimated to be $4.4 million – compared with $4.3 million generated in 2006/07.

With no catch from the Cockburn Sound crab fishery, the blue swimmer crab catch in the West Coast bioregion for 2007/08 was valued at around $0.94 million. Fishers were able to negotiate an increase in the beach price (averaging around AUS$7/kg live weight) for blue swimmer crabs sold at local markets as the Cockburn Sound closure led to a tightening of local supply. While most of the catch from the West Coast bioregion was sold through local markets, the increase in beach prices was also supported by the continued cultivation of interstate 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 (2008/09)

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 were halved to 10 crabs per person and 20 crabs per boat.

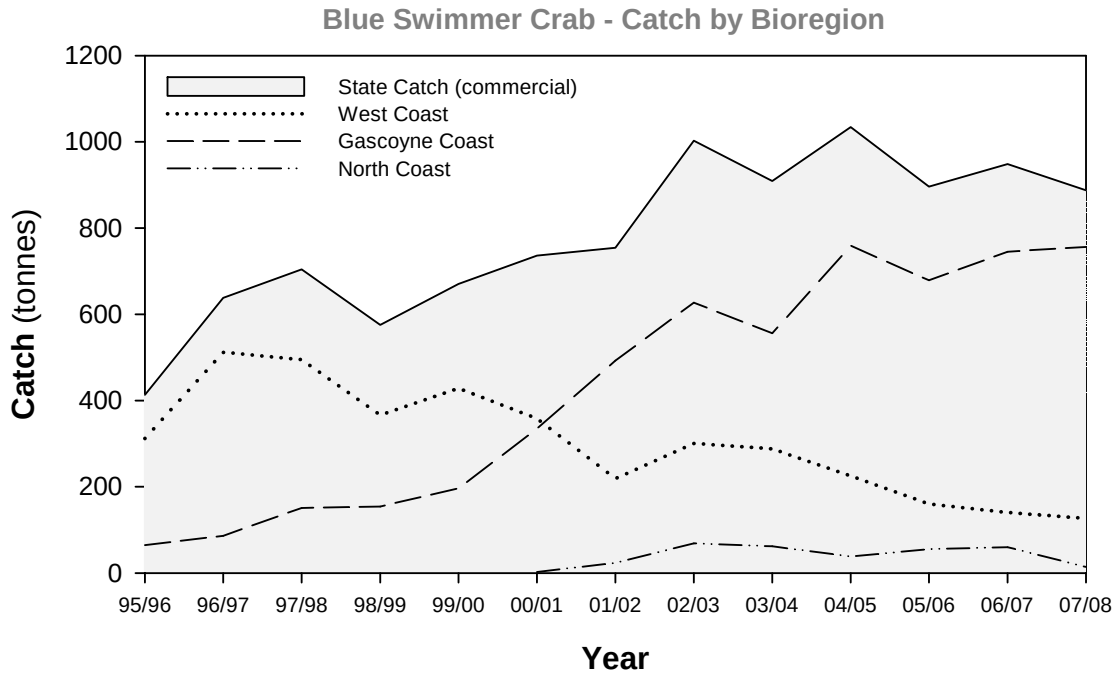
These arrangements will be reviewed following the completion of the research programs being carried out in both Cockburn Sound and the Peel-Harvey Estuary.

As a result of the bi-partisan commitment to close the Swan River to commercial fishing, the Department will be implementing a Compulsory Fisheries Adjustment Scheme to complete this initiative.

The Mandurah to Bunbury Developing Crab Fishery underwent its final review by the Developing Fisheries Assessment Committee (DFAC) in mid-2007 as part of the 'Developing New Fisheries' process. The Department of Fisheries is considering the recommendations of the DFAC and intends to make clear recommendations in 2010 regarding the future viability of a fishery in this region.

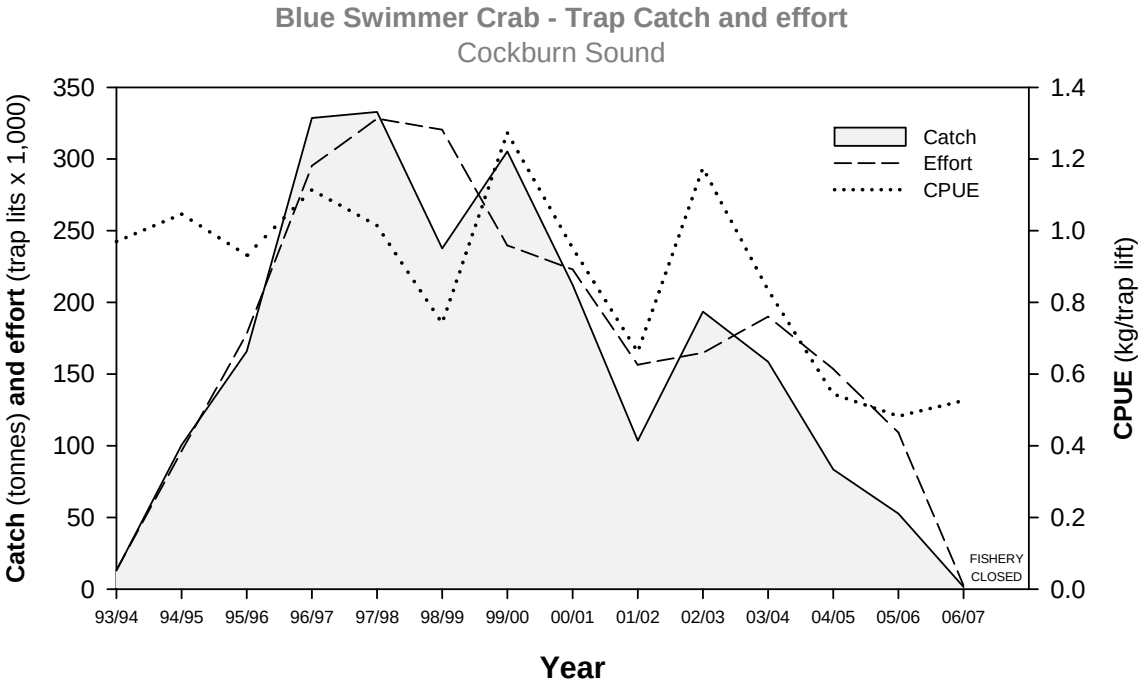
External Factors

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 (e.g. water temperature) both 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.



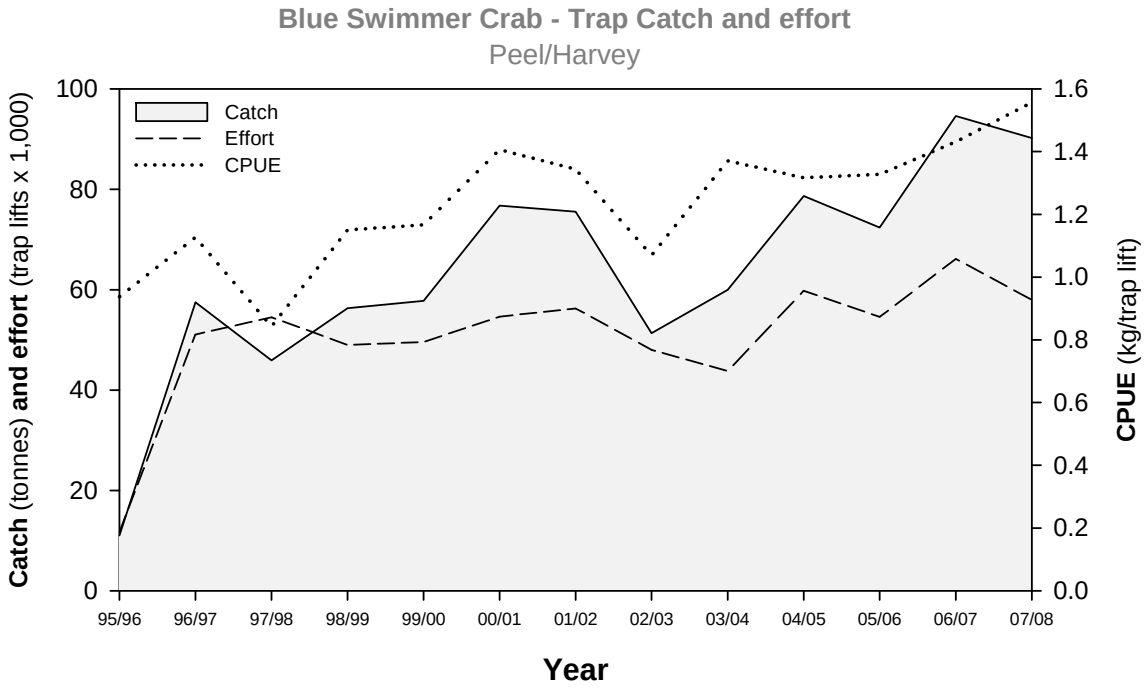
WEST COAST BLUE SWIMMER CRAB FIGURE 1

State and bioregion commercial catch history for the blue swimmer crab (*Portunus pelagicus*) in Western Australia since 1995/96.



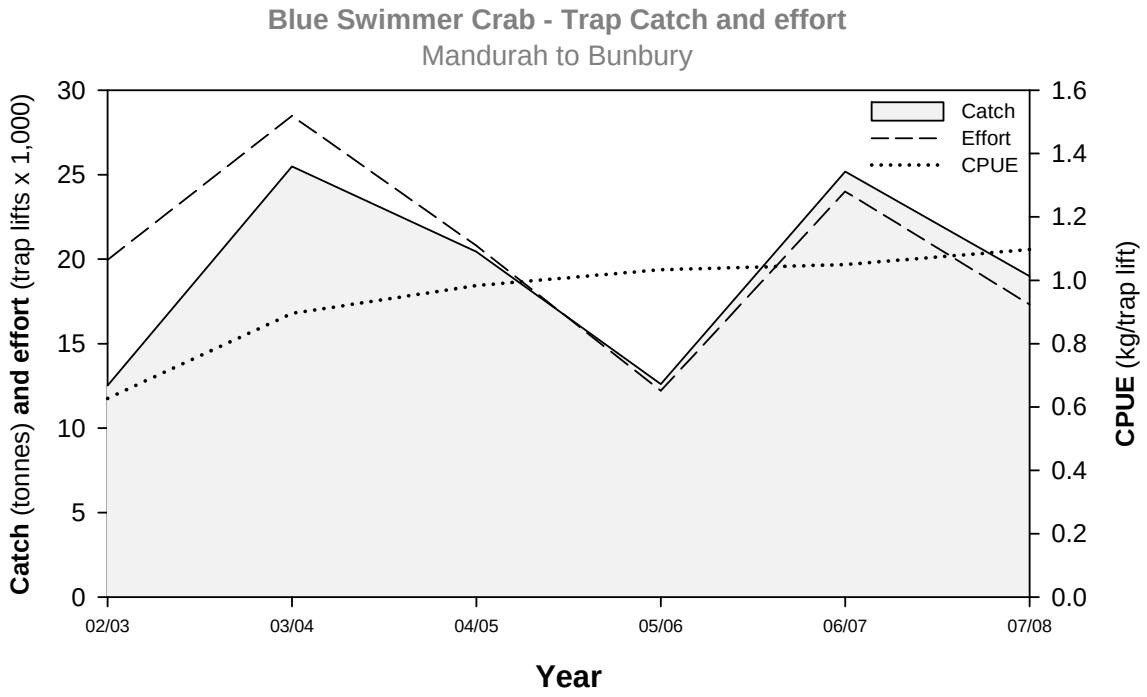
WEST COAST BLUE SWIMMER CRAB FIGURE 2

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 2007/08 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 2007/08 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 2007/08.

West Coast Deep Sea Crab Fishery Status Report

R. Melville-Smith, A. Thomson and P. Unsworth
Management input from D Pupazzoni

Main Features

Status

Stock level - Acceptable

Fishing Level - Acceptable

Current Landings

Crystal Crabs - 139 t

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

Fish Resources Management Act 1994

Fish resources Management Regulations 1995

West Coast Deep Sea Crustacean Fishery (Interim) Management Plan 2007

Australian Government *Environmental Protection and Biodiversity Conservation Act 1999* (Wildlife Trade Operation).

Consultation processes

Meetings between the Department of Fisheries and industry.

Boundaries

The boundaries of this fishery are all the waters lying north of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150m isobath out to the extent of the Australian Fishing Zone.

Management arrangements

The West Coast Deep Sea Crab (Interim) Managed Fishery is managed by a TAC, currently (2008) set at 140t. The fishery mostly operates in depths of 500-800 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.

The Department of Fisheries has regulations to protect breeding females through the use of appropriate minimum size limits. For the main target species, crystal crab, a minimum of 120 mm carapace width applies and for the lesser targeted species, champagne and giant crab, minimum sizes of 92 and 140 mm carapace length respectively applies. There are currently seven permits operating in the fishery. A new interim management plan came into effect on the 1 January 2008. This plan introduced a number of key management changes such as the removal of management zones in 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 currently involves annually assessing the 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.

Retained Species

Commercial landings (season 2008): 139 tonnes

A catch of 139 t of crystal crabs was taken in the fishery in 2008 – a decrease of 40% on the catch taken in the 2007 season (233 t) (Deep Sea Crab Figure 1). This was due to the imposition of a 140 t Total Allowable Catch in 2008. There were no catches of giant crabs or champagne crabs landed by the fishery during the 2008 season.

Recreational catch estimate (season 2008): Nil

Fishing effort/access level

Effort decreased by 27% from an estimated 123,000 pot lifts in the 2007 season to 90,000 pot lifts in the 2008 season. This is based on detailed catch and effort research logbook returns, which have been required to be completed by fishers in this fishery since its developmental status.

Stock Assessment

Assessment complete: Yes

Assessment method: Catch rate

Breeding stock levels: Adequate

The catch and effort data obtained from research logbooks in this fishery are now considered sufficiently reliable to use instead of compulsory Catch and Effort Statistics. The standardised catch per unit of fishing effort for crystal crabs decreased by 17%, from 1.48 kg/pot lift in 2007 to 1.23 kg/pot lift in 2008 (Figure 2).

The long term catch per unit effort dataset for the fishery (Figure 2) shows a decrease in the early years of the fishery, presumably in response to depletion of accumulated biomass. Catch rates have been relatively stable since 2003 but the 2008 catch rate is similar to the lowest on record. 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. The change to quota management in 2008 and removal of zones are likely to have affected the catch rate.

Crystal crabs are known to be 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. Estimates of age are not available for females, but the size at maturity information shows that they mature well below the legal size limit and probably moult once after reaching maturity. Their contribution to the fished biomass is small and therefore egg production in the fishery is well protected by the legal size limit provided that there are sufficient males.

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 'commercial landings' section). As the fishery has moved to catch quota, the performance measure needs to be revised to whether the fishery has achieved its quota and the effort required to take the quota.

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 50,600 km2. Assuming that all the ground is equally productive, this means that at catch levels experienced in the past season that less than 3 kg of crabs are being removed each year per square km.

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. There were three vessels operating in 2008.

Economic Effects

Estimated annual value (to fishers)

for year 2008: $1.8 Million

The beach value of the fishery was about $1.8 million in 2008, 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

Current Fishing (or Effort) Level: Acceptable

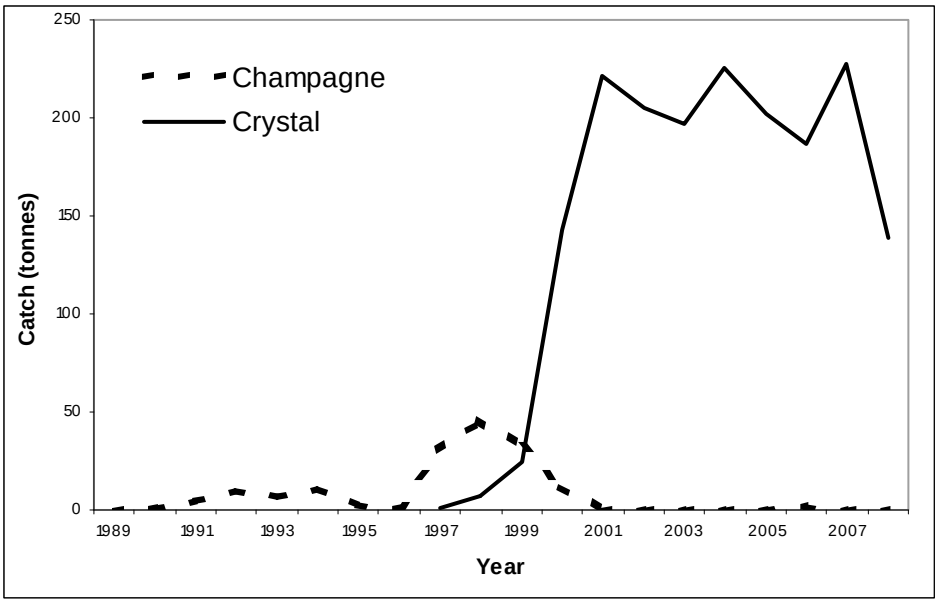
Because of the TAC, the catch in the crystal crab fishery is lower than it has been for several years. This is a relatively new commercial fishery that has only been fished on a full-time basis since 2000 and the target is a long-lived species. Sustainable levels of fishing are therefore still being determined.

Target commercial catch range: 100-140 tonnes

The TAC (140 t) for the fishery has been set well below landings of recent years and is at the lower end of the catch range developed for the WTO assessment. The effort range required to achieve the TAC still needs to be determined.

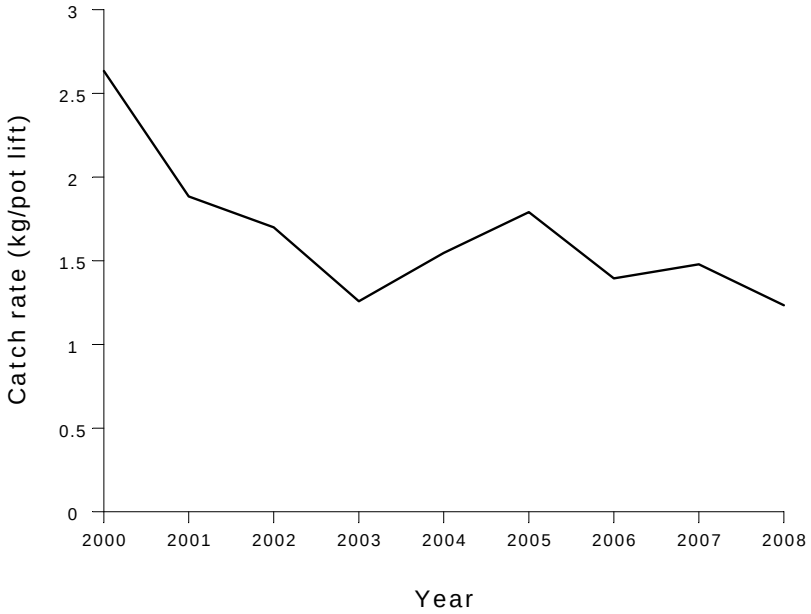
New management initiatives (2009)

The fishery has recently (2008) moved to output controls. No new Initiatives are being considered in 2009.



WEST COAST DEEP SEA CRAB FIGURE 1

Annual catches of crystal and champagne crabs since 1989. Catches of giant crab have always been small so they have been excluded.



WEST COAST DEEP SEA CRAB FIGURE 2

Catch per unit effort for crystal crabs (kg/pot lift).

West Coast Estuarine Finfish Fisheries Status Report

K. Smith and J. Brown

Management input from N. Harrison/J Pezzaniti

Main Features

Status

Stock level - Acceptable - except for cobbler

Fishing level - Acceptable

Current Landings

Commercial - 107 t (finfish only)

-174 t (Peel Harvey only - both finfish and crabs)

Recreational - 30-100% of total catch (2000/01) of key recreational species in different estuaries

Fishery Description

Commercial

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 (see page XX). The finfish component is described in this report.

The Hardy Inlet fishery, although not included in the WCEF interim management plan implemented during 2003, is also reported here as it shares the characteristics of the other west coast estuarine fisheries.

The fishing methods used to target finfish are gillnets and haul nets.

Recreational

Most finfish caught recreationally in west coast estuaries are taken by line fishing.

Governing legislation/fishing authority

Commercial

Swan/Canning and Peel/Harvey Estuaries

West Coast Estuarine Fishery (Interim) Management Plan 2003

West Coast Estuarine (Interim) Managed Fishery Permit

Fish Resources Management Act 1994 and subsidiary legislation

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

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council).

Recreational

Recreational Fishing Advisory Committees

Boundaries

Commercial

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

Leschenault estuary: Closed to Commercial fishing

Recreational

Recreational fishing in west coast estuaries has few areas where it is restricted.

Management arrangements

Commercial

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. Finfish fishing methods are restricted to gill nets and haul nets.

Recreational

Recreational fishers in west coast estuaries take various finfish and invertebrate species. Size and bag limits for the west coast bioregion applies to these species. As many of these species are also targeted by the commercial sector, resource-sharing issues are a major consideration in future management arrangements for this fishery, particularly in the Peel/Harvey estuary.

Research summary

Historically, monitoring of fisheries and fish stocks in west coast estuaries was based on monthly catch and effort statistics (CAES) provided by commercial fishers. However, commercial fishing effort in west coast estuaries has been declining since 1992. Therefore CAES is used for in combination with increasing amounts of data from recreational fisheries and fishery-independent surveys. The Research Angler Program (recreational fisher log books) and annual fishery-independent surveys of juvenile fish recruitment (including herring, whiting and mullet) 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 monthly commercial returns, recreational catch levels are estimated only occasionally when recreational fishing surveys are conducted. The most recent 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).

This report presents specific data for 3 finfish species that are important in west coast estuaries, namely black bream *(Acanthopagrus butcheri)*, *cobbler (Cnidoglanis macrocephalus)* 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 2008):

107.6 tonnes (finfish only)

In 2008, the total finfish catch (which excludes blue swimmer crabs) from west coast estuaries was 107.6 t, including the following catches of key target species:

Sea mullet	*Mugil cephalus*	51.8 t
Yellow-eye mullet	*Aldrichetta forsteri*	19.9 t
Yellow-finned whiting	*Sillago schomburgkii*	15.9 t
Australian herring	*Arripis georgianus*	5.7 t
Cobbler	*Cnidoglanis macrocephalus*	5.2 t
King George whiting	*Sillaginodes punctata*	4.9 t
Tailor	*Pomatomus saltatrix*	1.0 t
Black bream	*Acanthopagrus butcheri*	1.0 t
Perth herring	*Nematalosa vlaminghi*	0.7 t
Other species		1.5 t

Note: For *Sillago schomburgkii*, the previous common name of western sand whiting has been updated to yellow-finned whiting.

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. Since 2005, the catch and effort has gradually declined due to further reductions in the number of licensees. A single vessel operated in 2008.

In 2008, the commercial effort in the Swan/Canning Estuary was mainly directed towards the capture of blue swimmer crabs. As a consequence, finfish (mainly sea mullet, yellow-eye mullet and black bream) comprised a very minor component of landings.

Peel/Harvey: 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 finfish catches were stable and averaged 257 t. Annual finfish catches declined to 124 t in 2000, but were then relatively stable from 2000 to the present. In 2008, the total Peel/Harvey estuary catch was 94 t, an increase of 11 t from 2007.

In 2008, sea mullet, yellow-eye mullet, yellow-finned whiting and Australian herring comprised 87% of the finfish catch. Of interest, cobbler recorded its largest catch since 1999 and was 2.6 t more than the 10-year (1998-2007) average. Also, the 2008 yellow-finned whiting catch was 1.0 t higher than the 10-year (1998-2007) average. In comparison with the previous years catch, the two whiting species, yellow-finned whiting (up 7.0 t) and King George whiting (2.9 t) both increased significantly from 2007 to 2008.

Hardy Inlet: The total fishery catch in the Hardy Inlet in 2008 was similar to the catch in 2007 (actual figure not reportable owing to the small number of operators). The total fishery catch rate has been relatively stable since 1996. In 2008, the Hardy Inlet catch consisted of 5 different finfish species. Yellow-finned whiting and sea mullet comprised the majority of the finfish catch (54 and 25%, respectively), with King George whiting, black bream and cobbler comprising the rest. The catch of King George whiting in 2008 was the second highest on record and the highest since 1988.

Key finfish species

Black bream: Commercial landings of black bream were reported from the Hardy Inlet and Swan/Canning Estuary in 2008, although the amount caught in the latter was minimal. In the Swan/Canning Estuary, the catch in 2008 was lower than in 2007, and well below the 10-year (1998 to 2007) average for this species in this estuary. The 2008 black bream catch in the Hardy Inlet was higher than the previous year, and only

slightly below the 10-year (1998-2007) average.

Cobbler: In 2008, cobbler was primarily caught in the Peel/Harvey Estuary, with a smaller 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. After 1998, annual catches in the Swan/Canning Estuary did not exceeded 170 kg. The situation is similar in the Peel/Harvey Estuary, where cobbler catches also declined following a peak of 232.8 t in 1980. Between 2000 and 2007, annual catches did not exceed 5 t, with the 2007 catch of 498 kg being the lowest on record. In 2008, the catch increased to 5.0 t, the highest level since 1999.

King George whiting: In 2008, 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 did not exceed 5.0 t between 2000 and 2007, with the 2007 catch of 772 kg being the lowest on record. In 2008, the catch of King George whiting in the Peel Harvey estuary increased to 3.7 t. In Hardy Inlet, the 2008 catch of King George whiting was the highest in the past 20 years, suggesting a recruitment pulse in this region.

Recreational catch:

30% – 100% of total catch (approximately) in each estuary

An estimate of the total recreational catch level in west coast estuaries is not available for the current year (2008). The most recent estimate is available from the 2000/01National Recreational and Indigenous Fishing Survey. 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 for that same time period.

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.

As the Leschenault estuary is closed to commercial fishing 100% of the catch will be by recreational fishers.

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

Fishing effort/access level

Commercial

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

The levels of access listed above are as at July 2008. 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 previously 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 Estuary: 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 1 in 2008.

Peel/Harvey Estuary: 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 2,045 days fished per year between 2000 and 2008 (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 2008.

Recreational

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 Estuary (43% of fishing events), Swan/Canning Estuary (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 Estuary, 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 Estuary, 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 Inlet 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
Assessment method:	Catch rates
Breeding stock levels:	
black bream, King George whiting	Possibly Adequate
cobbler:	Possibly 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 likely due to natural recruitment and not related to stocking.

Increasing catch rates of black bream in the Swan/Canning 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 Estuary is unclear due to limited data, but is probably similar to that of the Swan/Canning Estuary 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, even with the increase in catch in the Peel/Harvey estuary in 2008, the 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. Low juvenile recruitment occurred in 2007 suggesting that there will be relatively low catches in west coast estuaries in the next 2-3 years.

Non-Retained Species

Bycatch species impact:	Low

These small-scale commercial 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 gill nets and haul nets over predominantly sand and mud bottoms is unlikely to have any impact on these habitats in estuaries.

Social Effects

Commercial

In 2008, there was an average of 13 fishers operating each month in the west coast estuarine fisheries, largely supplying fresh fish to meet demand for locally-caught product.

Recreational

The estuaries on the West Coast bioregion are key areas for recreational fishing effort and therefore have a great influence on the social amenity of the region.

Economic Effects

Estimated annual value (to fishers) for year 2008:

$1.19 million

Fishery Governance

Commercial

Current fishing level (2008): Acceptable

Target catch range:

75 – 220 tonnes (Peel/Harvey only)

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 abundances in west coast estuaries are thought to be primarily due to environmental factors rather than fishing. Current commercial fishing levels are considered acceptable.

Under the current management regime, the target range for total catch in the Peel/Harvey Estuary fishery is 75 – 220 t. The total 2008 catch of both finfish and crabs of 198 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. A suitable catch range for just finfish will need to be developed over the coming year

Acceptable catch ranges for the Swan/Canning Estuary 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.

Recreational

Current fishing level (2008): n/a

Target catch range: Not developed

New management initiatives (2008/09)

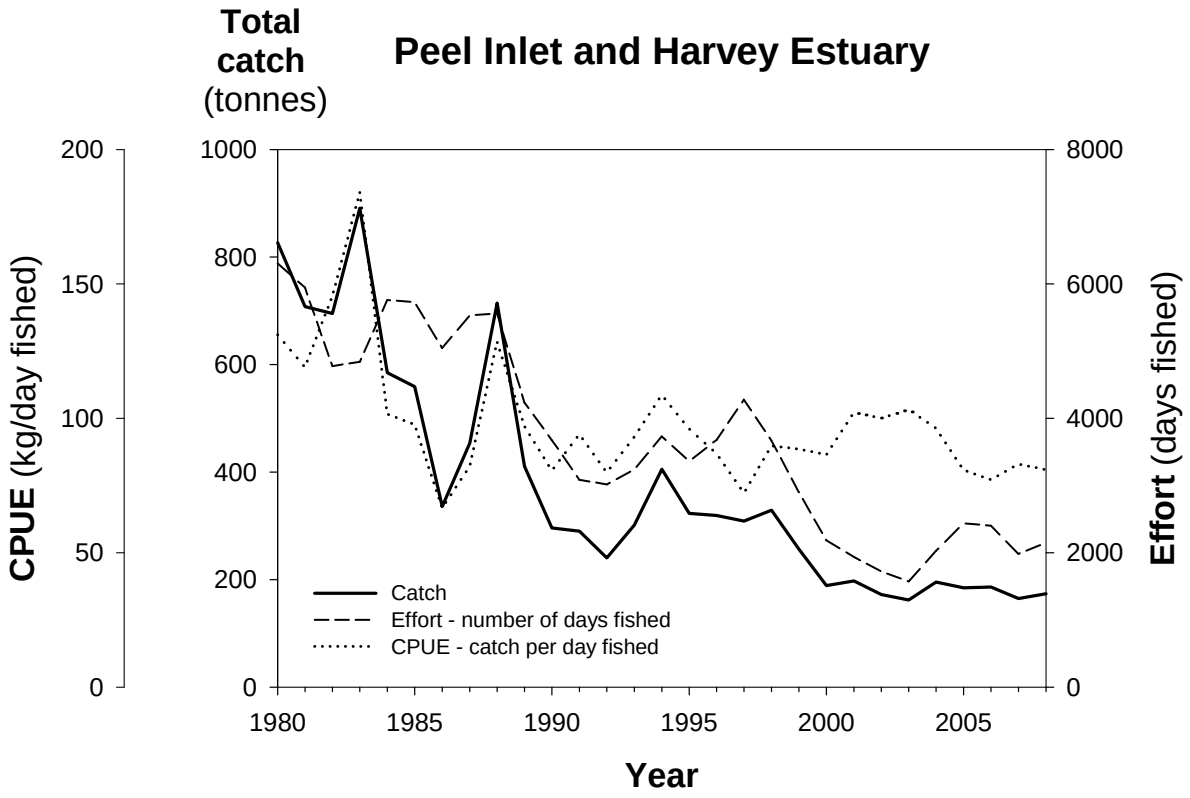
The West Coast Estuarine Fishery (Interim) Management Plan 2003 ceased to have effect on the 7 November 2008 and was conditionally extended for 2 years to allow for further consultation on the transfer of this fishery from an interim managed fishery to a managed fishery status. The Inclusion of the Hardy Inlet commercial fishery into either the West Coast or South Coast Estuarine Fishery Management Plan will also be decided during this process.

As a result of the both the Liberal and Labor parties' commitment to close the Swan River to commercial fishing, the Department will be implementing a Compulsory Fisheries Adjustment Scheme to complete this initiative.

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). Stocks declines in west coast estuaries are most pronounced among 'estuarine-dependent' species, i.e. those that rely on estuarine habitats for spawning, feeding and/or nursery areas (e.g. cobbler, Perth herring, black bream).



WEST COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the total fishery (fifnish and crabs) of the Peel/Harvey Estuary over the period 1980 – 2008.

Cockburn Sound Fisheries Status Report

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

Main Features

Status

Stock level - Not assessed

Fishing level - Acceptable

Current Landings

Commercial - 21 t (non bait finfish only)

Recreational - 80% of total catch (2000/01) of key recreational finfish species

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).

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.

Commercial

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)*).

Fishing methods employed in 2008 by the Cockburn Sound (Line and Pot) Fishery include handlines, squid jigs and unbaited octopus pots. The Cockburn Sound (Fish Net) Fishery uses gill nets and haul nets.

Recreational

Cockburn Sound is a very popular recreational fishing area and many of the species taken in Cockburn Sound – including Australian herring, garfish, squid, blue swimmer crabs (Portunus pelagicus) and pink snapper – are also targeted by commercial fishers. The majority of non-bait finfish landings in Cockburn Sound are taken by the recreational sector using line methods.

Governing legislation/fishing authority

Commercial

Cockburn Sound (Fish Net) Management Plan 1995

Cockburn Sound (Line and Pot) Management Plan 1995

Fish Resources Management Act 1994 and subsidiary legislation

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council).

Recreational

Recreational Fishing Advisory Committee

Boundaries

Commercial

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

Recreational

Recreational fishing can occur in most parts of Cockburn Sound except in restricted areas around the Naval base and industrial structures.

Management arrangements

Commercial

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. This extended closure period remained for the 2008/09 season.

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.

Recreational

Recreational fishers in Cockburn Sound take a number of different finfish and invertebrate species. The various size and bag limits for the west coast bioregion applies to these species. As many of these species are also targeted by the commercial sector, resource-sharing issues are a major consideration in future management arrangements for this fishery.

The same closed seasons on the take of pink snapper and blue swimmer crabs described above also applies to the recreational fishing sector.

Research summary

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.

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. As commercial fishing activity has declined CAES is now being used for stock assessments in combination with data from recreational fisheries and fishery-independent surveys.

The most recent estimates of 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. The Research Angler Program (RAP), including recreational fisher log books, and annual fishery-independent surveys of juvenile fish recruitment are among the additional

strategies employed by the Department of Fisheries to monitor the status of fishery stocks in Cockburn Sound.

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 is used as a relative index of octopus abundance 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 and King George whiting). The recruitment indices derived from survey data are used to forecast fishery landings of each species. During 2007/08, two additional survey sites were added to the northern end of Cockburn Sound.

Retained Species

Commercial landings
(season 2008): 21 tonnes of finfish (non-baitfish)
31 tonnes of cephalopods

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 2008, the finfish catch was 21.3 t, which was the lowest catch on record. This represents a decline of 14.0 t from 2007 and is more than 30 t below the 10-year average (1998-2007).

The 2008 finfish catch included at least 14 teleost species. The majority of the 2008 catch consisted of southern sea garfish and Australian herring, which were caught primarily by gill netting. The next most abundant components of the catch were yellowtail scad *(Trachurus novaezelandiae)*, sea mullet *(Mugil cephalus)* and pink snapper.

Prior to 2000, the commercial catch of cephalopods in Cockburn Sound was relatively low and mainly comprised of equal parts of squid and octopus, 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. Between 1994 and 2007, the catches of herring have been lower and relatively stable, fluctuating between 15 t and 30 t per year. However, in 2008, the herring catch dropped to its lowest level since 1980 (actual figures cannot be reported as there are fewer than five operators catching this species) and was well below the 10-year average for the period 1998 to 2007. 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 2008, the total annual commercial catch of sea garfish in the west coast region ranged from 11 to 44 t. 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 are 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 (Cockburn Sound Figure 4). The 2008 catch was at the lower end of this range, just below the 2007 level, and was the lowest recorded in the last 17 years.

Octopus: For the period 1995 to 2000, the annual commercial catch of octopus in Cockburn Sound averaged 3.3 t per year. From 2001, the octopus catch steadily climbed, reaching a peak of 45.2 t in 2006. Since then, the octopus catch has declined, reaching 30.1 t in 2008. (Cockburn Sound Figure 5). About 18% of the total west coast commercial catch of octopus in 2008 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 2008. The most recent estimates of catches and effort are from the National Recreational and Indigenous Fishing Survey conducted in 2000/01. In this survey, about 40 finfish species were estimated to have been retained by recreational fishers, with Australian herring, various species of whiting, garfish, tailor, trevally and yellowtail scad being the most numerically dominant species. The 2000/01 survey also indicated that the shore-based fishers caught 74% of all retained finfish.

Key species

The 2008 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. In 2000/01, recreational landings of herring were estimated to comprise 76% of total Cockburn Sound landings (i.e. 2000/01 recreational catch plus 2001 commercial catch).

Southern sea garfish: In 2000/01, an estimated 213,072 garfish (or approximately 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: 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 to 353 boat days in 2005. The decline in commercial effort after 1999 reflected a reduction in the number of active fishers operating in Cockburn Sound. Since 2004, the number of operators has remained the same and effort levels have been relatively stable, averaging 389 boat days for the past 5 years. In 2008, a record low of 339 boat days was reported.

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 by April 2003, these numbers were reduced to 13 and 1 respectively. Since 2003, the number of licenses in these 2 fisheries has been constant which is reflected in the total reported effort.

The commercial effort associated with the capture of octopus has increased over the past 5 years which is associated with an increase in the use of pipes as the method of capture and is now the basis of the developing octopus fishery.

From 2000 to 2004, the total number of fishing boat days spent using these methods in Cockburn Sound was stabilised at approximately 275 days per year. Effort then increased to 498 days in 2005 and 451 days in 2006. In 2007 and 2008, the effort declined to 274 days and 200 days respectively, as some licensees chose to operate in the ocean blocks outside of Cockburn Sound. Fishing effort is likely to be more efficient, with better fisher knowledge and improved trap design in particular.

Recreational: 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:	No
Assessment Method:	Catch rates (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 indicate 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 (Jones et al. 2000). In South Australia, population structuring of sea garfish is complex, with distinct non-mixing populations separated by distances as small as 60 km (Steer et al. 2009). Although such fine spatial scale information is not yet available for WA garfish, the evidence from South Australia suggests that garfish in Cockburn Sound may comprise a discrete stock and management unit.

The breeding stock level of sea garfish in Cockburn Sound 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 general downward trend in CPUE, suggesting a gradual decline in the stock level over this period. The CPUE trend was very similar to the total west coast catch trend, suggesting that annual variations in catch rate 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. In 2008, the CPUE increased to a level similar to the mean for the 2001 to 2007 period.

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(s).

Gloomy octopus: Gloomy octopus are found along the Western Australian coast from Exmouth Gulf to Albany. Juveniles and adults are benthic but the larvae are planktonic and have been found 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 outside the Perth area. The individuals found in Cockburn Sound are assumed to belong to a single west coast breeding stock.

Gloomy octopus migrate into deeper waters (>20m) at sexual maturity. Males attain maturity earlier than females. Octopus caught within the relatively shallow waters of Cockburn Sound are mostly immature and are predominantly females (Larson 2008).

Gloomy octopus have a short life cycle and attain a maximum age of 12 to 15 months (Larson 2008). 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.

The breeding stock level of octopus on the west coast is currently not assessed. Fishery catch rates in Cockburn Sound, using unbaited pipes as the method of capture, provide a relative annual index of octopus abundance. A mean annual catch rate is calculated from data supplied by commercial fishers in voluntary daily log books since 2003. The annual catch rate in Cockburn Sound has been gradually increasing since 2005, probably as a result of improved fisher knowledge and gear technology.

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

Expected to be insignificant.

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 2008, 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 snorkelling.

Economic Effects

Estimated annual value (to fishers) for year 2008: $111,000 (finfish)

$202,000 (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

Commercial

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 the majority 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.

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 2008 catch of 21.3 t was below the target range and can be attributed to a decline in fishing effort. Relatively low effort levels are expected to continue in this fishery and will necessitate a revision of the target catch range in the future.

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. The majority of octopus landings in the west coast region are 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. Nevertheless, the commercial catch has risen dramatically since 2000 and recent catch levels are historically high. Therefore, the octopus fishery in Cockburn Sound should continue to be closely monitored for potential impacts. 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.

Recreational

Current fishing level: n/a

Target catch range: Not developed

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

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 6 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 catch level is essentially unconstrained under current management arrangements.

New management initiatives (2008/09)

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.

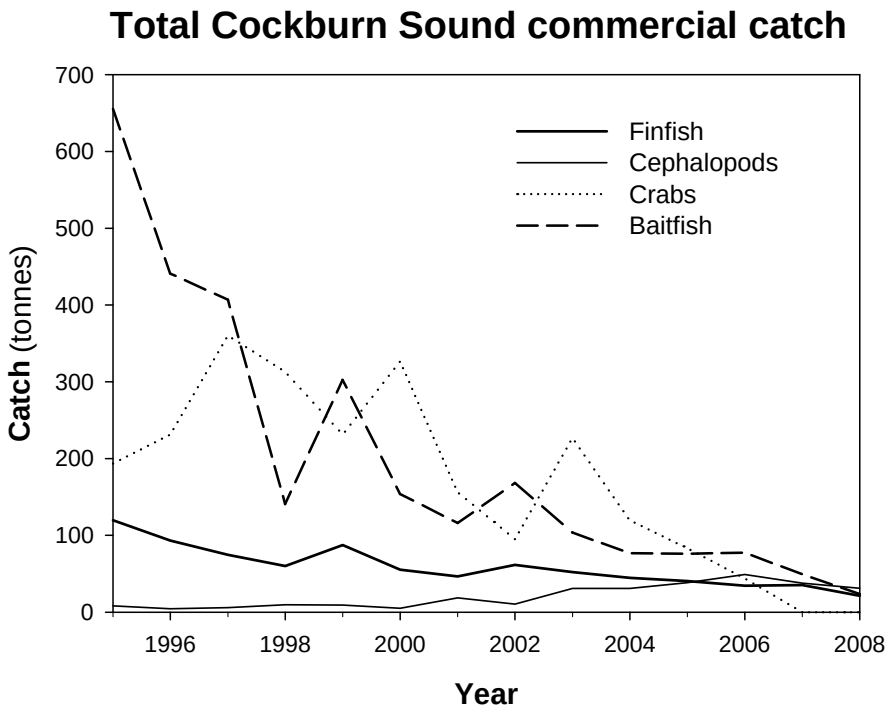
External Factors

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).

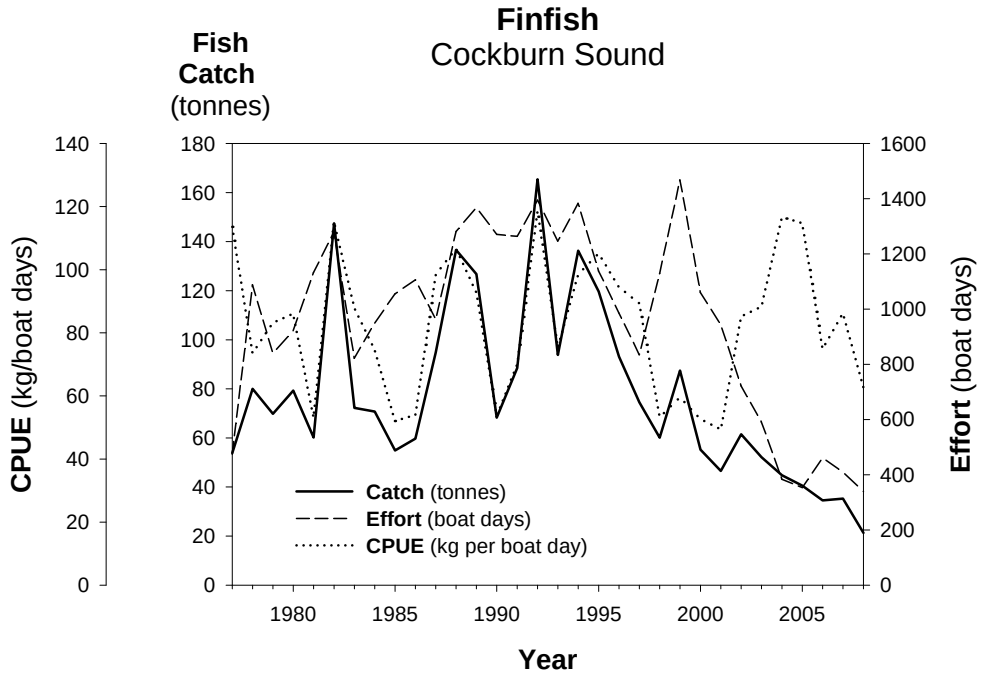
COCKBURN SOUND FIGURE 1.

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



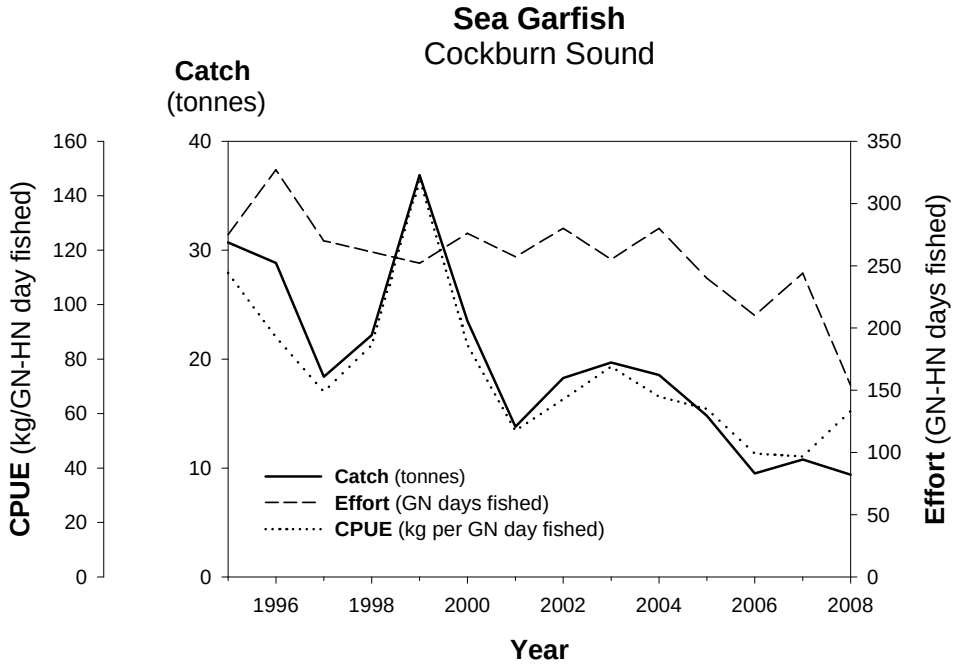
COCKBURN SOUND FIGURE 2

Total annual landings in Cockburn Sound by all commercial fisheries from 1995 to 2008. 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.



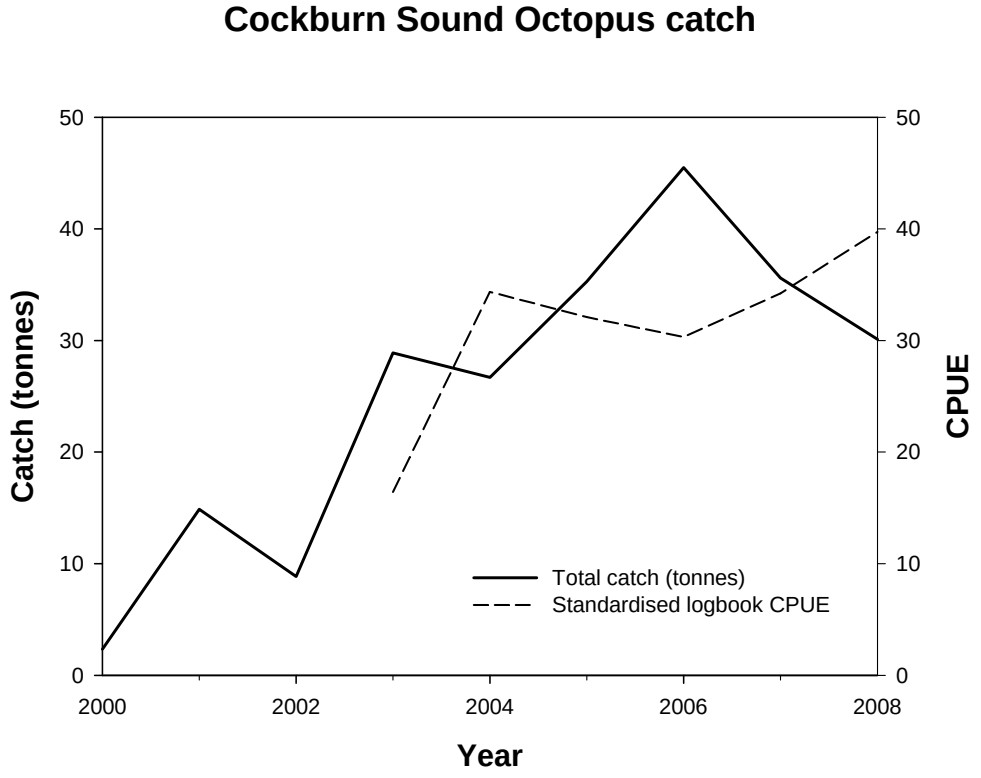
COCKBURN SOUND FIGURE 3

The annual catch, effort and catch per unit effort (CPUE) for finfish (excluding bait fish) for the Cockburn Sound fisheries over the period 1977 – 2008.



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 – 2008.



COCKBURN SOUND FIGURE 5

Annual Cockburn Sound commercial catch and standardised Cockburn Sound commercial log book CPUE for octopus over the period 2000 – 2008.

West Coast Beach Bait Managed Fishery Report: Statistics Only

B. Molony and E. Lai
Management input from N. Chambers

Fishery Description

The West Coast Beach Bait Managed Fishery is reported together with the South West Beach Seine (SWBS) Fishery. Both fisheries target whitebait *(Hyperlophus vittatus)* and also capture blue sprat *(Spratelloides robustus)* and mullet *(Mugil cephalus and Aldrichetta forsteri)*. Other fish species are captured in smaller amounts including Australian herring, tailor and minor incidental captures of squid and octopus.

Boundaries

West Coast Beach Bait Managed Fishery: From Moore River (north of Perth), to Tim's Thicket, (south of Mandurah).

South-West Beach Seine Fishery: From Tim's Thicket south to Point D'Entrecasteaux, with most effort reported 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). Consultation for future management arrangements for the South-West Beach Seine (SWBS) Fishery (Bunbury sector) has been completed and legislation to implement these arrangements will be finalised in 2009.

Landings and Effort

Commercial catches and effort declined again in 2008 (West Coast Beach Bait Managed Fishery Figure 1). Whitebait catches were 57 t, down from 101 t. A total of 38 t of other finfish species were also landed, dominated by blue sprat. Catches of other species were below the 57 t recorded in 2007.

Fishery Governance

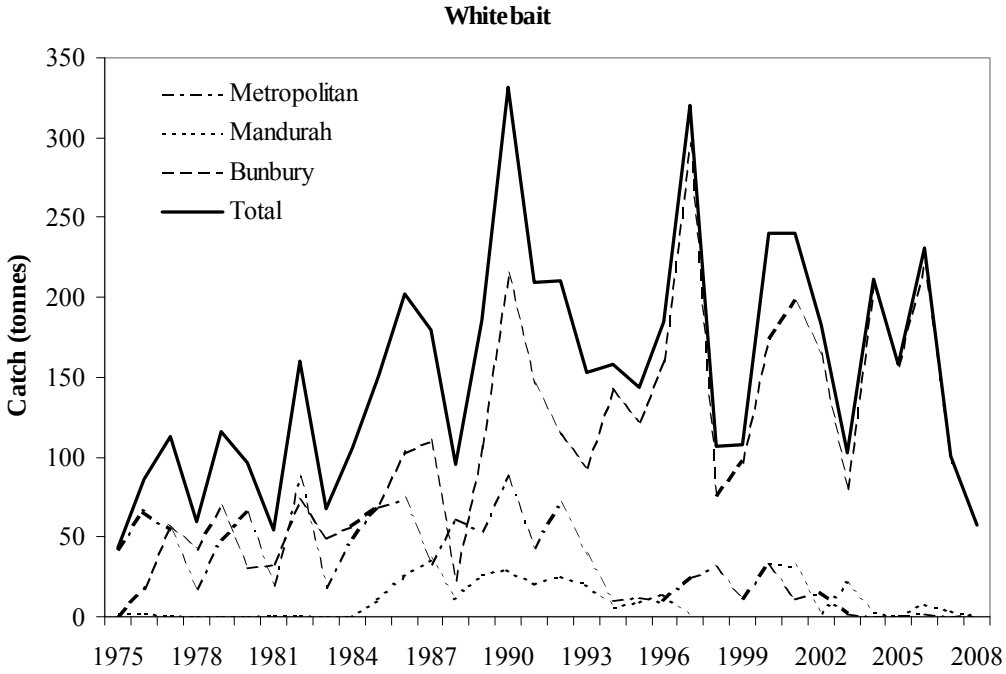
Target catch range: Whitebait: 60 – 275 tonnes

The 2008 catch was slightly below the target catch range. This is likely a result of the continued decline in the fishery and unfavourable enviromental conditons, influencing rercuitment of whitebait.

Current Fishing (or Effort) Level: Acceptable

New management initiatives (2009/10)

The release of Fisheries Management Paper No. 184 'Management of the Proposed South-West Beach Seine Fishery' and subsequent consultation led to the release in November 2007 of a Ministerial statement of decision outlining the future management arrangements for beach seine fishing in the South West. These arrangements will include a fishing closure between Port Geographe Marina and Black Point.



WEST COAST BEACH BAIT MANAGED FISHERY FIGURE 1

Annual catches of Whitebait along the West Coast, by fishing region

West Coast Purse Seine Fishery Report: Statistics only

B. Molony and E. Lai
Management input from D. Puppazoni

Fishery Description

The West Coast Purse Seine Fishery mainly captures pilchards *(Sardinops sagax)* and the tropical sardine *Sardinella lemuru* (hereafter referred to as sardinella) by purse seine in the West Coast Bioregion. Smaller catches of Perth herring *(Nematalosa vlaminghi)*, yellowtail scad *(Trachurus novaezelandiae)*, Australian anchovy *(Engraulis australis)* and maray *(Etrumeus teres)* are also reported.

Boundaries

There are three defined fisheries. The Perth metropolitan fishery operates between 33° S and 31° S latitude. The Southern Development Zone covers waters between 33° S and Cape Leeuwin. The Northern Development Zone covers waters between 31° S and 22° S.

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 2008/009 licensing period (1 April 2008 – 31 March 2009) 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.

Landings and Effort

Effort levels continued to decline in 2008. As a consequence, catches were 45 t, down from 139 t in 2007 and well below the 4,000 t catches recorded in the mid to late 1990s (West Coast Purse Seine Figure 1).

Fishery Governance

Target commercial catch range: 0 – 3,000 tonnes

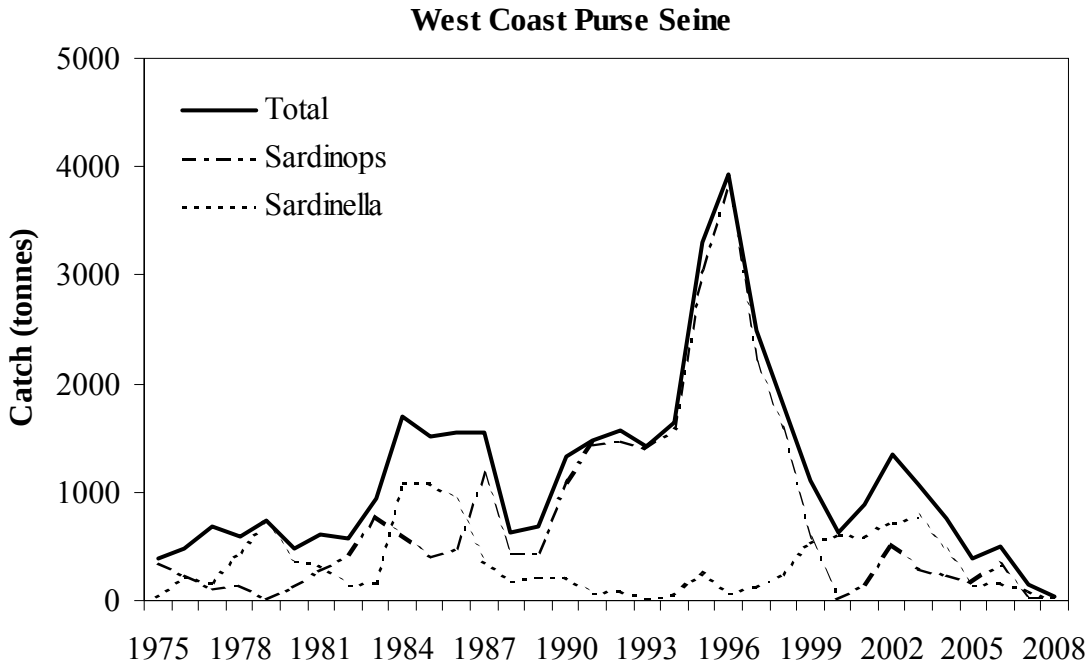
Current Fishing (or Effort) Level: Acceptable

Recently, total catch and effort have varied among years due to factors other than stock size (e.g. demand, economics). In addition, fishers have reported that the presence of schools is not as predictable as in previous years.

New management initiatives (2009/10)

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.



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, C. Johnson and E. Lai
Management input from N. Harrison, T. Nicholas and S. Blazeski

Main Features

Status

Stock level	- Unacceptable
Fishing Level	- Commercial: acceptable
	- Recreational: unacceptable

Current Landings (2007/08)

Commercial sector :

Total (2007/08)	500 t
WCDSIMF only (2008)	413 t

Indicator species (07/08)

Pink snapper	170 t
West Australian dhufish	86 t
Baldchin groper	13 t

Recreational sector (2005/06, last estimate)

Indicator species:

Pink snapper	40 t
West Australian dhufish	186 t
Baldchin groper	28 t

Charter sector (2007/08)

Indicator species:

Pink snapper	22 t
West Australian dhufish	15 t
Baldchin groper	8 t

Fishery Description

The West Coast Demersal Scalefish Fishery (WCDSF) includes a complex of mostly line based fishing operations by commercial, charter and recreational sectors. Approximately 100 species are caught in the fishery each year, with fishers in each sector primarily targeting West Australian dhufish (*Glaucosoma hebraicum*) and pink snapper (*Pagrus auratus*). Substantial catches are also taken of other species, such as red throat emperor (*Lethrinus miniatus*), Bight redfish (*Centroberyx gerrardi*) and baldchin groper (*Choerodon rubescens*).

Commercial

A limited number of commercial fishers operate in the West Coast Demersal Scalefish (Interim) Managed Fishery (WCDSIMF). Fishers use handlines and droplines to target demersal species. However, fishers in the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery and the West Coast Rock Lobster Managed Fishery also catch demersal species.

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 licensed to fish in that sector.

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, but mainly in shallow waters, i.e. < 20 m deep.

Governing legislation/fishing authority

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

Commercial

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, Restricted Fishing Tour Operators Licence and/or Aquatic Eco-Tourism Licence

Recreational

Recreational fishing regulations

Consultation process

Commercial

Meetings between the Department of Fisheries and permit holders in the West Coast Demersal Scalefish Interim Managed Fishery.

Fishing and Aquatic Tour Industry (Charter)

Recreational Fisheries Advisory Committee (RFAC)

Charter Boat Owners & Operators Association

Recfishwest

Recreational

RFAC and a network of 12 Regional Recreational Fishing Advisory Committees

Recfishwest

Boundaries

Commercial fishery

The commercial fishery encompasses the waters of the Indian Ocean just south of Shark Bay (at 26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm 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, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore zone extends from the 250 m depth contour to the boundary of the AFZ (West Coast Demersal Scalefish Figure 1).

The Metropolitan Inshore zone has been closed to commercial 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) since 15 November 2007.

Fishing and Aquatic Tour Industry (Charter) and Recreational fishery

The boundaries applicable to the charter and recreational sectors in the West Coast bioregion encompass the waters of the Indian Ocean just south of Shark Bay to just east of Augusta and extend seaward to the 200 nm boundary of the AFZ (West Coast Demersal Scalefish Figure 1). The exact latitudes and longitudes delineating the tour management zones of the charter fishery are listed in Schedule 15 of the *Fish Resources Management Act 1994*.

Management arrangements

Commercial

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 Scalefish Fishery (Fisheries Management Paper No. 224). The new management arrangements for the 'West Coast Demersal Scalefish Fishery' were 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*.

During 2008, fishing was controlled through input controls (in the form of permits), which restrict access to the different management areas of the fishery, gear and other restrictions (in the form of maximum numbers of lines and hooks and arrangements regulating the carriage of lines and fish), and Vessel Monitoring System (VMS) requirements.

The second stage of implementation occurred at the beginning of 2009, when transferable entitlement for each zone was allocated to permits in the form of units that provide entitlement in "hours" of fishing time. The use of VMS allows 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 activities where fish can be taken home at the end of the tour.
- Restricted Fishing Tour Operators Licence: The focus is on eco-tourism activities, such as snorkelling or scuba diving, with fishing only allowed for the purpose of a meal eaten during the course of the tour. No fish can be taken home at the end of the tour and any fishing for a meal must be done with a handline. Fishing rods are not permitted on this tour category.
- 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 (boat size larger than 7.5 m), a combination land/boat (boat size less than 7.5 m) based operation and a land-based operation. Except where extraordinary circumstances can be demonstrated by the applicant, new Fishing Tour Operators Licences are no longer granted. Applications for Restricted Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences are still considered. Currently, the consideration of any Tour Operator's Licence Application is carried out in accordance with Regulation 128J of the *Fish Resources Management Regulations 1995* and Ministerial Policy Guideline No. 12 '*Assessment of Applications for the Granting, Renewal or Transfer of Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences*' All fishing is subject to recreational fishing regulations (see below).

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 managed using input controls (e.g. size limits, seasonal spawning closures for particular species and spatial closures), and output controls (e.g. limits on the numbers of fish that can be taken by individuals and boats). In January 2009, changes to fishing regulations were introduced to reduce effort and catch in the recreational fishery, as has occurred in the commercial fishery. These included reductions to individual and boat catch limits, increases to minimum size limits of pink snapper and reductions in possession limits at the Abrolhos Islands.

Research summary

Research in the WCDSF is focused on monitoring the status of indicator species for the fishery. The indicator species, West Australian dhufish, pink snapper and baldchin groper, were chosen, not only because of their importance in the fishery, but also because of their inherent vulnerability to fishing, e.g. they are long-lived, have low natural mortality and are relatively slow growing. Their status is used to indicate the status of the entire demersal suite of species.

Each year, fish frames of the indicator species are collected from the different zones of the west coast bioregion. Otoliths are removed from each fish and their ages determined. Estimates of fishing mortality are determined from the age structures for each zone, which enable the status of the stocks to be determined.

Reports have recently been published that investigated (1) variations in the biology of indicator species on the west coast (Fisheries Research Reports 163, 174), (2) post-release survival of indicator species (FRR 191) and (3) spawning aggregations (FRR 187).

Creel surveys of boat-based recreational fishing continued in 2008/09.

Catch and effort data both for the commercial and charter sectors were monitored from fishers' daily/trip logbooks, which provide fine-scale data from 10nm×10nm blocks. Onboard validation of logbook entries will be conducted in the near future.

Estimates of the number of individuals of demersal species taken as bycatch in rock lobster pots were determined from at-sea monitoring in 2007/08. Substantial numbers of demersal species, such as breaksea cod, Port Jackson and wobbegong sharks were caught. Full details are reported in the Rock lobster fishery status report.

A project is underway to investigate the stock structure of West Australian dhufish, pink snapper and baldchin groper in the West Coast bioregion, which was funded by the West Australian Marine Science Institution (Project 4.4.2) and is a collaboration between the Department of Fisheries, CSIRO and the Centre for Fish and Fisheries Research at Murdoch University. The project is using both genetic and otolith microchemistry techniques, but will also examine oceanographic influences on larval dispersal.

A project to investigate fidelity of pink snapper to Cockburn Sound spawning aggregations is due to commence, using acoustic telemetry techniques.

Surveys of the numbers of pink snapper eggs in Cockburn Sound were conducted to produce an estimate of spawning stock biomass using a daily egg production model.

Retained Species

Commercial production (season 2007/2008):

	500 tonnes
(season 2008 – WCDSIMF only)	413 tonnes
Pink snapper:	170 tonnes
West Australian dhufish:	87 tonnes
Baldchin groper:	13 tonnes

Cephalopods, mackerels, tunas, sharks and rays are not permitted to be retained by WCDSF fishers. Catches of those species by other managed fisheries are reported elsewhere in this report.

Landings

In 2007/08, 500 t of demersal scalefish were caught by commercial fishers in the WCDSF, which was more than 200 t less than in 2006/07. During the first six months of the 2007/08 financial year, the fishery was "open access", while the West Coast Demersal Scalefish Interim Managed Fishery commenced at the beginning of the second six months (January 2008). The lower catch was thus due to the reduction in the number of boats in the commercial sector that occurred leading up to and following commencement of the management plan for the fishery. The catch by this sector of the fishery for the entire 2008 season was 413 t which is less than their target catch for 2009.

The commercial catch in 2007/08 consisted of ca 80 demersal scalefish species and was dominated by pink snapper (170 t), red throat emperor (96 t) and West Australian dhufish (87 t). Together those species comprised 71 % of the total catch. Catches of only seven species were greater than 10 t, with Bight redfish and baldchin groper contributing 30 and 13 t, respectively.

As procedures for validating 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) are being developed, demersal scalefish catches from those fisheries for 2007/08 are currently unavailable. Note that data recovery has commenced and catch data should be available in 2010.

Dhufish

The total commercial catch of dhufish in the WCDSF in 2007/08 was 87 t, 52 t less than in 2006/07 and substantially less than the maximum of 234 t recorded in 2002/03. Approximately 10, 48 and 21 t of dhufish were caught by commercial fishers in the Kalbarri, Mid-West and South-West zones, respectively (West Coast Demersal Scalefish Figure 2). The remaining ca 8 t was taken in the Metropolitan zone prior to the closure to commercial fishing in that zone in November 2007.

Pink snapper

In 2007/08, the total commercial catch of pink snapper

reported (170 t) was 62 t less than in 2006/07 and approximately half of the largest recorded catch of 340 t in 2003/04 (West Coast Demersal Scalefish Figure 3). The majority of the catch was obtained from the Kalbarri (91 t) and Mid-West zones (65 t), while 9 t was taken in the South-West zone and 4.5 t was caught in the Metropolitan zone, prior to its closure to commercial fishing.

Baldchin groper

The commercial catch of baldchin groper in 2007/08 was 13 t, which was less than half of that in 2006/07 (29 t). The vast majority (97 %) of the catch of baldchin groper was taken from the Mid-West and Kalbarri zones (West Coast Demersal Scalefish Figure 4).

Last available recreational catch estimate (excluding charter, 2005/06)

Dhufish:	186 tonnes
Pink snapper:	40 tonnes
Baldchin groper:	28 tonnes

A creel survey of boat-based recreational fishers in the Metropolitan zone of the West Coast Bioregion was undertaken in 2007/08. Analyses of those data are not yet complete. The creel survey conducted in 2005/06 estimated that 186 t of dhufish and 28 t of baldchin groper were retained during that survey, which were similar to the catches of these species by the commercial sector in 2005/06. However, the 40 t of pink snapper retained in 2005/06 was much less than the catch of the commercial sector (278 t) in that year.

Charter catch (2007/08)

Pink snapper:	22 tonnes
Dhufish:	15 tonnes
Baldchin groper:	8 tonnes

At the time of this report, 90 % of charter fishery logbooks had been submitted for the 2007/08 year. Catches of the indicator species, pink snapper (22 t), dhufish (15 t) and baldchin groper (8 t), were slightly less than the 24, 18 and 11 t caught, respectively, in 2006/07. None of the catches of other demersal species, where weight could be determined, were > 4 t.

Fishing effort/access level

Commercial

Fishing effort by the "wetline" fishers in the 2007/08 year was estimated from the required monthly logbook returns for the first half of the year (before the *West Coast Demersal Scalefish (Interim) Management Plan 2007* commenced) and in the second half of the year from the daily/trip statutory returns.

In the West Coast bioregion during the first half of 2007/08, 112 licensed fishing boats line-fished for demersal finfish. In the second half of that year, following the commencement of the West Coast Demersal Scalefish Interim Managed Fishery on 1 January 2008, 41 boats fished. A total of 1,895 and 1,207 days were fished in the first and second halves of the financial year, respectively, which, in total is a marked decrease from the 8,486 days reported in 2006/07.

The number of effort days reported for 2007/08 for West Australian dhufish, pink snapper and baldchin groper was 2,497, 2,757 and 1,686 days, respectively, with at least 50 % of that effort for each species occurring in the Mid-West zone. Effort days for individual species represent the total number of days on which a particular species was caught by all fishers.

Fishing and Aquatic Tour Industry (Charter)

During 2007/08, a total of 22,003 fisher days were reported by charter fishers, based on 90 % of logbooks having been returned at the time of this report. The number of effort days in 2007/08 is 3,784 days less than in 2006/07.

Recreational

Total recreational fishing effort for the West Coast bioregion is not available for 2007/08.

Stock Assessment

Assessment complete:	Yes
Assessment method	Fishing mortality
Breeding stock levels	
Pink snapper:	Unacceptable
Dhufish:	Declining
Baldchin groper:	Declining

West Australian dhufish and pink snapper are both long-lived species, i.e. reaching over 40 years of age. Samples of those two species collected from the WCDSF in 2007/08 indicate that their age distributions are now severely truncated. In each of the different zones of the west coast bioregion, the age compositions of West Australian dhufish and pink snapper were dominated by fish less than 15 and 10 years of age, respectively. This indicates that the breeding stock of dhufish is declining in the West Coast Bioregion, while that of pink snapper is unacceptable.

An assessment of the status of the stocks in the WCDSF is conducted primarily from the determination of estimates of rates of fishing mortality (F), using a range of methods, for each of the indicator species (West Australian dhufish, pink snapper and baldchin groper). Estimates of F are determined separately where possible from samples collected from both the commercial and recreational sectors in each of the zones where those species are important in catches. Values of F are then compared to international benchmarks to determine the overall status of the stocks in the WCDSF. Those benchmarks are (1) The target level, where $F \leq 2/3$ the rate of natural mortality (M), which is what the level of fishing mortality should not exceed, (2) Threshold, where $F = M$, which indicates that fishing has exceeded sustainable levels and (3) Limit, where $F = 1.5M$, which indicates that fishing has greatly exceeded sustainable levels. If the rates of fishing mortality exceed the threshold or limit levels then management actions are required for the purposes of ensuring sustainability of the stocks.

The estimates of F in West Coast Demersal Scalefish Table 1 represent the highest calculated estimates of F for each species, derived from the different methods, and are thus the

most precautionary estimates of stock status. The estimates of F for the indicator species reflect the status of the entire demersal suite. Using a precautionary approach, the whole fishery is assumed to have the same status as that of the indicator species that is experiencing the highest levels of fishing mortality across the West Coast Bioregion, i.e. pink snapper (West Coast Demersal Scalefish Table 1). The status of pink snapper indicates that overfishing is occurring and management actions are required.

Independent external reviews of two stock assessments (based on data collected between 2002 and 2006 and during 2007/08) have been completed. The reviews supported the Department's conclusions that overfishing was occurring of the stocks of dhufish, pink snapper and baldchin groper in the West Coast Bioregion and management actions are required to ensure sustainability (O'Neill, 2009).

There is limited biological information for targeted deepwater demersal species (eightbar grouper *Hyporthodus octofasciatus*, bass groper *Polyprion americanus*, hapuku *Polyprion oxygeneios*, blue-eye trevalla *Hyperoglyphe antarctica* and ruby snapper *Etelis carbunculus*), which comprise most of the catches of the WCDSF from the offshore zone. These deepwater species are particularly vulnerable to overfishing, as the limited knowledge of their biology indicates that they are long-lived and would therefore have low rates of natural mortality and productivity. In addition, some aggregate to spawn and most suffer high rates of barotrauma due to the depths in which they are fished (> 250 m).

Non-Retained Species

Bycatch species impact — Low

Line fishing for demersal species using baited hooks is highly selective. However, demersal species are often susceptible to the effects of barotrauma and released fish may not survive. Released fish include inedible species, e.g. silver toadfish, and small species, such as wrasses, which also suffer from barotrauma.

Protected species interaction — Negligible

As line fishing is highly selective, interactions with protected species are minimal. Logbooks used by commercial and charter fishers, introduced in 2007, include specific sections for recording protected species interactions. One grey nurse shark (*Carcharias taurus*) was caught and released alive in 2007/08 by a fisher in the charter sector.

Ecosystem Effects

Food chain effects — Low

An FRDC study examined the last 30 years of catch by all commercial fisheries in this region and found no evidence of any shift.

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.

Social Effects

Commercial

Forty one permitted boats fished in the second half of 2007/08, following the introduction of the West Coast Demersal Scalefish Interim Managed Fishery. On average, boats fished for 28 days during that period and employed two crew.

Fishing and Aquatic Tour Industry (Charter)

In 2007/08, there were 138 charter operators who were licensed to operate in the West Coast bioregion via a Fishing Tour Operators Licence and 22 who held a Restricted Fishing Tour Operators Licence and/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 2007/08 — $3.4 million

The estimated value of the WCDSF in 2007/08 ($3.4 million), which includes all demersal scalefish species caught by handlines and droplines in the west coast bioregion, was less than in 2006/07 ($4.8 m), due to the decreases in effort and thus catch. West Australian dhufish, pink snapper and redthroat emperor contributed $1.2 m ($13.50/kg), $864,000 ($4.95/kg) and $529,000 ($5.50/kg), respectively to the total value of the fishery. As the commencement of the West Coast Demersal Scalefish (Interim) Managed Fishery involved a large reduction in the numbers of commercial boats that can access the fishery and entitlements can be transferred among the limited number of fishers that now have access, supply of fish may vary substantially in the first few years of the fishery. In conjunction with varying demand, changes in supply will influence prices per kg. Thus, some of the prices used above are likely to be conservative and may underestimate the value of the fishery.

Fishery Governance

Commercial

Current Fishing (or effort) level	Acceptable
Target catch (or effort) range:	
Commercial (2007/08)	558-798 tonnes
All commercial (2008/09)	< 550 tonnes
WCDSIMF only (2009)	< 460 tonnes

The initial target catch range of 558-798 t for the WCDSF remained the same in 2007/08 as the previous year. The range was based on the 80 % confidence limits around the mean catch from the decade 1990/91 to 1999/2000. The total commercial catch of 500 t in 2007/08 was below the lower boundary of the target catch range, reflecting the reduced effort in the fishery. The commercial catches of dhufish (87 t), pink snapper (170 t) and baldchin groper (13 t) fell below or within their respective target catch ranges of 125 – 179 t, 153 – 254 t and 27.5 – 35.5 t. Those catches are considered appropriate based on the ranges set for the 2007/08 financial

year.

The catch of 413 t reported for the first full year of the WCDSIMF, i.e. 2008, is below the target catch of 459 t proposed for the fishery for 2009, when restrictions on fishing effort come into effect. The decision on what will be the best season to use for reporting on the catches of the various fisheries in this complex will be determined over the coming year. When restrictions on effort commence in 2009, catches of demersal fish by both the WCDSIMF and the demersal gill net and demersal longline fishery should be restricted to < 550 t.

Recreational/charter

Current Fishing level

(at 2005/06,last available estimate) Unacceptable

Target catch (or effort) range (2008/09): < 200 tonnes

The proposed target catch range for the recreational and charter sectors for the 2008/09 year should be at most 50 % of the 2005/06 level, i.e. < 200 tonnes. Actual catch will be dependent on the effect of changes to the management of those sectors.

New management initiatives

In 2009, each boat in the WCDSIMF has been allocated a share of the total effort (fishing days), with a view to managing the fishery to a target catch (TCC). Following review of the catches each year, the number of effort days allocated to commercial fishers can be modified to ensure catch in each area does not exceed the TCC.

A series of new arrangements for recreational boat fishing in the West Coast and elsewhere have been announced by the Minister in 2009. Further details can be found on the fisheries website.

External Factors

Recruitment success of both West Australian dhufish and pink snapper is highly variable and presumably influenced by environmental factors. Thus, the stocks of those species and catches in the fishery mainly rely on a limited number of strong recruitment years.

Cockburn Sound is the only known significant spawning location for pink snapper in the West Coast Bioregion. Furthermore, juveniles occupy the area for approximately one and a half years following settlement, prior to leaving Cockburn Sound. Ongoing industrial development in the area may have detrimental effects on the habitats that are important for both spawning and juvenile survival and thus influence future recruitment success.

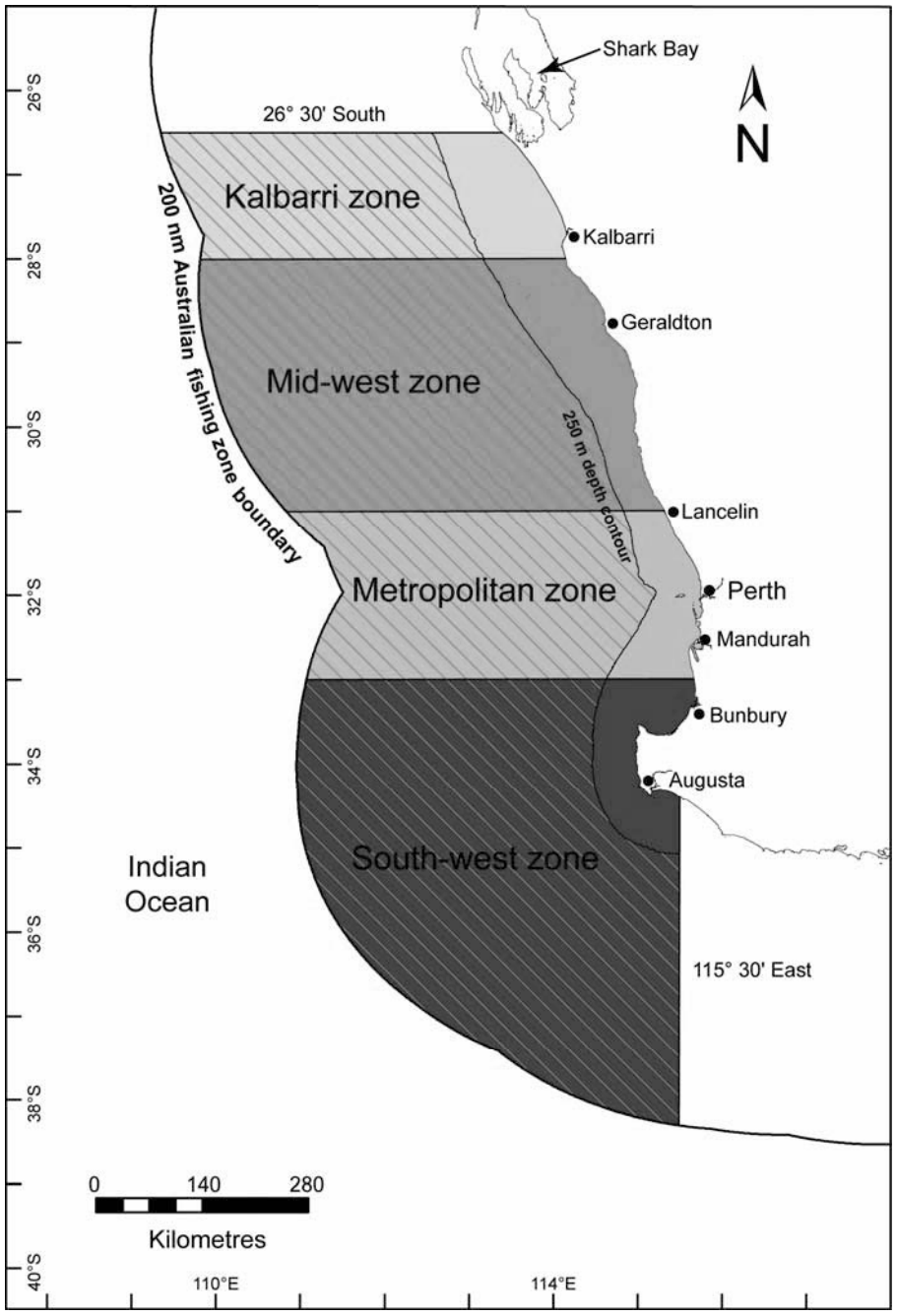
The Commonwealth Western Deepwater Trawl Fishery fishes in waters along the west coast of Australia in waters from the 200 m isobath to the boundary of the AFZ and between approximately Exmouth and Augusta. This fishery overlaps the WCDSF and has obtained substantial catches, in several years, of demersal species of interest, e.g. ruby snapper *Etelis carbunculus* and deepwater flathead *Platycephalus conatus*. The geographical overlap of catches by the two fisheries indicates that they are likely to be fishing the same stocks.

The Commonwealth's South-west Marine Bioregional Plan incorporates the aim of introducing marine reserves, which are likely to contain areas closed to fishing. This has the potential to restrict access to fishing in parts of the west coast bioregion to all sectors, i.e. commercial, recreational and charter.

WEST COAST DEMERSAL SCALEFISH TABLE 1.

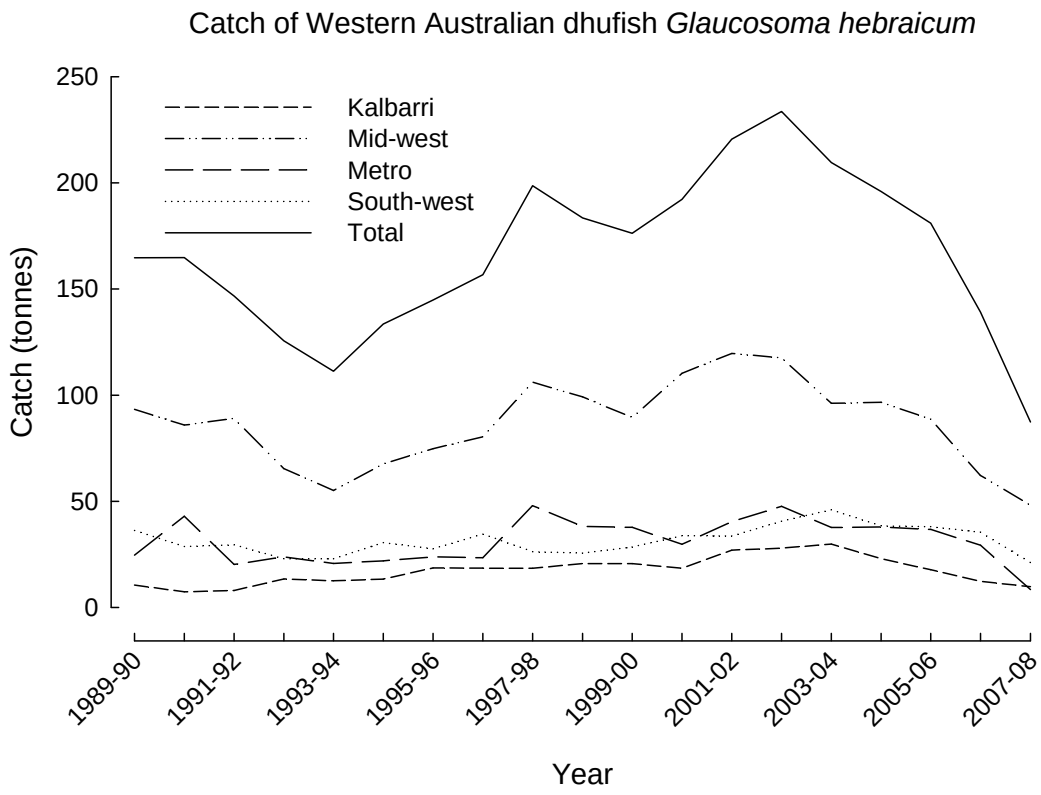
Estimates of fishing mortality (F) calculated for each of the three indicator species collected in the different zones of the West Coast Bioregion during 2007/08. F estimates presented are the highest values calculated using four different methods from samples collected from both the commercial and recreational sectors. ns = not sampled, as the species is not an indicator in that zone.

	Zone			
Indicator species	*Kalbarri*	*Mid-West*	*Metro*	*South-West*
West Australian dhufish	ns	$F > F_{limit}$	$F > F_{limit}$	$F_{threshold} < F < F_{limit}$
Pink snapper	$F > F_{limit}$	$F > F_{limit}$	$F > F_{limit}$	$F > F_{limit}$
Baldchin groper	ns	$F > F_{limit}$	ns	ns



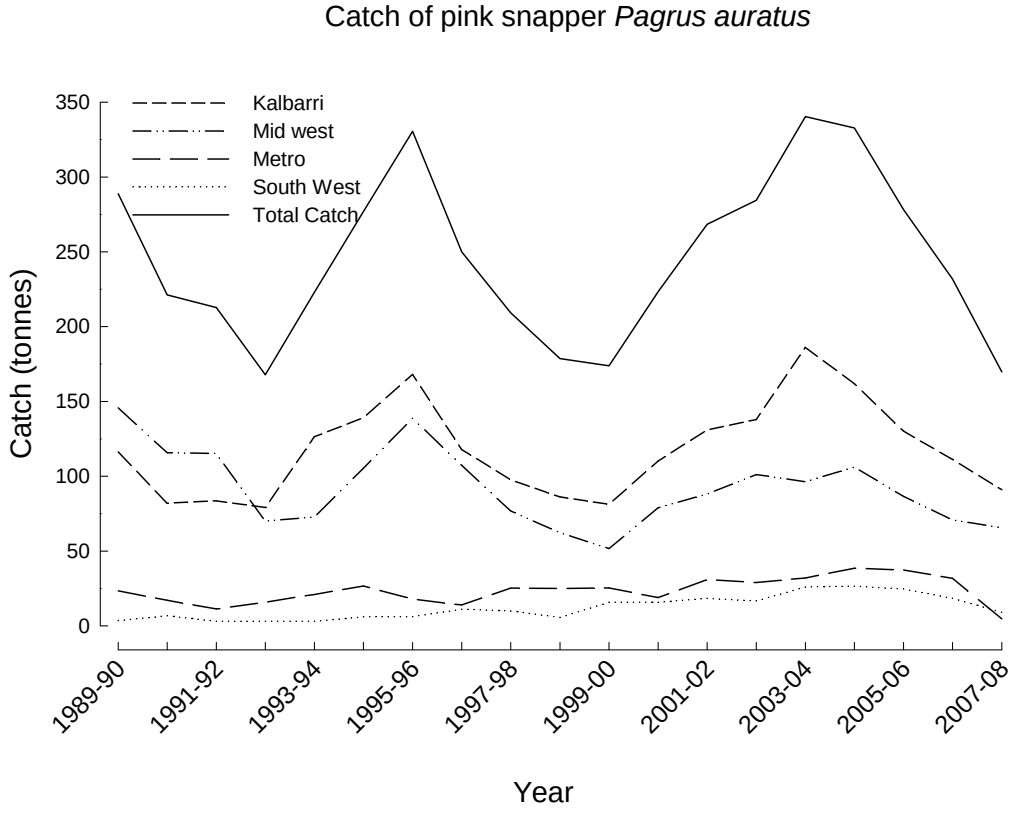
WEST COAST DEMERSAL SCALEFISH FIGURE 1

Map showing the boundaries of the West Coast Demersal Scalefish Fishery. Note the northern boundary of 26°30' S applies to the commercial fishery 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 nm AFZ and from 26°30' S to 115°30' E.



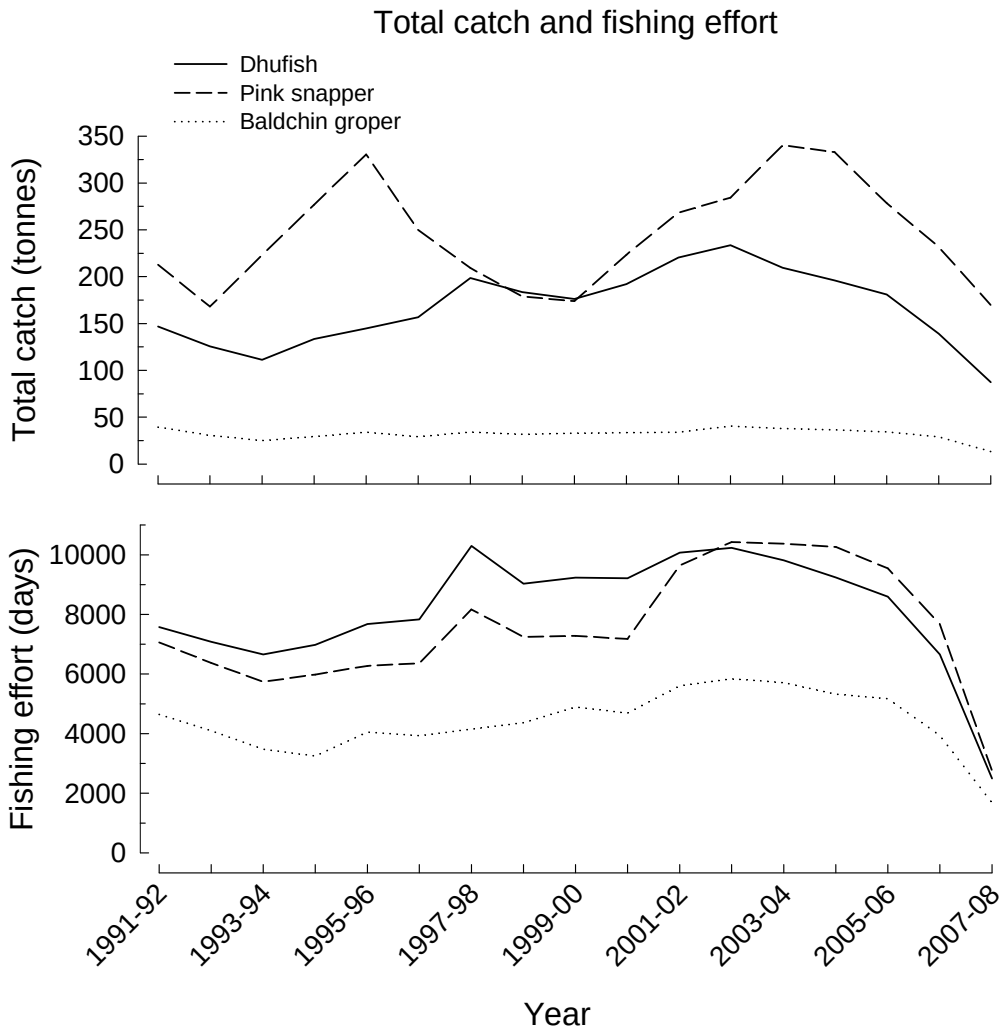
WEST COAST DEMERSAL SCALEFISH FIGURE 2

Total commercial catch of West 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 2007/08.



WEST COAST DEMERSAL SCALEFISH FIGURE 3

Total commercial catch of pink snapper *Pagrus auratus* in the West Coast Demersal Scalefish Fishery and commercial catch of pink snapper in each zone in each year between 1989/90 and 2007/08.



WEST COAST DEMERSAL SCALEFISH FIGURE 4

Total commercial catch and fishing effort (days) for West Australian dhufish, pink snapper and baldchin groper in the West Coast Demersal Scalefish Fishery from 1991/92 to 2007/08.

West Coast Tailor Fisheries Status Report

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

Main Features

Status

Stock level - Uncertain

Fishing level - Commercial: Acceptable

Recreational: Unacceptable in offshore regions

Current Landings

Commercial - 1.6 t in West Coast region

Recreational - 94% of West Coast catch (2000/01)

Fishery Description

Commercial

The majority of commercial landings of tailor (*Pomatomus saltatrix*) in Western Australia (WA) are taken from Shark Bay in the Gascoyne Coast bioregion using haul nets and beach seines. Minor commercial catches are taken in the estuarine fisheries of the West and South Coast bioregions using gill nets, haul nets and beach seines.

Recreational

Tailor is a key target species for recreational anglers in estuaries, along beaches and around coastal reef systems on the lower west coast of WA. This accessible distribution, coupled with strong schooling behaviour, makes the stock relatively vulnerable to growth over-fishing and potentially to recruitment over-fishing. These risk factors, together with naturally variable recruitment and growing inshore fishing pressure, were recognised by the Department in the early 1990s. During the 1990s, daily bag limits were reduced twice – from unlimited to 20, then from 20 to 8 per person. In 2003, the legal minimum length was increased from 250 to 300 mm and the daily bag limit was modified so that a maximum of 2 fish over 600 mm could be retained.

The majority of the recreational catch of tailor in WA is taken from the metropolitan area in the West Coast bioregion.

Governing legislation/fishing authority

Commercial

Fish Resources Management Act 1994 and subsidiary legislation

Various management plans e.g. SCEF, WCEF, Cockburn Sound

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council)

Recreational

Recreational Fishing Advisory Committee

Regional Recreational Fishing Advisory Committees

Boundaries

Commercial

Tailor inhabit estuarine, 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 of WA. Tailor can be taken commercially throughout this range.

Recreational

Recreational fishing for tailor can occur in all WA waters except in areas closed to recreational fishing.

Management arrangements

Commercial

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.

Recreational

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 bioregions that only 2 of these fish may be over 600 mm.

The legal minimum length of tailor is 300 mm for recreational and commercial fishers.

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.

Assessment of the status of tailor in the West Coast region is dependent on annual data supplied by volunteer anglers. In 1995, a volunteer angling program was commenced to monitor

the relative abundance of 0+ year-class in the Swan River estuary. Catch rates from this ongoing program are an indicator of the strength of tailor recruitment to the lower West Coast fishery 1-2 years later. A voluntary recreational angler logbook was implemented in 2004. Logbooks provide information about the size structure of the recreational tailor catch and logbook catch rates provide a relative index of abundance.

Recreational catch levels of tailor in the West Coast region are only estimated when recreational fishing surveys are conducted. Estimates of 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). Commercial catch levels are determined annually from data reported in compulsory commercial returns.

A new research project designed to provide more rigorous monitoring and assessment of the status of tailor and other inshore species will commence in mid-2009. Volunteer anglers will be asked to donate samples of tailor to enable researchers to determine the age structure of the recreational catch along the lower west coast. The project will also examine aspects of stock structure, including potential sources of recruitment to the metropolitan tailor fishery.

Retained Species

Commercial landings (season 2008):

1.6 tonnes in West Coast region

In the West Coast bioregion, the majority of the total 2008 commercial catch of 1.6 t was reported from the West Coast Estuarine Managed Fishery (65.7%). The remainder was reported by wetline fishers in coastal areas between Kalbarri and Cape Naturaliste (31.2%), and within the West Coast Demersal Scalefish Fishery (2.3%).

In 2008, the total state commercial catch of tailor was 26.1 t. The vast majority of landings occurred in the Gascoyne Coast bioregion (93.3% of total landings), with the West Coast and South Coast bioregions contributing 6.1% and 0.6%, respectively.

Further details of Gascoyne commercial landings are contained in the Shark Bay Beach Seine and Mesh Net Managed Fishery report.

Recreational catch: 94% of total (2000/01)

An estimate of the total recreational tailor catch is not available for the current year (2008). The most recent estimate is available from the National Recreational and Indigenous Fishing Survey conducted between May 2000 and April 2001 (Henry and Lyle 2003). The recreational catch for the state was estimated 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 state-wide recreational landings of tailor were reported in the West Coast bioregion, with minor quantities taken in the Gascoyne Coast and South Coast bioregions. Within the West Coast bioregion, recreational fishers caught an estimated 94% of the 2000/01 total catch. An estimated 88% of the recreational catch in the West Coast bioregion during the survey was from shore-based fishing.

In the boat-based creel survey undertaken by the DoF in 2005/06, the number of tailor retained by boat-based recreational fishers in the West Coast bioregion was 4,826 fish during the 12-month survey period. This was significantly less than the 24,251 tailor that were estimated to have been retained by boat-based recreational fishers in 1996/97 during a similar creel survey by the DoF.

The legal minimum length for tailor was raised from 250 to 300mm between the 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 in the West Coast bioregion still appears to have declined significantly since 1996/97.

The boat-based share of the recreational tailor catch is relatively minor (<15%) and so the recent boat-based catch estimates cannot be used to estimate the recent catch of shore-based fishers, who account for the vast majority of recreational tailor landings in the West Coast bioregion.

Fishing effort/access level

Commercial

In the West Coast bioregion, the West Coast Estuarine Managed Fishery; Wetline Fishery; West Coast Demersal Scalefish Fishery; Cockburn Sound (Line and Pot) Managed Fishery; and the Cockburn Sound Fish Net Fishery caught minor quantities of tailor. Tailor is not a primary target species in these fisheries and landings are mostly byproduct.

Recreational

The 2000/01 National Recreational and Indigenous Fishing Survey, which included all methods and bioregions, provided the most recent information on total 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 DoF 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% from 1996/97 (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: Yes

Assessment method: Catch and Catch rate

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 of age (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 area (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 remain in local waters where they spawn and potentially 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 area, then high levels of targeting of offshore fish by recreational fishers could result in depletion of the spawning biomass.

Anecdotal evidence suggests that boat-based recreational fishers have been increasingly targeting breeding size adults around offshore reefs along the lower west coast in recent years. But, recent creel surveys of boat-based fishing indicated that the recreational catch rate of tailor in these offshore waters declined significantly between 1996/97 and 2005/06, suggesting that the abundance of breeding tailor in the region has also declined between surveys.

Logbook data and anecdotal reports from recreational fishers suggest that large, mature fish have only comprised a low proportion of the recreational catch in the Perth metropolitan area in recent years, compared to earlier years. This also suggests that the breeding stock on the west coast may have declined

Since the angler-based recruitment index began in the Swan River estuary in 1995, there have been highly variable levels of annual recruitment (Tailor Figure 1). Relatively high annual recruitment was recorded from 1995 to 1997 but this was followed by an extended period of relatively low recruitment from 1998 to 2004. There was moderate recruitment in 2005 and in 2008, recruitment was the highest since 1997. This is likely to result in higher catch rates in the oceanic areas in 1-2 years. Future catch rates will be monitored.

Whilst stronger recruitment in 2008 is a positive signal and suggests an improvement in the catch rate of tailor will occur in 1-2 years, the longer-term status of the stock remains uncertain due to continuing fishing pressure, unpredictable recruitment and lack of data to enable a more detailed assessment of the breeding stock.

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

Commercial

A small number of commercial fishers, including estuarine haul and gill nets fishers, capture tailor in the west coast region. However, the quantities caught in the west coast region are minor compared to the Shark Bay fishery. Additional employment is created in the processing and distribution networks and retail fish sales sectors.

Recreational

The annual spring – summer appearance of tailor along Perth metropolitan beaches has historically been targeted by thousands of shoreline anglers each year. However, recent lower catch rates have resulted in fewer fishers participating in this activity.

Economic Effects

Estimated annual commercial value (to fishers) for year 2008: minimal

Fishery Governance

Commercial

Current fishing level (2008): Acceptable

Commercial fishing levels are considered acceptable. The

commercial catch of tailor in the West Coast bioregion 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.

Recreational

Current fishing level: Unacceptable

Target recreational catch range: Under Development

Shore-based recreational fishers catch the vast majority of tailor in the West Coast bioregion. 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 effort or catch taken by this sector.

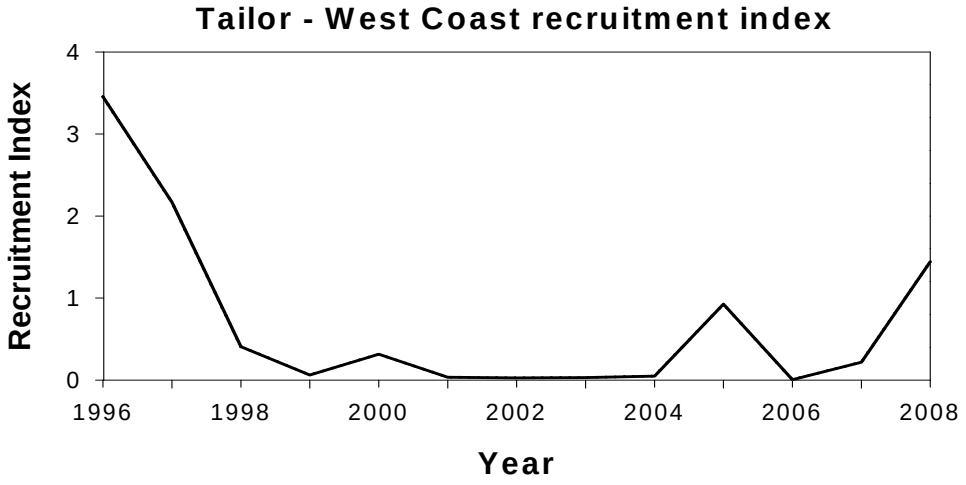
Available evidence (a significant decline in boat-based catch, anecdotal reports of low shore-based catch rates, highly variable annual recruitment) suggests that, despite recent changes to bag and size limits, the recreational exploitation rate of tailor in the West Coast bioregion is at an unacceptable level.

New management initiatives (2008/09)

In October 2009, the maximum legal size limit of tailor will be reduced from 600 mm to 500 mm (i.e. only 2 fish above 500 mm may be retained as part of a total daily bag of 8), in response to a proposal by the Metropolitan Region Recreational Fishing Advisory Committee. This proposal was subsequently supported by the state Recreational Fishing Advisory Committee (RFAC). Data from voluntary recreational logbooks was used in the development of this proposal.

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.



TAILOR FIGURE1

The annual recruitment index for the lower west coast Tailor fishery over the period 1996 – 2008, derived from volunteer angler catch rates of age 0+ juveniles in the Swan Estuary.

AQUACULTURE

Regional Research and Development Overview

Aquaculture production statistics are compiled at the Western Australian Fisheries and Marine Research Laboratories (WAFMRL) at Hillarys.

In 2007/08, the value of aquaculture increased by around 34% and aquaculture tonnage increased by1% compared to equivalent data for 2006/07 (excluding marine algae and all pearl oysters). However, aquaculture production is still less than the peak in 2003/04.

The framework to allow for the granting of leases for aquaculture has been finalised; however, its release has been delayed to allow for the amendments to the *Land Administration Act* by the Department of Planning and Infrastructure. Currently, the Minister has granted two leases: one for the aquaculturing of octopus in Cockburn Sound and another in Flinders Bay in the south west of the state. The granting of the latter lease has been delayed due to an expected new marine park in the area.

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.

Arrangements are progressing with the Department of Health for the ongoing management of the Western Australian Shellfish Quality Assurance Program and its links to the new Food Bill.

Significant progress has been made on the development of a new framework for the environmental arrangement for aquaculture applications, both large- and small-scale. The Ecologically Sustainable Development (ESD) reports for marine finfish have been completed and an Environmental Code of Practice drafted in conjunction with industry and the Department of Environment and Conservation (DEC). This sector will be the first to be run through a process to deregulate it from Part V of the *Environmental Protection Act 1986*. It is envisaged the ESD reports will be finalised and Codes developed for prawn and land based finfish aquaculture by the end of 2009.

A Memorandum of Understanding to formalise these new arrangements will also be finalised with DEC and the Environment Protection Authority by the end of 2009. The process will include agreed Management and Environmental Monitoring Plans and a Guidance Statement for baseline data collection. These will be required for all new applications.

Proposed legislative amendments to the *Fish Resources Management Act 1994*, designed to improve the regulatory environment and streamline the approvals processes, have been prepared and are expected to be drafted this financial year.

The Department of Fisheries' marine finfish aquaculture research team continued its work on the development of microdiets for larval fish nutrition with financial support from the FRDC and in collaboration with research and development centres in Tasmania, Spain, Portugal, Japan, Malaysia and Mexico. The automated feeding system (patent registration completed) developed in an earlier stage of the project continues to be manufactured by the Department, with steady sales of systems overseas. The control box for the automated feeding system has been contracted to an external company.

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.

The system has now developed into a commercial-scale system, based on new rearing protocols. 'Domestic-grown' *Artemia* products are now available commercially, reducing the reliance on unpredictable supplies of imported product for aquaculture feeds.

The Aquaculture Development Council is continued to determine the feasibility of offshore production systems for growing marine finfish in unsheltered WA coastal waters. As part of this initiative, the Council sponsored a successful session on open ocean aquaculture at the 2008 Australasian Aquaculture Conference. International authorities, researchers and equipment suppliers presented their latest work and technology developments during the session.

The Council is identifying and assessing suitable marine areas for potential aquaculture zones to support industry expansion. Further, it is supporting the Department's negotiations with the Commonwealth Government to develop a regulatory framework for aquaculture in Commonwealth waters. In co-operation with the Department and industry, the Council is undertaking a major project to determine the environmental carrying capacities of several locations on the WA coast. This project will assist industry development by significantly improving the environmental approvals processes for large-scale aquaculture in coastal waters.

A number of new aquaculture projects have been, or are in the process of being, established off the west coast. These include a proposal to farm greenlip abalone in the waters of Flinders Bay using innovative below-surface infrastructure. Octopus aquaculture has started in Cockburn Sound and the licensee is seeking funding to undertake research into closing the life cycle of this species in collaboration with the Department.

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 Fisheries Volunteers (formerly known as Volunteer Fisheries Liaison Officers) based in Busselton, Bunbury, Mandurah, Fremantle, Hillary's, Dongara, Geraldton and Kalbarri. Staff from the Marine Discovery West team and The Naturaliste Discovery Centre also provide education services and activities at Hillary's and in the Regions.

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 size from 5 m to 12 m. They also provide support to seagoing personnel and provide a wide variety of educational and extension services through formal and informal media to commercial fishers, fishing related operations (wholesale/retail/processors), other resource management agencies and community members.

The Department also delivers at-sea marine safety compliance services on behalf of the Department for Planning and Infrastructure in the 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 2007/08

During 2007/08, FMO's delivered a total of 16,625 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- and intelligence-based approaches to compliance planning and prioritization.

The 12-metre patrol vessel "PV Waterman" was a welcome addition in undertaking compliance operations and research projects in the Metro Region. The "PV Waterman" is used throughout the year and provides a valuable resource for at sea compliance activity including gear and entitlement checks in the West Coast Rock Lobster fishery, West Coast Demersal Scalefish fishery, marine safety compliance, Marmion Marine Park compliance and education and shark response as part of the whole of government approach to the shark hazard program. Compliance planning for the West Coast Rock Lobster Managed Fishery focused on the outcomes and directions from the Compliance Risk Assessment. Compliance operations targeted a number of significant risks incuding over potting, fishers interfering with other fishing gear and black market operations, which resulted in a number of apprehensions.

Targeted operations were also conducted to address other issues, which included illegal fish sales, failing to release totally protected rock lobsters, and pulling rock lobster pots prior to the prescribed starting time each day.

Compliance in commercial fisheries was similar to previous years, although an increase in the number of prosecutions from 25 to 35 is of some concern. The number of of infringements were up slightly compared to previous years, with a total of 85 infringement85 infringement notices being issued. However, it was pleasing to see that infringement warnings were down from 325 to 244, which indicates a greater level of awareness and care in ensuring that minor offences were being minimised by industry.

Within the West Coast Rock Lobster Managed Fishery, each vessel had its catch inspected by FMOs on at least one occasion, with an average of 6 checks per vessel throughout the fishery (West Coast Compliance Table 2). On average 17 baskets were inspected per vessel which is similar to the number in 2006/07. The percentage of total catch inspected was slightly down ondown on the previous season with approximately 2.0 - 2.5% of the catch inspected (compared to 2.4 – 3.0% in 2006/07). The observed per-animal non-compliance rate for the catch remained stable with an estimated range of 0.0010-0.0015. This range has been used to estimate that between 8.6 and 13.4 tonnes of illegal rock lobster were consigned during 2007/08.

In addition to the rock lobster fishery, FMO's focused activity on ensuring high levels of compliance in other commercial fisheries such as the abalone, demersal scalefish (Wetline), crab, shark, scallop, pilchard and estuarine fisheries.

Considerable compliance activity was directed towards recreational fisheries within the bioregion, with FMOs achieving 39,331 field contacts with recreational fishers, a significant increase on the previous year. The majority of the compliance effort focused on rock lobster, abalone, marine finfish and crabs.

Throughout the bioregion a total of 739 infringement warnings, 318 infringement notices and 93 prosecutions were instigated for recreational offences during 2007/08. This is similar to 2006/07 for prosecutions (90), but significant increases in infringement warnings and infringement notices (from 467 and 172 respectively in 2006/07).

The Department continues to work collaboratively with the Department of Environment and Conservation 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 metropolitan abalone season which occurs predominately within the Marmion Marine Park, and in the Jurien Marine Park, where DEC officers undertake joint patrols with FMOs thereby increasing the effectiveness of compliance service delivery.

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 continuing 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 Department for Planning and Infrastructure, Australian Customs Service and WA Police Service.

The Fisheries Volunteer (FV's) 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 bioregion conducted beach patrols, school talks, fishing workshops, and attended various boat shows and festivals.

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

Initiatives in 2008/09

Drawing on an improved intelligence capacity, a number of targeted rock lobster compliance operations are planned during the 2008/09 rock lobster season, with a focus on over potting, gear related offences and black market operations.

The Department continues to improve its at sea patrol capability with the design of a new 22m PattrolPatrol Vessel to be based in Geraldton, an 11m Rigid Inflatable Boat (RIB) for the Mandurah DitstcitDistrict and twoand two 8.5 m RIB's for the Rockingham and Lancelin DisrictsDistricts.

The construction of the the new multi-agency Marine Operations Centre for the Mandurah District will draw to completion during 2008/09 and be ready for occupation in early 2009/10. This building will house over fifty staff from the Department of Fisheries, Water Police and the Department of Environment and Conservation. This facility will provide further capacity to increase compliance services in the Peel Region in future years.

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

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 (JADGDLF), which include effort restrictions and a 3-month whiskery pupping closure. Abalone compliance activities will continue to focus on targeted inspections of landings based on analysis of the existing intelligence.

Joint operations with regional Water Corporation Rangers and DEC officers was increased during the 2008 season and will be continued into the 2009 season. These joint patrols increase the compliance presence in the marron fishery and the expert knowledge Water Corporation rangers have of the dam areas and activities greatly assist in the compliance operations.

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.

The Volunteer program is to be instrumental in delivering information to marron fishers and campers during the opening of the marron season at the Collie River, Harvey Dam and through the Blackwood River basin.

The Volunteer 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.

In the Metro area community education will focus on school-based incursions working on conservation and education themes developed by the Marine Discovery West team and delivering information and education at major events such as the Mandurah Boat Show and Crab Fest.

WEST COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the west coast bioregion during the 2007/08 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	16,625 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field Contacts by Fisheries & Marine Officers	426
District Office contacts	5,490
Infringement warnings	244
Infringement notices	85
Prosecutions	35
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	39,331
District Office contacts	11,754
Infringement warnings	739
Infringement notices	318
Prosecutions	93
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY***	
Field Contacts by Fisheries & Marine Officers	660
District Office contacts	4,441
Fishwatch reports**	444

*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 PV's Hamelin and MacLaughlan. Contacts made by PV Walcott are included in North Coast Compliance Table 1.

***This represents the total number of Fishwatch reports, both commercial and recreational, since the service provider reporting mechanism cannot differentiate between sectors. It also includes any calls relating to the southern inland bioregion that were referred to Busselton, Bunbury, Mandurah, Rockingham, Fremantle, Hillary's, Lancelin, Jurien, Dongara and Geraldton District staff.

WEST COAST COMPLIANCE TABLE 2

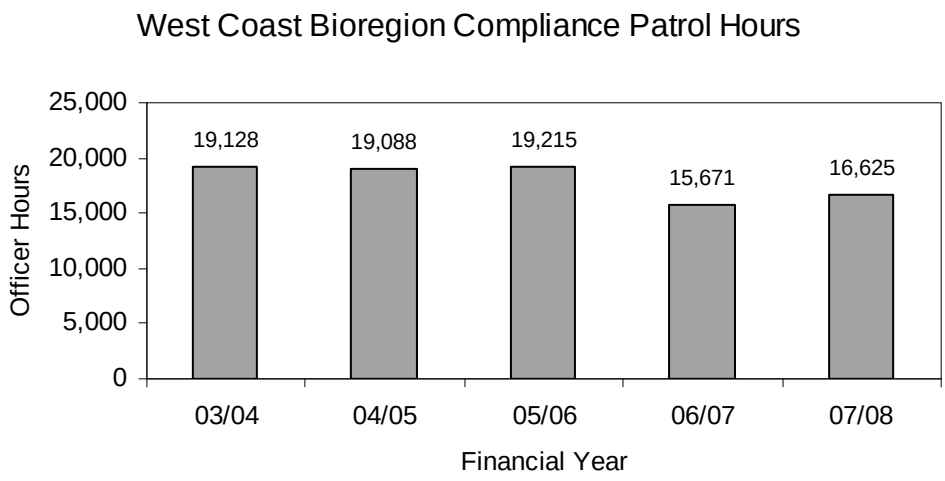
Summary statistics for Commercial West Coast Rock Lobster compliance in all bioregions in the 2007/08 fishing season.

TOTAL COMPLIANCE HOURS*	21,034 Officer Hours
Field Contacts by Fisheries & Marine Officers	3,038
District Office contacts	1,431
FACTORY INSPECTIONS OF CONSIGNMENTS	
Number of unique vessels checked	465
Average number of inspections per vessel	6
Average number of baskets checked per vessel **	17
Proportion of total commercial catch inspected	2.0 – 2.5%
Non-compliance rate (per-animal basis) ***	0.0010-0.0015
Total consigned commercial catch ('000 kg)	8,926
Estimated total illegal catch consigned ('000 kg)	8.6-13.4

*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.



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 07/08 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.)

*A reporting error resulted in the 06/07 total in Figure 1 being incorrectly reported as 14,518 in the last edition of State of the Fisheries. These figures do not include 3,278 "on-patrol" hours delivered in 2007/08 by *PV Hamelin* and *PV MacLaughlan*.

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.

GASCOYNE COAST BIOREGION

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.

SUMMARY OF FISHING ACTIVITY

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.

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, cods and deeper water species such as 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.

ECOSYSTEM MANAGEMENT

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).

There are a number of marine protected areas under the *Conservation and Land Management Act 1984* and the *Fish Resources Management Act 1994* in the Gascoyne (see Gascoyne Coast Habitat Protection Figure 2). These include the Ningaloo and Shark Bay marine parks, the Muiron Islands Marine Management Area, and the Quobba and Miaboolya Beach Fish Habitat Protection Areas.

The Australian Government is also considering nominating an area of the Ningaloo area for 'World Heritage' listing in view of the significant environmental values of the land, 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*.

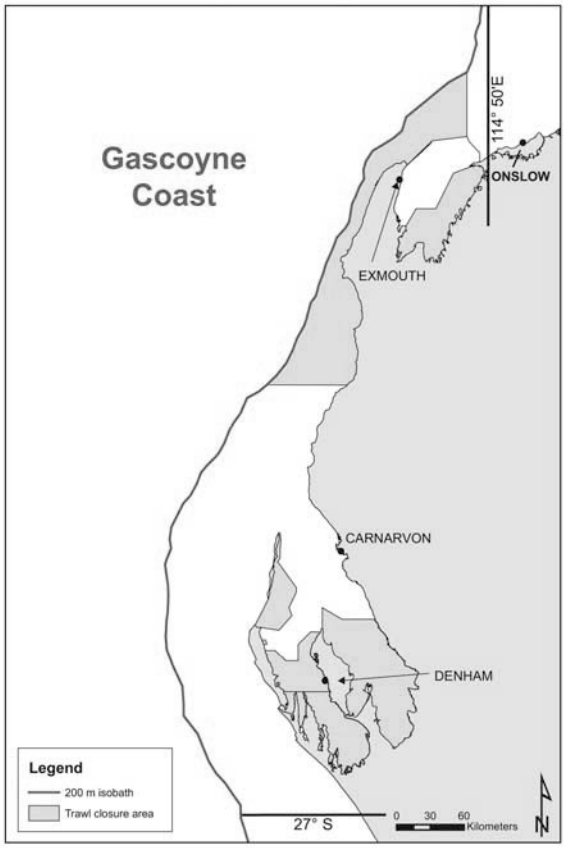
The Australian Government Department of Environment, Water Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border. DEWHA plan to complete a draft North West Marine Bioregional Plan (MBP) in late 2009. This Draft Plan will include proposed marine protected areas, and will be released for a 3 month public consultation period.

Specific commercial fishing regulations implemented in the 1970s and 1980s preclude the use of large-mesh gillnets and long-lines throughout the region, to prevent the incidental entanglement of dugongs and turtles which inhabit the region. These controls have also provided protection for the large shark species which are a feature of this region. More recently, bycatch reduction devices ('grids') installed in trawl nets have increased the protection for sharks, rays and the occasional loggerhead turtle encountered on the trawl grounds.

In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has an initiated Ecosystem Based Fisheries Management (EBFM) framework.

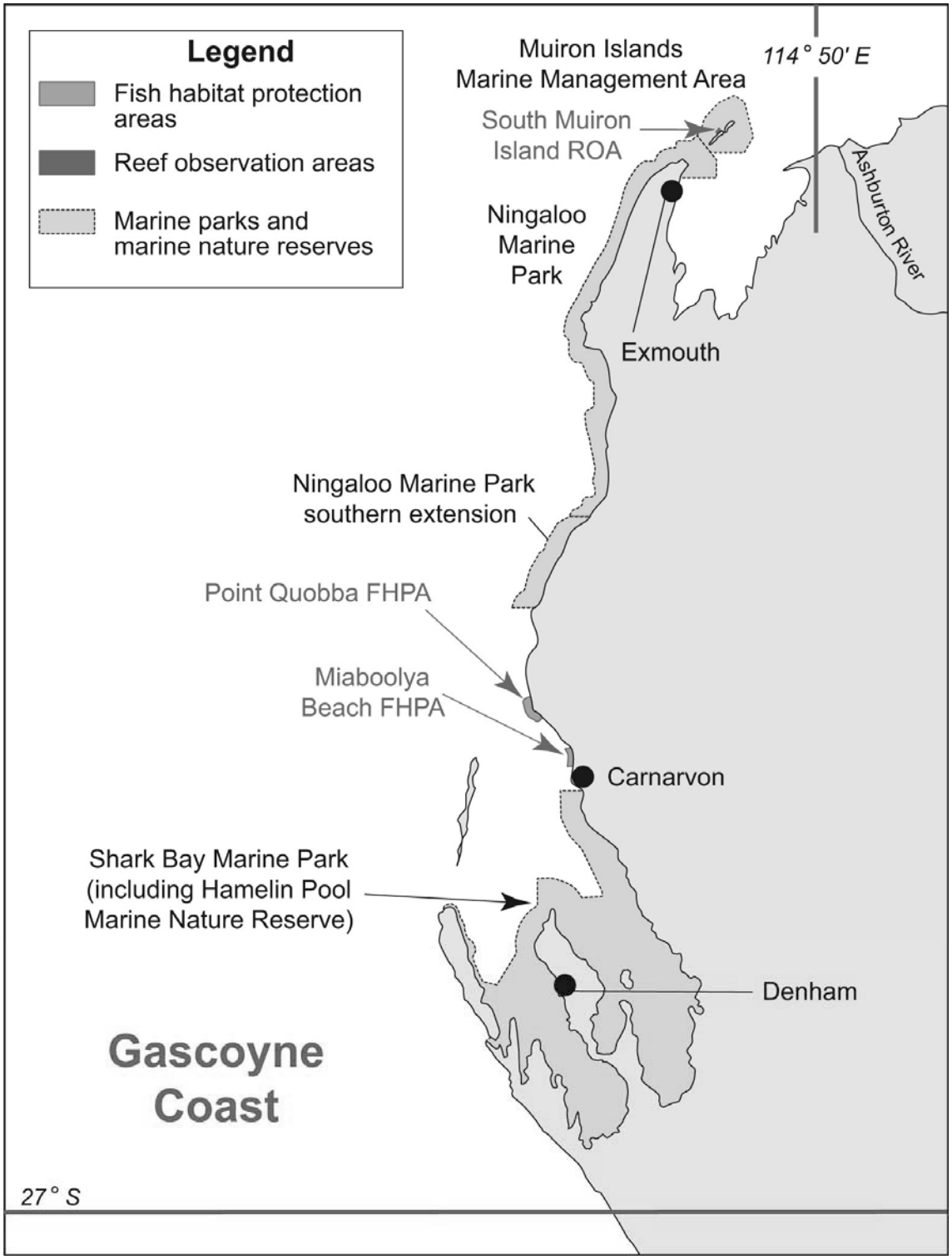
EBFM is a risk based management approach, which recognizes the social, economic and environmental values of the region, and ecological links between exploited fish stocks and the broader marine ecosystem. EBFM will now guide fisheries management arrangements to ensure the sustainable management of fish stocks in the future. The EBFM risk assessment process for the West Coast Bioregion has been completed (see Table 1 for the West Coast Bioregion) and serves as an example of what will be undertaken for the Gascoyne Bioregion. 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.

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 exotic aquatic organisms, or other incidents which have the potential to have an adverse effect.



GASCOYNE COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas permanently closed to trawling in the Gascoyne Coast bioregion.



GASCOYNE COAST ECOSYTEM MANAGEMENT FIGURE 2

Map showing current and proposed areas of protected fish habitat in the Gascoyne Coast

FISHERIES

Shark Bay Prawn and Scallop Managed Fisheries Status Report

E. Sporer, M. Kangas and S. Brown
Management input from R.Gould

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings

Prawns 1232 t

Scallops 3674 t

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.). The Shark Bay Scallop Managed Fishery catches the saucer scallop *(Amusium balloti)*, and is usually Western Australia's most valuable scallop fishery.

Governing legislation/fishing authority

Shark Bay Prawn Management Plan 1993

Shark Bay Prawn Managed Fishery Licence

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

Meetings between the Department of Fisheries and industry.

Boundaries

The boundaries of the Shark Bay Prawn Managed Fishery and the Shark bay Scallop 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 and Scallop Figures 1 & 2).

Management arrangements

Management of the prawn and scallop fisheries is based on input controls which include limited entry, seasonal and area openings and closures, gear controls and limits on crew numbers. The prawn fishery also has moon closures. These management arrangements are designed to keep effort at levels that will maintain sufficient spawning stocks and achieve optimal yields. Management is aimed at catching prawns and scallops at the best size and condition for the market, thereby maximising the economic return while maintaining breeding stock levels. Fishing is undertaken by both fleets using otter trawls, with 'bison' otter boards (under exemption) and standard flat wooden otter boards.

Both fleets (prawn and scallop boats) have standardised net headrope allocation whereby each boat has an equal allocation of net headrope for each fishery. For the prawn fishery, boats are authorised to operate with two eight fathom nets (29.27 metres) and boat units no greater than 375. The prawn fleet is operating under an exemption from both the net size and the 375 hull unit rule to provide for trawl gear amalgamation and improved economics. The total net headrope allocation for the prawn fishery is 432 fathoms (790 metres). The total headrope net allocation for the scallop fishery A class boats is 196 fathoms (358.4 metres). The A class boats are permitted to take scallops by a maximum of two seven fathom nets (25.6 metres).

Bycatch reduction devices ('grids') are fitted to all prawn and scallop trawl nets. In addition, secondary bycatch reduction devices (fish escape devices) are fitted to nets of prawn boats. Scallop boats have larger 100mm cod end mesh resulting in only a small amount of bycatch being taken during trawl operations and therefore do not require the secondary devices.

The Australian Government's Department of Environment, Water, Heritage and the Arts has assessed the fisheries under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* and has accredited the fisheries for a period of five years, allowing product from the fisheries to be exported from Australia. The comprehensive Ecologically Sustainable Development assessment of these fisheries has also identified potential sustainability risks requiring direct management actions. The issues identified through this process were that the breeding stock levels of target prawn and scallop species, bycatch species impacts, protected species interactions (including loggerhead turtles), habitat effects and provisioning effects are the issues for management. Boxed text in this status report provides the annual assessment of performance measures/indicators for these issues.

Prawns

The yearly cycle of operation for the prawn 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 estimate recruitment strength. 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 of prawns 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 hence 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 prawn fishing arrangements in Denham Sound have included Industry/Research 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. These closures were evaluated by the Research Division and in 2004 were re-aligned and incorporated as statutory closures.

The season fishing arrangements for the 2008 prawn season opened on 5 March and closed on 13 October providing a total of 173 nights fishing although only 166 nights were actually fished. Fishing patterns during the season involved, flexible fishing arrangements and voluntary rolling area openings, based on assessment of both king and tiger prawn size through fishery-independent surveys.

Scallops

The scallop catch is taken 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).

The opening date of the scallop 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 2008 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 between 1982 and 2006.

The 2008 scallop season officially opened on 22 February although actual fishing commenced on 26 February with all 14 Class A scallop boats (dedicated scallop boats) fishing in Denham Sound. The early opening has 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 5 March the dedicated scallop boats moved into the northern part of Shark Bay to commence fishing in North West Peron area and the Red Cliff area together with the B class scallop boats (north of 25°30.20′ S latitude). The A Class scallop boats returned to Denham Sound on 20 March and remained there until 16 April, then returning to northern Shark Bay to continue fishing scallops. A Class scallop boats ceased fishing on 5 May at a higher catch rate than the threshold and the B class boats continued fishing for scallops. The A class boats left Shark Bay to fish in the Abrolhos Islands and Mid West Trawl Fishery. The B class boats fished until 0800 hrs 19 May, which was the moon closure date.

The Department of Fisheries' Research Division carries out daily monitoring of the scallop fleet for catch and effort to provide advice on when to close areas based on the threshold catch rates. This, together with the VMS, is a major element of the management strategy to control spatial and temporal closures.

Research summary

Research activities continue to focus on stock assessment and annual monitoring of the stocks, particularly tiger prawns and scallop stocks. 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 prawn surveys have proved to be valuable in ensuring that the prawns are targeted at an optimal market size.

Research for monitoring the status of the scallop stock in Shark Bay also requires real-time monitoring of catch levels to monitor the threshold 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.

An FRDC collaborative project with the Department and Edith Cowan University to analyse prawn survey and logbook data using geostatistics to provide a better understanding of stock and fleet dynamics and to enable better delineation of tiger prawn spawning was completed in mid 2008. A two-year FRDC project on research into prawn/scallop gear interactions, scallop and prawn larval movement patterns in Shark Bay and potential effects of area closures in scallop/prawn management commenced in March 2008.

Retained Species

Commercial production (season 2008)

Prawns 1,232 tonnes

Scallops 3,674 tonnes (whole weight)

Landings

Prawns

The total prawn (whole weight) landings were 1232 tonnes comprising 848 tonnes of king prawns, 384 tonnes of tiger prawns, less than 1 tonne of endeavour prawns (Shark Bay Prawn and Scallop Figure 3). The total landings were similar to last year's catch of 1250 t. but below the target catch range (1501 to 2330 tonnes).

Tiger prawn landings (384 t) were slightly below the acceptable catch range (400-700 tonnes) with the average catch over the last 15 years being 556 tonnes. King prawn landings (848 t) were also below the acceptable catch range (1100 to 1600 tonnes). For the 2008 season, the effort on king prawns affected total catch as the fleet targeted larger king prawns for economic value. There was also a small shift of effort by some boats to target scallops in the early part of the season. The focus by industry to target larger size prawns and the effort shift has resulted in expected lower landings of around the 950 to 1450 tonnes under normal environmental conditions compared to historical catch ranges. The total landings for 2008 were below the target level mainly because of reduced effective effort on king prawns. The acceptable catch will be reviewed in the future and adjusted to reflect current fishing/targeting strategies.

By-product landings from the prawn fishery included 135 t of blue swimmer crab *(Portunus pelagicus)*, 10 t of squid, 10 t of cuttlefish, 10 t of tuna (wetlining), 2 t of bugs *(Thenus orientalis)* and <1t of mulloway *(Argyrosomus hololepidotus)* and snapper *(Pagrus auratus)*. By-product landings recorded by the A Class boats was 3 t of blue swimmer crab *(Portunus pelagicus)*.

Scallops

The total scallop landing for this fishery, includes both A and B Class scallop boats, was 3674 t (whole weight) which was the highest in 14 years (Shark Bay Prawn and Scallop Figure 4). A Class boats landed 2837 t (77.2 %) and the B Class boats landed 837 t (22.8%). The 2007 scallop survey provided a catch prediction of 5045 t scallop (whole weight) for the entire Shark Bay scallop fishery based on historic fishing practices, which have now been significantly altered by the timing that fishing occurs and to allow a significant carryover. The scallop landings from Red Cliff and North West Peron areas from the scallop and prawn boats were 2084 t. This area provided the majority of scallops in Shark Bay for the 2008 season. The scallop landings from Denham Sound (1590 t) have been relatively stable since 2002 and were the highest since 1983.

Fishing effort/access level

There are 27 licences in the Shark Bay Prawn Managed Fishery, but as a result of changes in gear configuration only 18 boats operated in 2008, with 17 towing quad gear (4 x 5.5-fathom nets) and one boat towing 4 x 4 fathom nets for a short period only. This fleet rationalisation incorporated a reduction of total headrope length from 432 fathoms to 390 fathoms.

The total nominal effort recorded by the prawn fleet in 2008 was 23,522 hours and is 48% lower than that historically recorded by 27 boats between 1990 and 2004 (mean 44864 hours). Since 1990 the number of boats have been reduced (27 boats 1990 to 2004, 25 boats 2005-2006, 18 boats 2007–2008). Because of gear amalgamation, effective effort has not reduced as much as nominal effort because the remaining boats are towing larger nets and there has only been a 10% reduction in overall gear being towed An adjustment is made to the effort for the increased headrope (37.5%) towed by the quad boats with the 2008 adjusted effort being 32343 hours (twin-gear equivalent effort). This adjusted effort is 10% lower than last year and the lowest level of effort recorded since the development phase of the fishery 41 years ago.

The total effort recorded by the A Class scallop boats in 2008 was 9804 hours, an increase of 28% compared to 2007 (6176 hrs). The catch for 2008 was up by 27% on 2007 indicating that the additional effort reflected a higher abundance of scallops.

Recreational component: Nil

Stock Assessment

Assessment complete: Yes

Assessment method: Direct survey/catch rate

Breeding stock levels: Adequate

Prawns

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 26.2 kg/hr (equivalent to twin gear units) for king prawns observed in 2008 remains relatively high compared to past years, even though the total landings of king prawns were low although higher than 2007. The 2008 tiger prawn catch rate of 11.9 kg/hr was at the mean catch rate (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 2008 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, and threshold levels are in place to maintain spawning stock for tiger prawns in Shark Bay above acceptable levels. 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 2008. Recruitment surveys are undertaken mainly to provide information regarding abundance and size structure of prawns. This is used to determine the extent of areas opened to fishing for market requirements. These data will also be used in the future to forecast a predicted catch range for tiger or king prawns. Additional surveys were carried out during May and June 2008 to obtain grade size information of king and tiger prawns within the Carnarvon/Peron line to assist with harvesting strategies and optimise returns to fishers.

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. 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. Some of the king prawn breeding stock is also protected by this closure and their catch

rates are also recorded during the surveys. In 2008, surveys were undertaken in late June and July as the TPSA closed to fishing on 9 June. The mean catch rate of tiger prawns from these two surveys was 22.6 kg/hr which was similar to last year whilst the mean king prawn catch rate of 27.6 kg/hr was observed. The mean fleet catch rate (over four nights) for tiger prawns two days prior to the closure was 27 kg/hr but the night before the closure the catch rate had declined to 17 kg/hr and hence the closure date was appropriate.

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.

Fishery-independent survey data allows fishing to target appropriate prawn sizes for market value each season and have a long-term aim of providing catch predictions. The current indices that are derived indicate trends in recruitment.

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 assessment indicates 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 prawn fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2008, the breeding stock indicator for tiger prawns was slightly lower than the threshold target range however fishing for tiger prawns occurred about the appropriate time. The king prawns were slightly below the indicator range but this was due to reduce effort, targeting larger size prawns and a small shift of effort from king prawns to scallops.

Scallops

The catch rate of 57.9 kg/hr (based on class A boats) for scallops was the highest since 1992 and comparable to 50.6 kg/hr in 2007. This reflects the best recruitment since the early 1990's and the recent changes in fishing practices.

The status of the scallop stock is determined from the annual pre-season survey of recruitment and residual stock carried out in November–December. This survey enables the management arrangements of the fishery to be determined that take into account fishing scallops at an optimum size and allows an adequate spawning stock.

Recruitment of juveniles to the stock and residuals are estimated using the data from the scallop survey for the main fishing grounds and in Denham Sound. The survey design and analysis of the data provides separate catch forecasts for the Shark Bay separated into two sectors, northern Shark Bay (Red Cliff and North West Peron) and Denham Sound, allowing separate opening dates for each area to optimise scallop meat size and condition each season. Scallops mature at about one year of age and spawning typically occurs from April to November. Fishing is therefore controlled to ensure that sufficient scallops remain through the key spawning season (April to July), which is the critical period for generating future recruits.

The 2007 November survey showed that a proportion of the scallops were left at the end of the 2007 season (more than twice that observed in the previous four years) and provided carry over of residual stock into the 2008 season adding to the seasons catch and breeding stock.

The performance measure is to ensure adequate breeding stock levels. Since 2004, a catch threshold level is used to cease fishing to maintain breeding stock during the key spawning period. In 2008 the fishing season was opened prior to the start of the spawning season, however a cut-off threshold catch rate was applied for the fishery based on daily fleet average catch of 400kg/boat day in northern Shark Bay and 300 kg meat weight/boat day (day fishing only) in Denham Sound to ensure adequate breeding stock levels. This catch rate has continued to be adjusted upwards since being implemented in 2005 and the 400kg/boat day for both areas (Shark Bay north and Denham Sound) may be adequate to provide recruitment in the acceptable range given 'normal' environmental conditions. The cut off catch rate of 400 kg/boat day should be trialled for a further three years to determine if this level ensures adequate breeding stock. Also the fishing strategy has involved leaving part of the stock to be carried over to the following year providing a buffer in case of low recruitment.

Projected scallop catch next season (2009):

3150 tonnes (whole weight)

The catch projection for the 2009 season is based on the 2008 survey results. On the main fishing grounds (North West Peron and Red Cliff) in Shark Bay, observed recruitment was much higher than the previous years and a relatively low abundance of residuals. This results in a catch forecast for this area of approximately 2250 t whole weight which can be compared to last year's forecast of 5050 t. Recruitment levels were higher than residuals in Denham Sound, giving a predicted catch of 900 t whole weight. The catch projection for the fishery as a whole is therefore 3150 t in the range of 2500 - 3800 t whole weight. These predictions provide a relative indicator of catch trends based on historic fishing practices. These estimates need to be revised to take into account of management changes since 2005 that have

significantly altered by the timing that fishing occurs and which allow a significant carryover of scallops. It is intended to complete this revision during 2010/11which provides a minimum of five years of data with the new fishing strategies in place.

Non-Retained Species

Bycatch species impact: Low

Prawns

Bycatch composition for the prawn fishery is dominated by dead wire weed, which breaks off from the extensive shallow Wooramel seagrass bank annually over summer. The bycatch also contains a number of small size 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 taken in trawl nets are moderate relative to other subtropical trawl fisheries at about 4–8 times the prawn catch. Field sampling for a study on the bycatch of trawled and untrawled areas of Shark Bay is now available (Kangas et al. 2008). Grid and secondary bycatch reduction devices (square mesh panels in cod-ends) are fully implemented and should further reduce the quantity of small fish retained in trawls.

Scallops

For the scallop fishery owing to the legislated design of the nets (which use 100 mm mesh) and the relatively short duration of the fishery, the total bycatch of fish is minimal.

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. Data analysis indicates that trawled areas have similar diversity to the larger adjacent untrawled areas, indicating that the performance indicator will be met. For provisioning, the indicator has been met due to the lower and more targeted trawl effort (~10% reduction in the past two years) and implementation of BRDs in the fleet. Both actions have reduced the rate of discards relative to the pre-BRD period.

Protected species interaction: Low

Although protected species including whales, dolphins, dugongs, turtles and sea snakes are particularly abundant in Shark Bay generally, only sea snakes are seen regularly in the trawl catches in certain areas, and these are mostly returned to the sea alive. The full implementation of bycatch reduction devices (grids) in the fishery since 2002 has generally eliminated the occasional capture of turtles in trawl nets.

One performance measure for the fishery is for 90% of turtles from non-BRD nets to be returned alive. No grid exemption period was in place for 2008. For the 2008 season, 9 turtles were recorded as caught in nets. One turtle was recorded as dead whereas all others were recorded as being returned to the sea alive. For the scallop fishery, no turtles were reported as being taken in scallop nets in 2008.

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 and scallop predators are opportunistic due to these natural variations in prawn and scallop populations. Consequently, it is not likely that the commercial take of prawns and scallops 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, prawn fishery
Low, scallop fishery

Prawns

There are extensive permanent and temporary closures in the Shark Bay fishery (Shark Bay Prawn and Scallop 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.

Scallops

For the scallop fishery fishing is concentrated on a small sector of the typically bare sand habitat associated with concentrations of this species. The percentage of fished area in 2008 is 9% of the inner Shark Bay area and 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.

Performance measures for habitat impact relate to the spatial extent o f prawn trawling within Shark Bay's sand/shell and coral/sponge habitats. In 2008 the performance measure was met as the total area trawled within Shark Bay (at approximately 774 square nautical miles or ~16% 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 2008, 250 skippers and crew were employed in the prawn and scallop fisheries. There are also processing and support staff employed at Carnarvon, Geraldton and Fremantle. These industries are a major contributor to regional employment.

Economic Effects

Estimated annual value (to fishers) for year 2008:

$14.1 million prawns

$14.3 million scallops

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	$11.00/kg
Tiger prawns	$11.85/kg
Coral prawns	$2.00/kg
Scallops	$3.90/kg

Fishery Governance

Target catch range: 1501 – 2330 tonnes prawns

1250 – 3000 tonnes whole weight scallop

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 1501 – 2330 t. Target catch ranges for individual species are king prawns 1100 – 1600 t, tiger prawns 400 – 700 t and endeavour prawns 1 – 30 t.

The focus by industry to target larger size prawns and the resulting effort shift has reduced expected landings to around the 950 to 1450 tonnes under normal environmental conditions compared to historical catch ranges. This reduction in total landings will be reviewed after the 2009 season and a new target catch range developed. As effort has been directed to avoid areas of smaller prawns and this is where endeavour prawns are mainly taken this species will no longer be included as a performance indicator for the fishery as it is no longer a target species.

The target catch range for scallops is approximately 1250 – 3000 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 and carryover stock from 2008.

New management initiatives (2009) Nil

A trial of scallop catch share arrangements between prawn and scallop boats was continued in 2008 and subject to review in 2009.

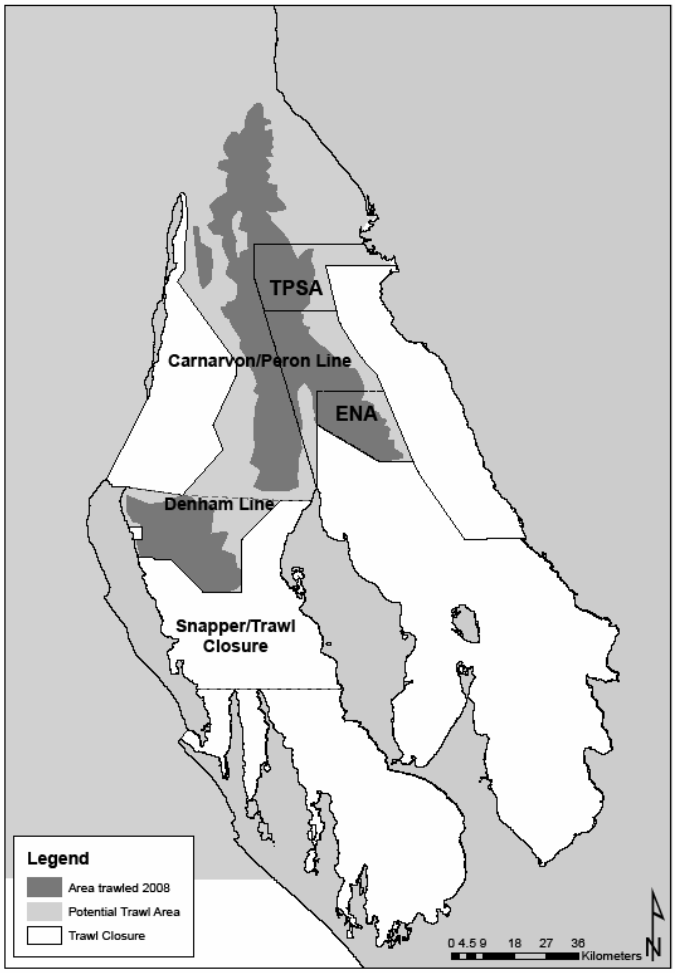
External Factors

High costs of fishing and lower returns due to the current economic climate and competition from aquaculture on small prawns has required focussing management and harvesting practices to reduce fishing costs (i.e. only fish efficient catch periods) and to target larger prawns and to shift the emphasis on domestic markets rather than the export market.

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.

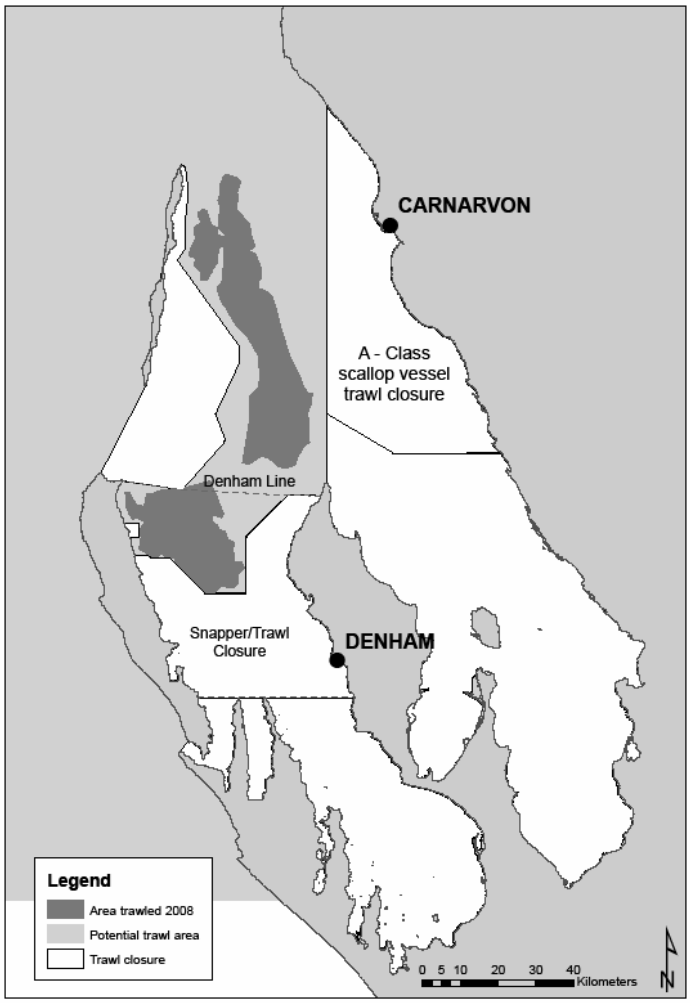
A relationship exists between sea level (at Fremantle) and the recruitment of scallops in Shark Bay, particularly in the Red Cliff area. Generally, high sea levels corresponding to strong Leeuwin Current correlate with poor recruitment. Due to this variability a redirection in effort away from prawn areas can artificially lower prawn catches when scallops are very abundant, due to a shift in effort/targeting.

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.



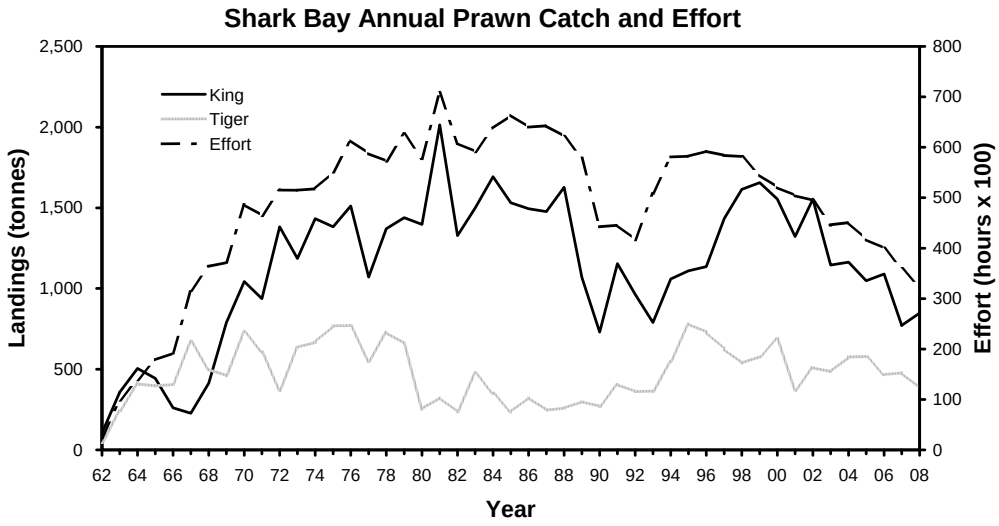
SHARK BAY PRAWN AND SCALLOP FIGURE 1

The main boundaries of the Shark Bay Prawn Fishery, TPSA, ENA, potential trawl (extends out to the 200m isobath) area and area trawled in 2008.



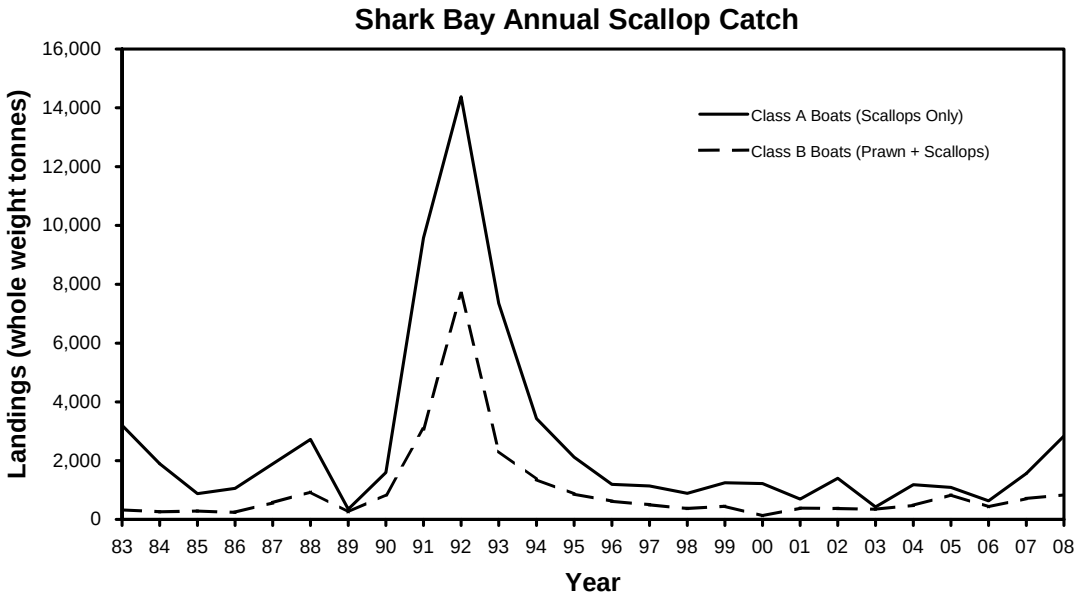
SHARK BAY PRAWN AND SCALLOP FIGURE 2

The main boundaries of the Shark Bay Scallop Fishery, potential trawl (extends out to the 200m isobath) area and area trawled in 2008.



SHARK BAY PRAWN AND SCALLOP FIGURE 3

Shark Bay Prawn Managed Fishery annual landings and effort 1962 – 2008.



SHARK BAY PRAWN AND SCALLOP FIGURE 4

Shark Bay Scallop Managed Fishery annual landings 1983 – 2008.

Exmouth Gulf Prawn Managed Fishery Status Report

E. Sporer, M. Kangas and S. Brown
Management input from R. Gould

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings 1170 t of prawns

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

Meetings between the Department of Fisheries and industry.

Boundaries

The main boundaries such as the areas where trawling is potentially permitted, the Tiger Prawn Spawning Area (TPSA) and nursery areas for 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 2008 season, official opening and closing dates were formally set at 7 April and 8 December respectively, providing a maximum of 208 nights for fishing. While the season commenced on 7 April, based on results from pre-season surveys it closed at 0800 hrs on 25 November resulting in a total of 184 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 (the Department) and industry jointly decide on the timing and extent of areas to be fished or closed, according to size and abundance of prawns. Research staff are onboard the commercial boats to undertake fishery independent recruitment and breeding stock surveys and at times industry undertake within season surveys to determine changes in prawn distribution, abundance and size composition during the season. This enables 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 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 Departments' vessel monitoring system (VMS) continues to monitor the activities of all boats.

The fishery is subject to a standardised net allocation whereby each boat has an equal allocation of net headrope and the boats are authorised to operate with two 7.5 fathom nets (29.27 metres) for a maximum total headrope allocation of 240 fathoms (438.9 metres). However, the gear configuration package (net and board sizes) permitted within this total allocation is under review, with vessels operating 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 total 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 and maintaining overall catch in this fishery whilst ensuring sustainability. All boats are also operating under and exemption from the 375 hull unit rule.

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 (fish escapement device) in each net. Industry, in association with the Department, 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. This certification was reviewed in April 2008 and subsequently approved. Industry also installed 'hopper' in-water sorting systems in 2002, which provide an improved quality of prawns and reduced mortality for some bycatch species.

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 accredited the fishery for a period of five years, allowing product from the fishery to be exported from Australia. The comprehensive Ecologically Sustainable Development assessment of this fishery has also identified potential sustainability risks requiring direct management actions. The issues identified through this process were breeding stock levels of target prawn species, bycatch species impacts, habitat and provisioning effects. Boxed text in this status report provides the annual assessment of performance measures/indicators 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 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 joint evaluation and implementation of gear modifications to reduce bycatch and improve product quality is ongoing.

Retained Species

Commercial production (season 2008): 1170 tonnes

Landings

The total landings of major penaeids for the 2008 season were 1170 t, comprising 279 t of king prawns, 576 t of tiger prawns and 315 t of endeavour prawns. The total landings were 48% greater than the last two seasons.

The tiger prawn and endeavour prawn landings were slightly higher than the normal catch range of 250–550 t and 120-300 t respectively (Exmouth Gulf Prawn Figure 2). King prawn landings were under the target catch range of 350–500 t.

Recorded landings of by-product included 12 t of coral prawns, 25 t of blue swimmer crab (*Portunus pelagicus*), 7.6 t of squid, 3.3 t of bugs (*Thenus orientalis*) and <0.1 t of cuttlefish.

Fishing effort/access level

There are 16 boat licences in this managed fishery, but as a result of changes in gear configuration only 9 boats operated in 2008 towing a total of 206 fathoms of net headrope, similar to last years level of 202 fathoms. In order to improve upon the economic efficiency achieved while maintaining sustainable catch levels in 2008 there were two differing net headrope sizes 5.5 fathom nets (5 boats), and 6 fathom nets (4 boats) for quad gear. Since 2000 the catch rates are adjusted to take into account each boat net size which is then standardised to 6 fathom nets.

Total nominal effort for the 2008 season was 18118 hours. The adjusted effort (as standard twin-gear nets) was 28119 hours, which was slightly higher than the last two years although lower than 2005 (31097 hours). Average adjusted effort in the last three years remains the lowest since 1969. Effort peaked in this fishery during the late 1970's at 52710 hours. Due to a combined reduction of boats, overall net headrope and nights fished a significant decrease in fishing effort has occurred.

Of the 208 nights allocated to fishing, the fleet fished 184 nights during the 2008 season. This is the greatest number of nights fished since 2004 (183) but reflects the high abundance of prawns available in the 2008 season and that fewer boats were fishing.

Stock Assessment

Assessment complete: Yes

Assessment method: Direct survey/catch rate

Breeding stock levels: Adequate

Projected catch next season (2009):

440 – 660 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 of 9.9 kg/hr for king prawns was below the 10-year (1989-1998) reference catch rate level of 11.7 kg/hr. The catch rate of 20.5 kg/hr for tiger prawn is very high compared to the reference point catch rate of 10.0 kg/hr. The endeavour prawn catch rate of 11.2 kg/hr was above the reference point catch rate of 5.6 kg/hr. The high catch rates of tiger and endeavour prawns reflect the high abundance of these species this year because of favourable environmental conditions for these two species and that the prawns were taken efficiently at relatively low effort. Both tiger and endeavour prawns occupy similar inshore structured habitats.

However, the catch trends for these two species do not necessarily follow each other historically because tiger prawns are more valuable and therefore, targeted. There is no concern for the king prawn stock as fishing effort on king prawns was not high because of the high abundance (and targeting) of tiger prawns this season.

There are regular surveys of the tiger and king prawns stocks each year, which permits variations to the management within the season to optimise catch and size grades. For tiger prawns, this process involves analysis of survey-based indices of recruitment and spawning stock and to assess this against the spawning stock–recruitment relationship. For the 2008 season the total landings were slightly above the catch prediction, based on recruitment survey indices, for this season (568 tonnes with a range of 450–680 tonnes). 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 fish grounds. This strategy maintains the spawning biomass of tiger prawns above the historically determined biological reference point. This has been adjusted to the present cut-off threshold catch rate of 25 kg/hr based on 6-fathom nets in quad gear configuration.

During 2008, tiger prawn commercial catch rates were monitored from May to August and the tiger prawn grounds were closed on 1 August. Three standardised tiger prawn breeding stock surveys carried out in the closed area (TPSA) from August to October. The average CPUE in the main spawning area (Q1) was 37.6 kg/hr (6 fathom quad gear). Therefore the stock level was maintained well above the threshold level. The August, September and October surveys showed a CPUE of 39.8 kg/hr, 40.2 kg/hr and 32.8 kg/hr respectively, therefore the TPSA was re-opened for fishing in November.

Catch predictions for tiger prawns in 2009 based on pre-season survey (March and April) is for a similar catch to 2008 of about 550 t (range 440 to 660 tonnes).

The spawning survey sampling sites extends to the central Gulf (Q2 area) and the spawning indices were even higher (mean 58.3 kg/hr) in this region.

King prawn breeding stock levels in the fishery are maintained at adequate levels during normal environmental conditions through controls on fishing effort and the extended breeding period and due to the lower catchability of the species compared to tiger prawns. The variability in the abundance of the king prawn stock has been assessed since 2002 by a pre-season recruitment survey. This additional survey was included to investigate the cause of the run of low catches following Cyclone Vance in 1999. Although there has not yet been sufficient survey data collected for a detailed stock assessment, the return to a normal range catch in 2004 to 2006, without any significant change to fishing practices, indicates that the low recruitment was unlikely to be related to the breeding stock levels. However, lower catches have been observed in the last two years and therefore further years of survey/catch data will be required to both confirm this recovery and assess the spawning stock–recruitment relationship for the king prawn stock.

There is no formal assessment for endeavour prawns, a secondary target species whose distribution overlaps that of tiger prawns, and they are fished to varying levels depending on the abundance of (and hence the fishing effort applied to) the more valuable tiger prawns. The breeding stocks of endeavour prawns are considered to be at adequate levels because their distribution overlaps that of the tiger prawns and the tiger prawn closures also protect a significant portion of the endeavour prawn breeding stock each year. In addition, endeavour prawns are also considered to be more resilient to fishing pressure due to their smaller size and lower catchability, which is similar to king prawns.

Environmental conditions were generally favourable for all species during the 2008 season, i.e. no cyclonic impacts or heavy rainfall during the summer months (December to March).

The main performance measures for the fishery relate to maintenance of breeding stocks for each of the major target prawn species. In 2008 the tiger prawn catch rate levels were well above the threshold level. The breeding stock indicator (catches within specified ranges) for endeavour prawns was met. King prawn catch was below the target range, probably due to greater targeting of tiger prawns. The zero catch recorded for banana prawns corresponded to a low rainfall year when the catch of banana prawns is negligible and individual prawns are not separately recorded and processed.

Non-Retained Species

Bycatch species impact: Low

Bycatch levels for Exmouth Gulf are relatively low by tropical trawl fisheries standards, with few species of significance to other fishing sectors being taken. Secondary bycatch reduction devices are now mandatory in this fishery and will further reduce the volume of overall bycatch species retained in the trawls, while improving the quality of the prawn catch. In addition, all nine boats during 2008 used 'hoppers' (in-water catch sorting systems), which adds another level of improvement for bycatch survival and product quality. Fishing effort (in hours) in 2008 was slightly above the past two years but still low compared to historical levels 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. Nine turtles were reported as being caught in nets and returned to sea alive during 2008.

Ecosystem Effects

Food chain effects: Low

Although the prawn species are managed such that the 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 2008 the performance measure was met as the total area trawled, at approximately 385 square nautical miles (~31%) per cent of Exmouth Gulf, was below the 40% level.

Social Effects

The estimated employment in the fishery for the year 2008 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 2008: $12 million

Ex-vessel prices for prawns vary, depending on the type of product and the market forces operating at any one time. In this fishery there is a high degree of vertical integration, with the fishing companies which own the boats undertaking direct marketing of the product into overseas markets. For this reason, the product prices quoted can only be estimates.

Estimated prices were as follows:

King prawns	$11.00/kg
Tiger prawns	$11.50/kg
Endeavour prawns	$7.00/kg
Coral prawns	$4.50/kg

Fishery Governance

Target catch range: 771 – 1,276 tonnes

Current fishing level: Acceptable

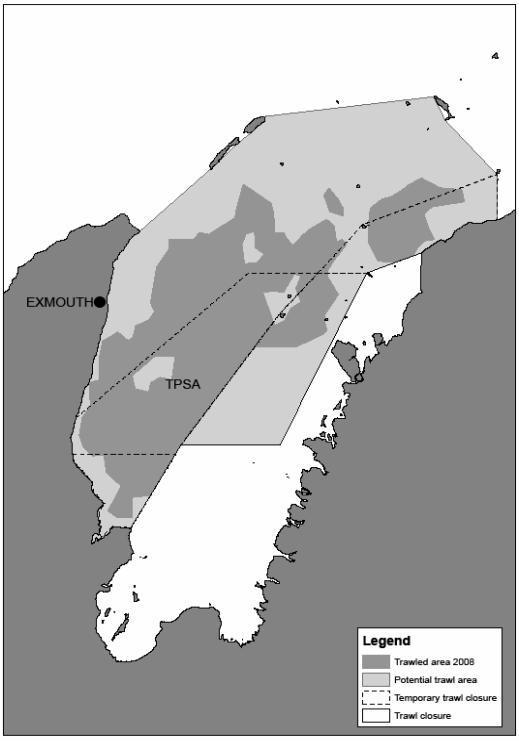
Under current fishing effort levels, the target catch range for major penaeids is 771 – 1276 t. The long-term target catch ranges for individual species are king prawns 350 – 500 t, tiger prawns 250 – 550 t, and endeavour prawns 120 – 300 t (noting that maximum or minimum catches do not occur for all species simultaneously). These overall and individual figures are for normal environmental conditions and generally based on a 10-year average (1989-1998). The target catch ranges for all species were slightly higher for tiger and endeavour prawns but lower for king prawns for the 2008 season.

New management initiatives (2009): Nil

External Factors

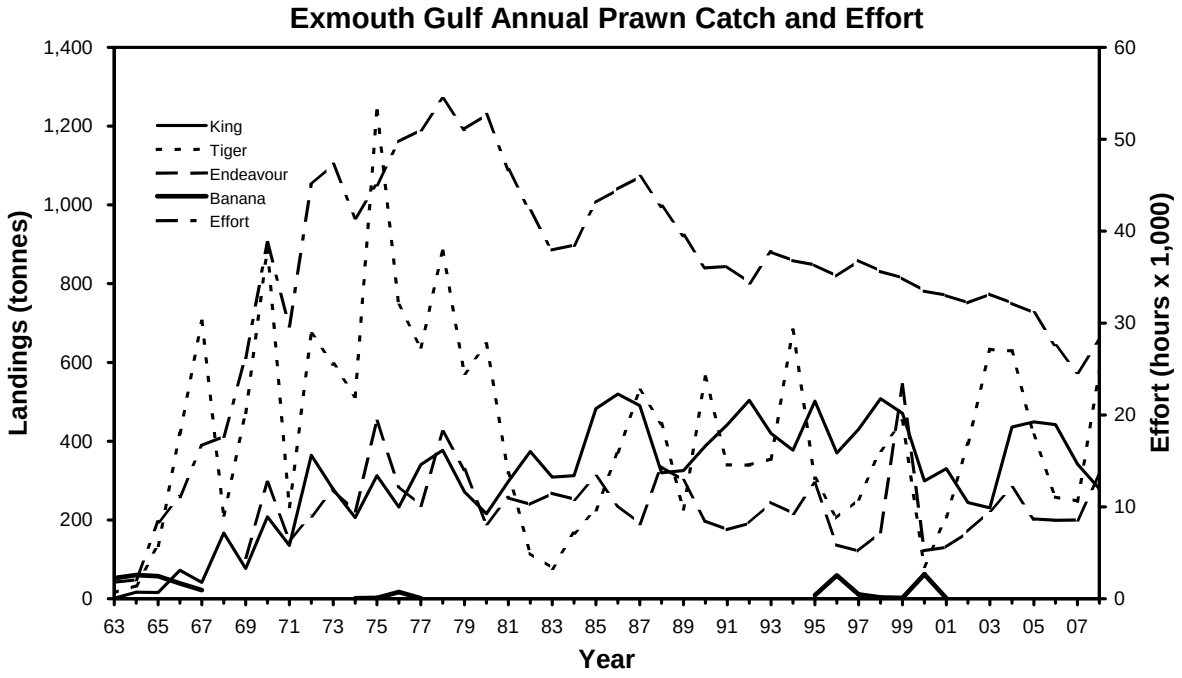
High costs of fishing and lower returns due to the current economic climate and competition from aquaculture on small prawns has required focussing management and harvesting practices to reduce fishing costs (i.e. only fish efficient catch periods) and to target larger prawns and to shift the emphasis on domestic markets rather than the export market.

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

The main boundaries of the Exmouth Gulf Prawn Fishery, TPSA and Q1 and Q2, potential trawl area and area trawled in 2008.



EXMOUTH GULF PRAWN FIGURE 2

Exmouth Gulf Prawn Managed Fishery annual landings and adjusted effort (twin-gear), 1963 – 2008.

Gascoyne Demersal Scalefish Fishery Status Report

G Jackson, R Marriott and E Lai

Management input from M Stadler

Main Features

Status

Stock level	Pink snapper: Recovering
	Goldband snapper: Adequate
	Spangled emperor: Adequate
Fishing Level:	Pink snapper: Acceptable
	Goldband snapper: Acceptable
	Spangled Emperor : Acceptable

Current Landings (2008)

Pink snapper:	Commercial – 255 t
	Recreational – 49 t
	Charter – 22 t
Goldband snapper:	Commercial – 121 t
	Recreational – 14 t
	Charter – 9 t
Spangled emperor:	Commercial – 7 t
	Recreational – 51 t
	Charter – 5 t

Fishery Description

The Gascoyne Demersal Scalefish Fishery encompasses commercial and recreational fishing for demersal scalefish in the continental shelf waters of the Gascoyne Coast Bioregion (Gascoyne Demersal Scalefish Fishery Figure 1). This includes the activities of the Shark Bay Snapper Managed Fishery (SBSF), commercial 'open-access' wetline fishing and recreational fishing from both licensed charter and private vessels.

Commercial fishing 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. Studies have shown that this stock is distinct from those found in inner Shark Bay (see Inner Shark Bay Fishery). The relationship between pink snapper in continental shelf waters off Shark Bay and elsewhere within its geographic range in Western Australia remains to be determined (see External Factors). Pink snapper in the Kalbarri region are currently treated as a separate population and are managed under arrangements within the newly created West Coast Demersal Scalefish Fishery (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) operate in waters outside of the SBSF management zone (see Boundaries) and catch a similar variety of species. 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) also catch this suite of species.

This report focuses on the three Gascoyne demersal indicator species, i.e. pink snapper, goldband snapper and spangled emperor.

Governing legislation/fishing authority

Commercial

Shark Bay Snapper Management Plan 1994

Shark Bay Snapper Managed Fishery Licence

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

Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC - Export Exemption)

Recreational

Fish Resources Management Act 1994, *Fish Resources Management Regulations 1995* and subsidiary legislation

Consultation process

Commercial

Department–industry meetings

Recreational

Recreational Fishing Advisory Committee

Regional Recreational Fishing Advisory Committees
(Denham, Carnarvon, Exmouth)

Boundaries

Commercial

The SBSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°34.'S and 26°30'S (Gascoyne Demersal Scalefish Fishery Figure 1). SBSF vessels are not permitted to fish in most of inner Shark Bay. A limited number of commercial vessels without SBSF-quota are permitted to fish (i) north of 21°56'S, and (ii) between 23°07' and 23°34'S. No state-licensed commercial vessels are permitted to fish between 21°56' and 23°07'S ('Point Maud-Tantabiddi Well' closure). Management arrangements for the West Coast Demersal Scalefish Fishery (WCDSF) permit a limited number of commercial vessels licensed in that fishery to operate in waters up to the southern boundary of the SBSF (26°30'S).

Recreational

The recreational fishery (taken to include activities of 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.

Management arrangements

Commercial

Commercial fishing for pink snapper (oceanic stock) came under formal management for the first time in May 1987. Between then and 2000, pink snapper catches taken during the peak season (May–August) were subject to individual quotas while gear controls applied in the off-peak season (September-April). From 2001, the SBSF 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 ('quota-year'), with a total of 5,125 units in the fishery (value of each unit = 5,125 ÷ total allowable commercial catch [TACC]).

There have been a number of significant reductions in TACC in recent years, in response to scientific advice on stock status: the TACC was reduced from 563,750 kg to 338,250 kg in 2004; the TACC was further reduced to 297,250 kg in April 2007; and most recently, to 276,750kg, in September 2007. An EPBC assessment for the SBSF fishery was completed in 2003 and was re-assessed in early 2009.

'Open-access' commercial wetline fishing in waters between 23°34'S and 23°07'S (Gascoyne Demersal Scalefish Fishery Figure 1) is incorporated within the Gascoyne Demersal Scalefish Fishery Management Plan (see Fisheries Management Paper No. 224 for further details). As previously noted, commercial fishing below 26°30.'S has been managed as part of the WCDSF since January 2008.

Minimum legal sizes apply to many of the commercial target species (emperors, pink snapper, red emperor, cods).

Recreational

The recreational fishery (including charter vessels) is managed using daily bag, possession, trip and size limits coupled with limitations on the use of certain fishing gears.

Research summary

Assessments of this fishery include annual analyses of commercial (daily/trip logbooks since February 2008 for SBSF vessels; monthly for wetline vessels) and charter (daily) catch and effort returns and catch-disposal records (SBSF, pink snapper only, to monitor individual quotas). Commercial catch and effort data reported here covers (i) all commercial line fishing within Gascoyne waters between 114°50'E and 27°S up to December 2007 and (ii) between 114°50'E and 26°30.'S since January 2008, unless stated otherwise.

Commercial catches are reported for the SBSF quota-year - September 1 2007 - August 31 2008 (referred to hereon as the 'season 2008').

Charter catches (reported) are those for period January – December 2007.

Recreational catches (estimated) were derived from the most recent survey of boat-based recreational fishing within the Gascoyne region undertaken between April 2007 and March 2008 (equates to commercial 'season 2007').

Pink snapper: Detailed research on pink snapper (oceanic stock) and the associated SBSF was undertaken throughout the 1980s and early 1990s. Commercial catches are sampled on a monthly basis to provide representative catch-at-age data. An integrated stock assessment model has been used to determine stock status since 2003 and was most recently updated in early 2009. A Western Australian Marine Science Institute (WAMSI) project is currently investigating the relationships between pink snapper populations from Shark Bay to the South Australian border.

Goldband snapper: Comprehensive research on goldband snapper commenced in 2007 as part of a Gascoyne Integrated Fisheries Management (IFM) project. A 'weight of evidence' based assessment has recently been completed and is pending review.

Spangled emperor: Comprehensive research on spangled emperor commenced in March 2007 also as part of the Gascoyne IFM project. A 'weight of evidence' based assessment has recently been completed and is pending review.

Retained Species

Commercial landings (season 2008):

Total 504 tonnes

Pink snapper 255 tonnes

Goldband snapper 121 tonnes

Spangled emperor 7 tonnes

Other species 121 tonnes

The total commercial catch of 504 t in the Gascoyne in 2008 included 255 t of pink snapper (oceanic stock) a decline on the 302 t taken in season 2007. The other main species landed included 121 t of goldband, 7 t of spangled emperor and 121 t of other scalefish species, which are all similar to the amounts taken in 2007.

SBSF licensed vessels fishing within the waters of the SBSF caught 231 t of pink snapper (TACC for 2008 season was 277 t) plus 222 t of other species including 118 t of goldband snapper, 6 t of spangled emperor and 97 t of other scalefish species.

Recreational catch estimate (2007/08):

Pink snapper 71 tonnes

Goldband snapper 23 tonnes

Spangled emperor 56 tonnes

Between April 2007 and March 2008 (season 2007), an estimated 49 t of pink snapper (oceanic stock) was taken by recreational vessels fishing in Gascoyne waters (excluding inner gulfs of Shark Bay). A similar level of catch at least was assumed to have been taken in 2008. The recreational catch of pink snapper (oceanic stock) taken from charter boats in 2008 was 22 t , the same as in 2007.

An estimated 51 t of spangled emperor was taken by recreational vessels fishing in Gascoyne waters in 2007. A similar level of catch at least was assumed to have been taken in 2008. The recreational catch of spangled emperor taken from charter boats in 2008 was 5 t.

An estimated 14 t of goldband snapper was taken by recreational vessels fishing in Gascoyne waters in 2007. A similar level of catch at least was assumed to have been taken in 2008. The recreational catch of goldband snapper taken from charter boats in 2008 was 9 t.

Fishing effort/access level

Commercial

Commercial line fishing between 23°34'S and 26°30'S is now entirely conducted by SBSF licensed vessels. In 2008, these vessels landed 90% of the total commercial catch of the demersal target species within the Gascoyne (includes pink snapper).

At the start of the 2008 season there were 54 licences in the SBSF. A total of 21 vessels actively participated in fishing in 2008 (20 in 2007).

The effectiveness of fishing effort has varied markedly on a seasonal basis, historically peaking in June–July, when pink snapper aggregate to spawn. SBSF catch and effort data are assessed using 'standard boat days' only, i.e. days fished by vessels that caught more than 4 t each of pink snapper by line during the period June–July. A total of 237 standard boat days were expended by SBSF vessels in June and July 2008.

Recreational

The estimated total of 236,851 recreational fisher days were expended in the Gascoyne between April 2007 and March 2008 is similar to the 243,389 fisher days for 1998/99. The 07/08 total comprised 96,199 fishers days by boats launched at public ramps, 45,130 fisher days by boats launched from beaches and 95,522 by shore-based fishers.

In 2008, of the 77 fishing tour and 15 restricted fishing tour/eco-tour operators licensed to operate within the Gascoyne, only 36% of licenses were active.

Stock Assessment

Assessment complete: Pink snapper: Yes

Goldband snapper: Yes

Spangled emperor: Yes

Assessment method:

Pink snapper: Composite Assessment

Goldband snapper: Fishing Mortality

Spangled emperor: Fishing Mortality

Breeding stock levels: Pink snapper: Recovering

Goldband snapper: Adequate

Spangled emperor: Adequate

Pink snapper: Stock assessment modeling using an age-structured model indicated that the spawning biomass of the oceanic pink snapper stock was at a depleted level in 2003. The assessment has been subsequently updated since then and was externally reviewed in July 2006.

The most recent assessment incorporated data from the 2008 season and indicated that the spawning biomass in 2008 was close to the management threshold (30% of the unexploited spawning biomass) level. At current harvest levels, it was estimated that the management target (40%) level would be reached by 2014.

Prior to the development of the assessment model, the breeding stock was assessed using the catch rate obtained during the peak of spawning season (June-July). This indicator was used in the original EPBC assessment for this fishery with a trigger level of 500 kg/std boat day. It was recognized that the use of catch rates as an index of pink snapper abundance must be treated with caution, due to the aggregating behaviour of the species during the winter (spawning) period.

The pink snapper catch per boat day in 2008 for SBSF licensed vessels for the peak months (June–July) was 600 kg snapper/boat day which is above the trigger level (see box below).

The current performance measure for the Shark Bay Managed Snapper Fishery is that the catch rate for the peak months (June–July) should not fall below a minimum trigger level of 500 kg/standard boat day.

Catch rates were observed to decline through the 1990s and early 2000s reaching a low of 450 kg/standard boat day in 2004. Since then, catch rates increased to 583 kg/standard boat day in 2006, decreased to 523 kg/standard boat day in 2007, before substantially increasing again in 2008, to 600 kg/standard boat day, i.e. well above the trigger level of 500 kg/standard boat day.

Spangled emperor: Commercial catch rate data for spangled emperor were found to be uninformative as an index of abundance. A 'weight of evidence' approach, based on an assessment of fishing mortality, has been used in each of two zones in the Gascoyne bioregion using data collected primarily in 2007. Biological assessments have shown spangled emperor to be moderately long-lived (maximum age around 30 years). Individuals commence life as females, then either change sex to male or remain female prior to reaching maturity. The average length at sex change and length at female maturity were both shown to be below the current minimum legal size limit.

The assessments of fishing mortality (F) indicated that in the south Gascoyne region, F was close to the target level. In the north Gascoyne region F was higher, with estimates from different methods ranging from around the threshold level, to just above the limit level. Full results from this work will be published next year.

Goldband snapper: Historical catch rate data from the SBSF were found to be uninformative for using as an index of relative abundance so it was not possible to confidently estimate stock biomass. Catch rate data were not considered useful for this purpose because changing catch rates have likely reflected an increased market demand and concomitant changes in targeted fishing effort for this species. In addition, these historical data were considered too coarse for a reliable analysis; although new data collected from higher resolution and finer spatial scale daily trip logbooks implemented in January 2008 may be more useful for future assessments.

A 'weight of evidence' approach, based on an assessment of fishing mortality (F) was used. Sufficient data from sampling the commercial fishing catches in both the 2006 and 2008 quota years were available for this analysis. Estimates of F for both years were within the target range, indicating that fishing is not currently having an unacceptable impact on the age structure of the population. However, while the breeding stock levels are currently assessed as adequate, due to the limited data available there is high uncertainty in these estimates.

Results from this work will be included in a Fisheries Research Report that will be published next year.

Non-Retained Species

Bycatch species impact — Negligible

The commercial catch consists of a number of species of demersal scalefish all with a medium to high market value; therefore there are few species captured by the fishery that are not retained.

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 bioregion. Food chain effects due to fishing for pink snapper are considered to be low because the quota system restricts SBSF catches to a relatively small percentage of the total biomass. 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 annual recruitment strength.

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 2008 was similar to previous years and reflects the combination of focus on fishing for pink snapper during the peak season and fishing for outer-shelf, deeper waters species throughout the rest of the year.

In 2008, 14 vessels fished for more than 10 days during the peak season (May–August) with average crew of 2-3.

Fishing and associated fish processing is one of the major sources of local employment in Denham and Carnarvon.

Shark Bay and Ningaloo are very popular tourist destinations, especially during the winter months and school holidays. Much of this tourism is recreational-fishing related. While data are currently lacking, research has been recently undertaken to assess levels of recreational fishing activity and human usage in the Ningaloo area as part of the WAMSI Node 3 Project.

Economic Effects

Estimated annual value (commercial fishers)

for year 2008 — $ 3.8 million

The overall value of the commercial component of the Gascoyne Demersal Scalefish Fishery (catch taken by SBSF and 'open-access' wetline vessels combined) was around $ 3.8 million in 2008 with $1.9 million from pink snapper and $1.9 million from all other scalefish species.

While a dollar value is difficult to assign 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 2008)

380-540 days

In 2008, SBSF vessels required 382 boat days to catch 231 t of pink snapper (oceanic stock - TACC for season 2008 was

277 t).

The average catch rate at 600 kg snapper/boat day for the 2008 season was above the EPBC performance measure (500 kg/standard boat day). Daily/trip catch and effort reporting was implemented with the SBSF in early 2008 and the current catch rate based EPBC performance measure for this fishery will be re-assessed when sufficient higher resolution (daily/trip) data are available.

New management initiatives (2008/09)

The stock assessment completed in February 2009 indicated that the spawning biomass of the oceanic pink snapper stock in 2008 had recovered to the 30% threshold level. At a level of annual catch of ~300 t (all sectors combined), it is estimated that the stock will reach the 40% target level by 2014, which is within the agreed 10-year recovery timeframe. Subject to ongoing research, monitoring and consultation, the Department has indicated it would be supportive of retaining the current TACC for a further 3 quota seasons (next assessment in early 2012 ahead of 2012/13 season). Concerns around the sustainability of fishing for the more vulnerable, deeper-water species (e.g. goldband snapper, ruby snapper, pearl perch, various cods) remain, largely due to uncertainty in the stock status of these species and their long-lived, slow growing life histories. As an interim measure, to address a potential shift in effort toward these species, SBSF fishers initiated an effort day cap to control effort in the SBSF until management arrangements being developed for the Gascoyne Demersal Scalefish Fishery are finalised. The interim effort day cap was implemented through a licence condition on 1 January 2009 and restricts operators to a maximum of 30 fishing days in the fishery per 100 units of pink snapper quota held.

A Vessel Monitoring System (VMS) became operational in the SBSF in May 2008. As previously noted, 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 has significantly improved the integrity of management arrangements for both bioregions.

The results of the most recent Gascoyne recreational fishing creel survey (conducted between April 2007 and March 2008) have been used to determine the recreational catches of pink snapper, goldband and spangled emperor, and will be used to as basis for management recommendations, to be developed in conjunction with stakeholders in 2009/10.

Integrated Fisheries Management (IFM) is scheduled for implementation in the Gascoyne in 2010. 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.

A review of how consultation is undertaken between the Department and key stakeholders on issues across all WA managed fisheries is currently being progressed.

External Factors

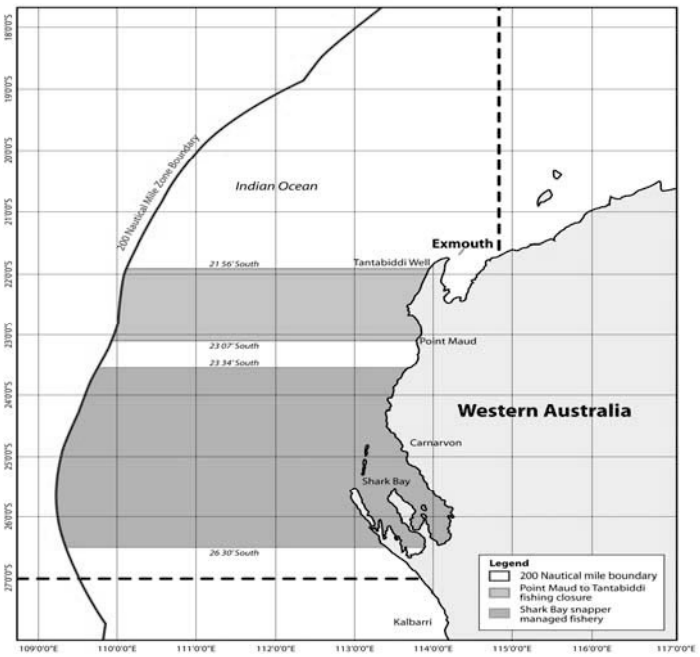
Under the Offshore Constitutional Settlement, commercial trawlers licensed by the Commonwealth may operate in the region outside the 200 m isobath as part of the Western Deepwater Trawl Fishery (WDWTF). Information on catches of pink snapper or other key species taken or undersize fish returned, by WDWT vessels in 2008, is not available.

A re-assessment of the exact location of the 200 m isobath along the WA coast was recently undertaken by GeoScience Australia on the request of WDWTF licensees. Based on results of this re-assessment, AFMA has proposed changes to management of the WDWTF that will see Commonwealth vessels access fishing grounds previously not available to them. Discussions between Department and the Commonwealth to resolve this issue are ongoing.

GASCOYNE DEMERSAL SCALEFISH FISHERY TABLE 1

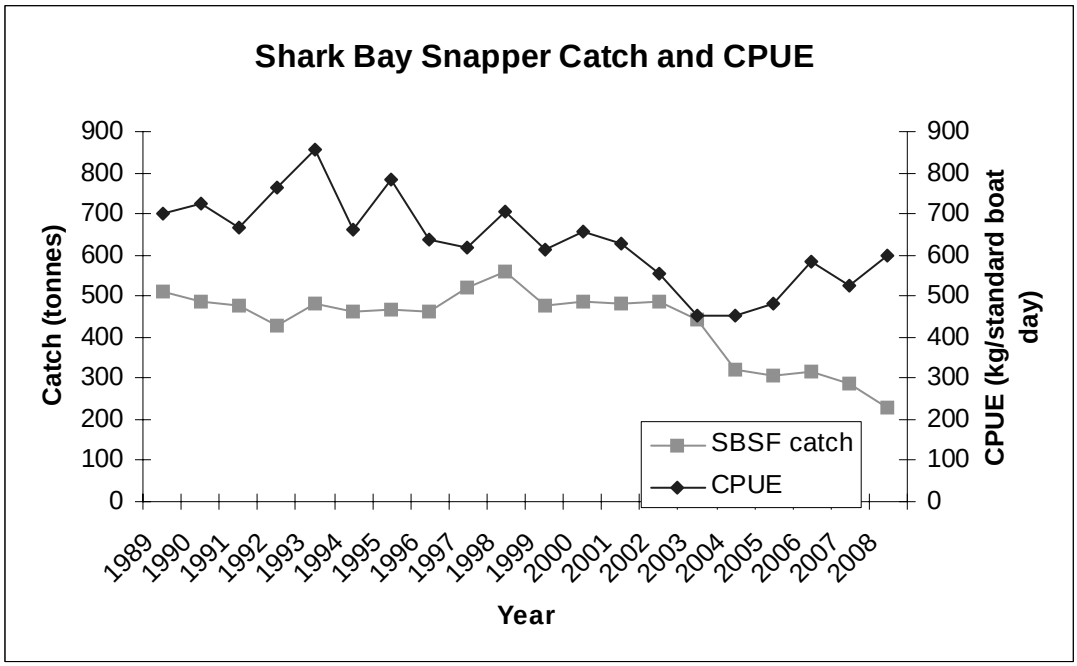
Total commercial catches of demersal scalefish species other than pink snapper taken in Gascoyne waters between 20001/02 and 2007/08 (excludes mackerels, sharks and tunas). Units are tonnes.

Species	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Goldband snapper	41.6	110.0	310.7	250.4	239.8	105.8	107.2	121.1
Spangled emperor	40.3	23.1	20.4	15.2	13.5	18.1	7.0	7.0
other emperors	35.6	25.7	25.8	37.4	31.8	29.2	34.3	26.8
Red emperor	24.4	21.3	18.6	21.3	18.5	19.4	17.0	12.8
Cods	27.2	29.7	38.0	39.2	27.9	21.9	21.5	15.0
Other	89.9	85.9	90.5	95.4	82.0	78.1	77.1	65.8
Total	259.0	295.7	504.0	458.9	413.5	272.5	264.1	248.5



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. Note commerical line fishing in waters between 26 deg 30 S and 27 deg S has been managed as part of West Coast Demersal Scalefish Fishery since January 2008.



GASCOYNE DEMERSAL SCALEFISH FISHERY FIGURE 2

Catch and catch per unit effort by year from 1989 to 2008 for the SBSF. Units are kg whole weight of pink snapper per standard boat day. The CPUE for line fishing by dedicated snapper vessels in June-July (peak season) is incorporated in the stock assessment model used for the oceanic pink snapper stock.

Inner Shark Bay Scalefish Fishery Status Report

G Jackson and J Norriss
Management input from M Stadler

Main Features

Status

Stock level: Whiting: Adequate
Mullet: Adequate
Tailor: Adequate
Yellowfin bream: Adequate
Pink snapper: Eastern Gulf – Adequate
Denham Sound – Adequate
Freycinet Estuary – Recovering

Fishing Level: Whiting: Acceptable
Mullet: Acceptable
Tailor: Acceptable
Yellowfin bream: Acceptable
Pink snapper: Eastern Gulf – Acceptable
Denham Sound – Acceptable
Freycinet Estuary – Acceptable

Current Landings

Commercial (2008) Whiting: 117 t
Mullet: 107 t
Tailor: 23 t
Yellowfin bream: 8 t
Pink Snapper: 2t

Recreational (Pink Snapper only)
Eastern Gulf: 4 t (2007)
Charter: 0.5 t (2008)
Denham Sound: 4 t (2007)
Freycinet: < 2 t (2007)

Fishery Description

The Inner Shark Bay Scalefish Fishery encompasses commercial and recreational fishing for scalefish species within the waters of the Eastern Gulf, Denham Sound and Freycinet Estuary in inner Shark Bay (Inner Shark Bay Fishery Figure 1). This involves the activities of 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)*.

Most recreational fishing is boat-based using rod and line/handline. The key recreational species are black snapper (grass or blue-lined emperor, *Lethrinus laticaudis*), western butterfish *(Pentapodus vitta)*, whiting (*Sillago* spp.), pink snapper *(Pagrus auratus)*, Queensland school mackerel *(Scomberomorus queenslandicus)*, tailor, and blackspot tuskfish (bluebone, *Choerodon schoenleinii*). Recreational fishers also take significant numbers of blue swimmer crabs, mostly in the Eastern Gulf.

A limited number of licensed charter vessels operate out of Denham (mostly fishing in the oceanic waters off Cape Inscription) 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:
Department–industry meetings

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, convenes every 3 years)

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.

Management arrangements

Commercial:
The SBBSMNF is managed through input controls in the form of limited entry and gear restrictions (e.g. vessel size, net length and mesh size). A unit in the fishery comprises one primary vessel, a maximum of three netting dinghies and a maximum fishing team of three individual fishers. Commercial line-fishing for pink snapper and other species has not been permitted in these waters since 1996 (see 'Gascoyne Demersal Scalefish Fishery').

Recreational:
The recreational fishery is managed using the normal combination of daily bag, possession, size and gear limits but with more complex arrangements for pink snapper within the Eastern Gulf, Denham Sound and Freycinet Estuary (Inner Shark Bay Fishery Figure 1). These stocks have been managed separately with explicit total allowable catches (TAC) in place since 2003. In 2008, the TACs were as follows:

Eastern Gulf – 15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)

Denham Sound – 15 tonnes (approx. 12 tonnes recreational, 3 tonnes commercial)

Freycinet Estuary – 5 tonnes (approx. 1,400 fish, i.e. 1,050 recreational and 350 commercial)

Research summary

Comprehensive biological research on pink snapper in the inner gulfs was undertaken between 1996/97 and 2005. Integrated stock assessment models have been used to assess the status of the Eastern Gulf, Denham Sound and Freycinet Estuary stocks separately, and to determine appropriate levels of TAC since 2002. These assessments are now updated every three years, most recently in 2008 (next assessment scheduled for 2011).

Estimates of recreational catch and effort were derived from surveys involving interviews with boat crews returning to the Monkey Mia, Denham, and Nanga boat ramps. Such surveys were conducted each year between 1998 and 2007.

Catches of the key species taken by licensed commercial and charter fishing vessels are derived from compulsory monthly catch returns. The status of the four SBBSMNMF target species (whiting, sea mullet, tailor, yellowfin bream) is monitored each year using data from commercial catch returns coupled with the extensive scientific knowledge gained from research dating back to the 1960s. Performance indicators based on catch and catch rates were determined for these species in 2003 as part of drafting an EPBC Assessment of the SBBSMNMF.

Research on pink snapper in the inner gulfs is now largely restricted to monitoring. At the last meeting of the Shark Bay Inner Gulf Pink Snapper Working Group (Denham, June 2008), the Department committed to undertaking one biological survey in each of the three areas, prior to updating the stock assessments for the next meeting in 2011. A survey of boat-based recreational fishing in inner Shark Bay involving interviews at the three main boat ramps is scheduled for 2010.

Retained Species

Commercial landings (season 2008):

Whiting 117 tonnes

Mullet 107 tonnes

Tailor 23 tonnes

Yellowfin bream 8 tonnes

Pink snapper: 2 tonnes

The total commercial catch taken by SBBSMNF licensed vessels in 2008 was 269 t (238 t in 2007). This comprised 117 t of whiting, 107 t of sea mullet, 23 t of tailor, 8 t of yellowfin bream and 14 t of other mixed scalefish species including 2 t of pink snapper. The catch of black snapper taken by SBBSMNMF vessels in 2008 was <50 kg.

Last available recreational catch estimates (including charter, season 2007)

Pink snapper: Eastern Gulf 4.5 tonnes

Denham Sound 4 tonnes

Freycinet Estuary 2 tonnes

Black snapper: 14 tonnes

As a direct result of management intervention, including the introduction of TAC-based management in 2003, recreational catches of pink snapper decreased significantly after 1998. While no recreational fishing survey was conducted in 2008, recreational catches of pink snapper in the Eastern Gulf, Denham Sound and Freycinet Estuary are assumed to be similar to 2007.

In 2008, around 500 kg of pink snapper was taken in the Eastern Gulf by licensed charter vessels with no recorded catch from Denham Sound or Freycinet Estuary. No catches of black snapper were reported by charter vessels in 2008.

Fishing effort/access level

Commercial
In 2008, of the 10 SBBSMNF licenses, seven vessels were actively involved in fishing. Fishing effort increased by 18% in 2008 (1,200 boat days) compared with 2007 (1,013 boat days) bringing it close to the average for the period 1990-2007 (1,216 boat days).

Recreational

In 2007, boat-based recreational fishing effort was estimated at approximately 33,000 fisher days.

Stock Assessment

Assessment complete: Whiting: Yes
Mullet: Yes
Tailor: Yes
Yellowfin bream:Yes
Pink snapper: Yes (2007)
Black snapper: Yes (2007)

Assessment method:
Whiting/Mullet/Tailor/YF Bream: Catch, Catch Rate
Pink snapper: Composite Assessment
Black snapper: Fishing Mortality

Breeding stock levels Whiting: Adequate
Mullet: Adequate
Tailor: Adequate
Yellowfin bream: Adequate
Pink snapper: Eastern Gulf – Adequate
Denham Sound - Adequate
Freycinet - Recovering
Black snapper: Adequate

Whiting, Mullet, Tailor, Yellowfin bream

Assessment of the four main SBBSMNF target species is based primarily on analysis of the commercial catch and effort data. A target range of annual catch and a CPUE trigger level have been determined for the fishery overall and for each species separately (Inner Shark Bay Fishery Table 1).

The 2008 total catch (all species) at 269 tonnes was within the target range of 235–335 tonnes. The overall CPUE at 224 kg/boat day (all species) was lower than in 2007 (235 kg/boat day) and lower than the average since 1990 (230 kg/boat day).

The 2008 whiting catch at 117 tonnes was well within the target range (93-127 tonnes) and the CPUE at 98 kg/boat day was above the minimum trigger level (75 kg/boat day).

The 2008 mullet catch at 107 tonnes was well within the target range (77-144 tonnes) and the CPUE at 89 kg/boat day was above the minimum trigger level (62 kg/boat day).

The 2008 tailor catch at 23 tonnes was just below the target range (25-40 t) for a fifth consecutive year and the CPUE at 19 kg/boat day, just below the minimum trigger level of (20 kg/boat day). While some reduction in natural abundance cannot be discounted, low tailor catches in recent years can mostly be attributed to processing restrictions imposed by the locals processor.

The 2008 yellowfin bream catch at 8 tonnes was just within the target range (7-15 t), and the CPUE of 6 kg/boat day was just above the minimum trigger (5 kg/boat day). Catches and catch rates of yellowfin bream have returned to similar levels observed in the early 2000s since a pulse of strong recruitment from the 1999 year class has passed through the fishery.

Pink snapper

Daily egg production method surveys that directly estimate pink snapper spawning biomass in the Eastern Gulf, Denham Sound and Freycinet Estuary have been conducted periodically since 1997. Research trawl surveys, to provide information on juvenile recruitment have been conducted each year since 1996. Since 2002, integrated stock assessment models have been used to assess the status of the three stocks in relation to the management target (40% of the unexploited spawning biomass). These assessments are now updated every three years.

The most recent assessments included data up to 2007. These estimated the spawning biomass of pink snapper to be above the target (40%) level in both the Eastern Gulf and Denham Sound. By contrast, the spawning biomass in the Freycinet Estuary was estimated to still be below the threshold (30%) level, however it is rebuilding and is projected to reach the target (40%) level by 2012.

Black snapper

Based on age-structure data collected in 2005, fishing mortality was estimated to around the threshold level (fishing mortality=natural mortality).

Non-Retained Species

Bycatch species impact Low

Bycatch is minimal in the SBBSMNF because netting operations are used selectively to targets 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 deploying the net. Fish are readily observed in the very shallow near-shore waters of Shark Bay. 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 are caught (rare) they are immediately released.

Ecosystem Effects

Food chain effects Low

The overall catch levels in the fishery have been relatively stable over several decades, despite a long-term reduction in effort, suggesting that recruitment of the main target species has not been significantly affected by fishing mortality. The total biomass of the key target species appears sufficient to maintain trophic function in these waters.

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 indicates that the fishery would have no lasting effect on the habitat.

Social Effects

Currently around 20 fishers are employed in the SBBSMNF based on 7 managed fishery licenses actually operating. Fishing and associated fish processing is one of the major sources of local employment - the 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: data indicate that approximately 30% of all visitors participate in recreational fishing during their stay.

Economic Effects

Estimated annual value (to commercial fishers) for year 2008 $1.02 million

Commercial:
The overall value of the SBBSMNMF in 2008 was estimated at $1.02 million and includes catch values of $644,000 for whiting, $246,000 for sea mullet, $34,000 for yellowfin bream and $51,000 for tailor.

Recreational:
While an actual dollar value cannot be assigned to the recreational catch, the availability of quality fishing 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 the SBBSMNMF catch overall is 235–335 t. Acceptable catch ranges for the four main target species (Inner Shark Bay Fishery Table 1) were developed (based on catch data from 1990-2003) to allow annual catch levels to fluctuate in response to natural variations in stock abundance. At this time, this fishery is considered a low risk and therefore a low priority.

Catches of pink snapper taken by recreational boats and SBBSMNMF vessels in 2008 were assumed to be within current levels of TAC in each area.

Current fishing (or effort) level Acceptable

Commercial: Total fishing effort in SBBSMNMF in 2008 had increased by 18% from 2007 levels.

New management initiatives (2008/09)

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 statewide minimum legal length for yellowfin bream (originally increased from 250 mm to 350 mm on 1 January 2006 following a DFWA 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) in the Gascoyne is scheduled for 2010 and will include consideration of the inner Shark Bay Fishery.

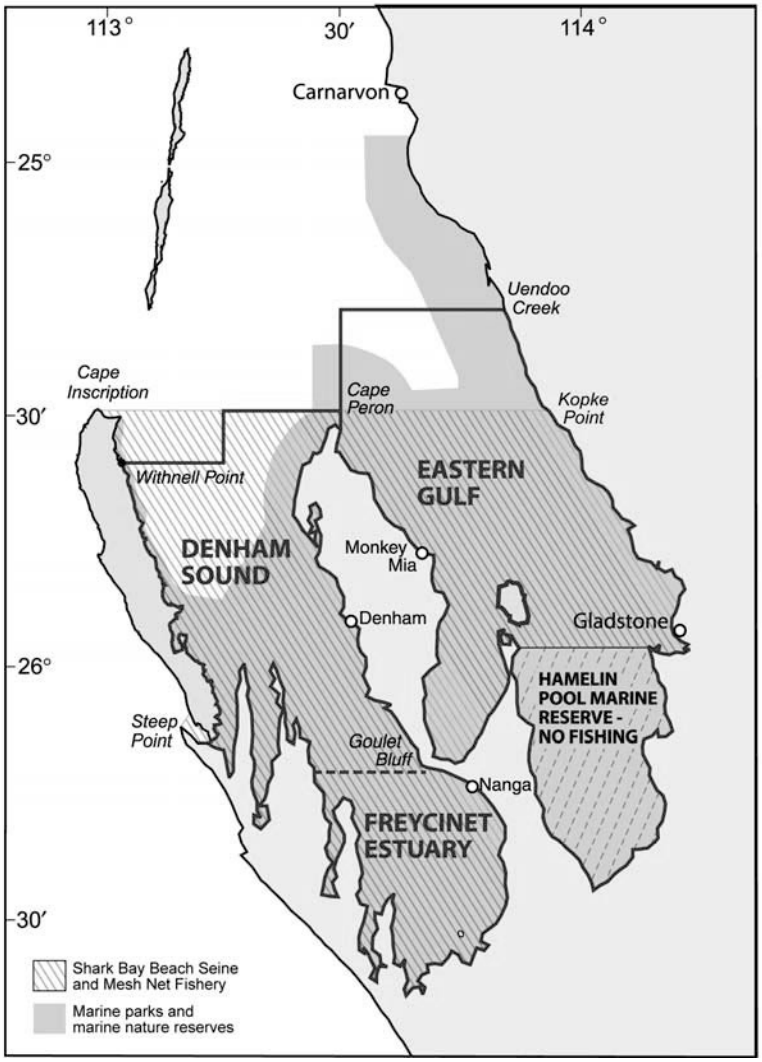
External Factors

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 TABLE 1

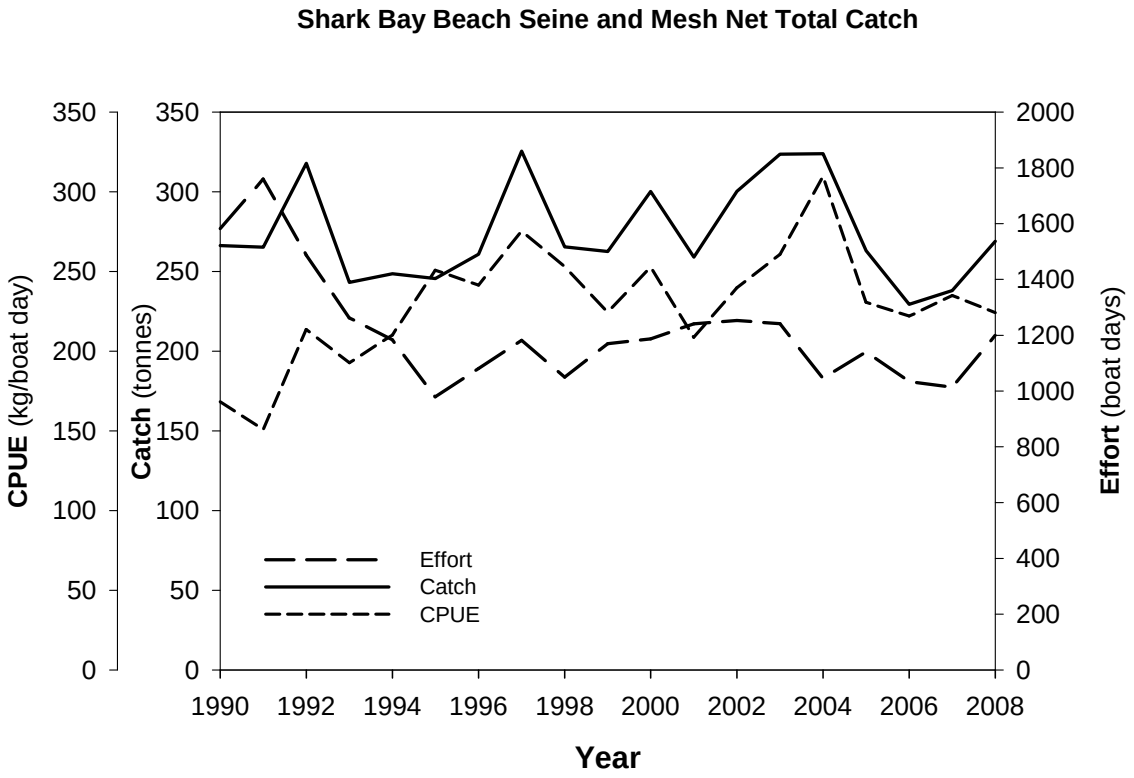
Annual catch per unit effort (kg/boat day) and minimum CPUE trigger levels for key species taken by Shark Bay Beach Seine and Mesh Net Managed Fishery vessels for the period 2001-2008.

Species	Trigger Level	2001	2002	2003	2004	2005	2006	2007	2008
Whiting	75	92	79	86	114	102	110	101	117
Mullet	62	93	80	120	137	74	60	91	107
Tailor	20	21	21	22	23	17	20	23	23
Bream	5	6.2	13	19	26	23	22	14	8



INNER SHARK BAY SCALEFISH FISHERY FIGURE 1

The commercial (scalefish) and recreational 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 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 1990–2008.

Gascoyne and Pilbara Coast Blue Swimmer Crab Fishery Status Report

D. Johnston and D. Harris
Management input from M. Stadler and N. Moore

Main Features

Status

Stock level
- Shark Bay – Under review
- Pilbara – Acceptable

Fishing Level
- Shark Bay - Under review
- Pilbara - Acceptable

Current Landings

Commercial catch – 770 t
- Shark Bay Crab Fishery – 514 t
- Shark Bay trawl fleet – 223 t
- Pilbara – 14 t
- Catch by other commercial fisheries – 19 t

Recreational catch – Minimal

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 and estuaries between Geographe Bay in the south west 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 crab fishery in WA, with an annual catch of about 650 t. It is a limited-entry fishery with a total of 5 licences authorising fishing in the waters of Shark Bay.

The Exmouth Gulf Developing Crab Fishery was established in October 2003 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7(3)(c) of the *Fish Resources Management Act*. A further exemption was issued under the process in June 2004. The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing blue swimmer crab stocks in the waters of Exmouth Gulf. As at 30 June 2008, two fishers held valid exemptions to operate in the fishery, one permitting the use of 200 traps, the other permitting the use of 300 traps.

The Pilbara Developing Crab Fishery was established in 2001 via the Developing New Fisheries process, following the granting of an exemption from existing trap prohibition legislation, pursuant to section 7(3)(c) of the *Fish Resources Management Act*. The exemptions were issued to allow for the sustainable exploration of the commercial viability of fishing crab stocks along the Pilbara coastline. Two operators currently hold exemptions to fish in the fishery, one using up to a maximum of 200 traps, the other using up to a maximum of 400 traps.

Blue swimmer crabs are targeted using a variety of fishing gear but most commercial crab fishers in WA now use purpose-designed crab traps. Operators in the Shark Bay Crab (Interim) Managed, Exmouth Gulf Developing Crab and Pilbara Developing Crab Fisheries are only permitted to use 'hourglass' traps. The State's prawn and scallop trawl fisheries that operate in this region 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

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* (Wildlife Trade Order – Shark Bay fishery only)

Note The Pilbara fishery has a three year WTO as well expiring November 2008

Consultation process

Meetings between the Department of Fisheries and industry

Meetings with Regional Recreational Fishing Advisory Committees

Boundaries

The Shark Bay Crab Interim Managed Fishery covers the waters of Shark Bay north of Cape Inscription , to Bernier and Dorre Islands and Quobba Point (Gascoyne Coast Blue Swimmer Crab Figure 1). In addition, one Shark Bay Beach Seine and Mesh Net Managed Fishery Licensee and one Cockburn Sound crab fisher with a long-standing history of

targeting crabs in Shark Bay are permitted to use 200 traps (of their 300-trap Shark Bay Crab [Interim] Managed Fishery endorsement) in the waters of Shark Bay south of Cape Inscription.

One of the exemptions that authorises fishing for crabs in the Exmouth Gulf Developing Crab Fishery permits the use 200 crab traps in Exmouth Gulf south of a line drawn between the northern most point of North West Cape and Locker Point, except within specific closed areas. The other exemption permits fishing using 300 crab traps within waters east of a line drawn due north from Point Murat (21° 48.90' south latitude and 114° 11.46' east longitude) and west of 115° 06.5' east longitude (Onslow), except within specific closed areas. The Exmouth Gulf Developing Crab Fishery abuts the western boundary of the Pilbara Developing Crab Fishery.

Crabbing activity along the Pilbara coast is centred 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. Of the two dedicated commercial crab fishers authorised to operate In the Pilbara Developing Crab Fishery, one may operate up to a maximum of 400 traps between longitudes 115o06.5' E and 120□ E (waters between Onslow to just east of Cape Keraudren), from the high water mark to the 200 m isobath. This fisher Is permitted to fish In Nickol Bay but is excluded from specified waters around Onslow, Dampier Archipelago, Karratha, Point Sampson and Port Hedland. The other fisher is authorised to use a maximum of 200 traps between longitudes 115o E and 120□ E (just west of Onslow to just east of Cape Keraudren), from the high water mark to the 200 m isobath. This fisher Is not permitted to fish In Nickol Bay or specified waters around Onslow, Dampier Archipelago, Karratha, Point Sampson and Port Hedland.

The boundaries of the Shark Bay Prawn, Shark Bay Scallop, Exmouth Gulf Prawn, Onslow Prawn and Nickol Bay Prawn Managed Fisheries which also capture crabs as by-product are described in the relevant status report elsewhere within this document.

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. In Shark Bay, the Shark Bay Crab Fishery (Interim) Management Plan 2005 sets the number of traps that can be fished, fishery specific spatial closures, gear specifications and other controls. Two permit holders also have a Fishing Boat Licence (FBL) condition that allows them to fish no more than 200 traps south of Cape Peron (south of the existing waters of the SBCIMF). The FBL condition reflects a long-standing history of these two operators fishing in this area. However, at no time may more than 300 traps in total be used by each of these operators across all of the waters of Shark Bay. .

The management arrangements for the Exmouth Gulf and Pilbara Developing Crab Fisheries are set by conditions on the exemptions and are aimed at ensuring the stock and environment are protected. The management measures Include gear restrictions, a minimum size limit, spatial closures and reporting requirements. While up to a maximum of 600 pots are permitted to be used In the fishery, only 400 traps may be used In Nickol Bay.

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 trawlers in these fleets.

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 commercial minimum size of 135 mm carapace width should ensure adequate egg production for associated blue swimmer crab stocks under typical environmental conditions.

A second comprehensive Ecologically Sustainable Development assessment of the Shark Bay fishery was completed in 2007. The Commonwealth Department of the Environment, Water, Heritage and the Arts approved the fishery to export product for a further three years, subject to several conditions and recommendations - for details refer to http://www.environment.gov.au/coasts/fisheries/wa/shark-bay/index.html.

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 and North Coast bioregions 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.

A significant amount of information on the biology and ecology of blue swimmer crabs has been generated by a number of Fisheries Research and Development Corporation (FRDC)-funded projects conducted by the Department of Fisheries and Murdoch University over the past decade. An FRDC project completed in early 2005 produced a preliminary stock assessment of the Shark Bay blue swimmer crab fishery. An update of this stock assessment for the Shark Bay Crab (Interim) Managed Fishery is due by the end of 2010.

Retained Species

Commercial landings (season 2007/08): 770 tonnes

The total combined catch for the Gascoyne and North Coast bioregions during 2007/08 was 770 t, which accounted for 85% of the state catch of blue swimmer crabs.

The annual blue swimmer crab catch from the Shark Bay crab fishery for the 2007/08 fishing season was 514 t, down 12% on the 2006/07 catch of 581 t (Gascoyne Coast Blue Swimmer Crab Figure 2, 3).

Landings from the Shark Bay trawl fleet increased during the same period by 60%, up from 140 t in 2006/07 to 223 t for 2007/08. This follows a 40% increase recorded 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. The significant increase in catch for 2007/08 was largely due to a one-off catch of 85-90 t that was taken from the Denham Sound area of the trawl fishery late in 2007.

A total of 18 t of blue swimmer crabs was landed in the Exmouth Gulf region during 2007/08 by the two fishers in the crab fishery and the trawl fleet. This was down 14% on the previous year's catch of 21 t (Gascoyne Coast Blue Swimmer Crab Figure 2).

The combined commercial catch of blue swimmer crabs from dedicated crab fishers and prawn trawlers operating along the Pilbara coast during 2007/08 was 14 t – the lowest catch since 2000/01 (Gascoyne Blue Swimmer Crab Figure 4).

Recreational catch:

Gascoyne Bioregion - approximately 1% of total catch

Pilbara coast - approximately 25% of total catch

A recreational survey monitoring 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 recreational catch was taken in inner Shark Bay. A subsequent recreational fishing creel survey was conducted in the Gascoyne region between March 2007 and March 2008. The analysis of data collected during this survey is expected to be available for the next State of the Fisheries Report.

Information on recreational blue swimmer catches in the inner gulfs of Shark Bay has also been extracted from recreational surveys targeting pink snapper. Data collected also indicated that the recreational crab catch was minimal compared with the take by commercial fishers operating in the gulfs. The surveys provided estimates of 0.7 t, 1.7 t and 1.3 t of blue swimmer crabs taken by recreational fishers in the gulfs for the 2005, 2006 and 2007 calendar years, respectively.

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

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 and the abundance has been consistent, it would provide for about 60% of the total catch based on current commercial catches.

Fishing effort/access level

Effort in the Shark Bay crab fishery remained constant during 2007/08, as operators continued to maximize profitability by capitalizing on peak catch periods. The 4 dedicated Shark Bay crab trap fishers reported 324,401 pot lifts (Gascoyne Coast Blue Swimmer Crab Figure 3) – similar to the 328,500 pot lifts reported for the previous year.

The two exemption holders in the Exmouth Gulf crab fishery undertook little fishing during 2007/08. The fishers reported a total of just 23 fishing days, a significant decrease in effort from the 111 days fished in 2006/07.

The significant decrease in catch along the Pilbara coast was mirrored by a similar decrease in effort. Commercial crab fishers operated on just 52 fishing days during 2007/08, compared to 192 days during the previous year.

Stock Assessment

Assessment complete:	Shark Bay:	Under review
	Pilbara:	Yes
Assessment method:		Catch rate
Breeding stock levels:	Shark Bay:	Under review
	Pilbara:	Acceptable

Length-frequency data gathered from ongoing monitoring programs in the Shark Bay crab fishery and the Pilbara crab 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 also 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 dedicated 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 2). This increase was achieved with only a 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 and distribution increased over time and

improvements were made to fishing gear and vessels.

Catch and effort have since stabilised, with the mean annual CPUE since 2000/01 ranging between 1.4 and 1.8 kg/trap lift. During 2007/08 the catch rate was 1.59 kg/traps lift (Gascoyne Coast Blue Swimmer Crab Figure 3) which represents a 10% reduction on the 2006/07 catch rate of 1.76 kg/trap lift, which was the highest catch rate on record. The status of crabs in the Shark Bay region will be fully reviewed as part of the review of the interim management plan. This review is scheduled to occur in 2010.

The trap based fishery for blue swimmer crabs in Exmouth Gulf had a relatively low catch rate of 0.49 kg/trap lift for the 2007/08 season. This catch rate is comparable with a mean 0.54 kg/trap lift reported the previous year. Fishers were again more intent on surveying large tracts of potential fishery rather than consolidating catches by returning to areas of higher catch. This exploration reinforced 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.

Trap catch rates in the Pilbara Developing 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.

The Pilbara Developing Crab Fishery recorded a mean catch rate for 2007/08 of 0.9 kg/trap lift – down from 1.2 kg/trap lift the previous year. This decrease was primarily due to some effort being used for exploratory fishing during the year.

The minimum legal size at first capture (127mm carapace width for recreational fishers; 135mm carapace width for commercial fishers based on industry agreement) 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 breeding stocks in the Gascoyne Coast bioregion and along the Pilbara coast are also supported by the influence of the warmer waters that occur at these latitudes which extends the spawning period over several more months of the year than on the lower west coast, where spawning is restricted to the late spring and early summer months.

The performance measure for the export of crabs from the Shark Bay fishery requires that the breeding stocks 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 2007/08 was 1.59 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.

1. Within two years, DFWA to review and update performance measures, indicators, management responses and information requirements for blue swimmer crab in the fishery. As part of this review, DFWA to develop a total acceptable catch range for blue swimmer crab as a performance measure.

2. Within two years, DFWA to develop performance measures, based on the best available information, for coral (Charybdis feriata) and three-spot sand crab (Portunus sanguinolentus).

3. DFWA to monitor performance measures and indicators for the SBCIMF. Within 3 months of becoming aware that a performance measure has not been met, DFWA to develop potential management responses and timeframes for implementation.

4. In its review of the management arrangements of the fishery, DFWA to take into consideration the findings of the FRDC project (2001/068) and any other relevant research.

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 2007/08, approximately 15 people were employed as skippers and crew on vessels fishing for blue swimmer crabs in the Gascoyne Coast bioregion and a further 4 people along the Pilbara coast. Additional employment for some 25-30 workers has been created in Carnarvon and Point Samson through the development of post-harvest processing of the crab catch.

Economic Effects

Estimated annual value (to fishers) for year 2007/08 — $3.9 million

Blue swimmer crab landings from the Gascoyne Coast bioregion during 2007/08 were worth $3.8 million – a slight increase on the $3.4 million generated during 2006/07. This marginal increase was largely due to the increase in numbers of blue swimmer crabs retained by the Shark Bay trawl fleet. The catch from the Pilbara region was valued at approximately $69,000.

A general increase was reported In the beach prices returned for blue swimmer crabs from the major trap fisheries throughout the 2007/08 financial year. Prices ranged anywhere from $4/kg to $15/kg live weight, with the average price in the Gascoyne fisheries for the year around $5.50/kg. Crabs landed by trawlers generally attract a slightly lower beach price than those landed from traps.

While the majority of the product was sold through local and inter-state markets, several Shark Bay fishers have been developing markets in south-east Asia and while focusing on the value-adding of product for the domestic market crab catch from the Pilbara region was sold through local and interstate markets.

Fishery Governance

Target catch (or effort) range:Gascoyne:Under review

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

Current fishing (or effort) level: — Not available

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.

The Pilbara Developing Crab Trap Fishery has undergone a steady expansion since exploration of the commercial viability of fishing blue swimmer crab stocks between Onslow and 120o E commenced in 2001.

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 very hot weather experienced during the summer months, which restricts fishing effort to the cooler months between May and November.

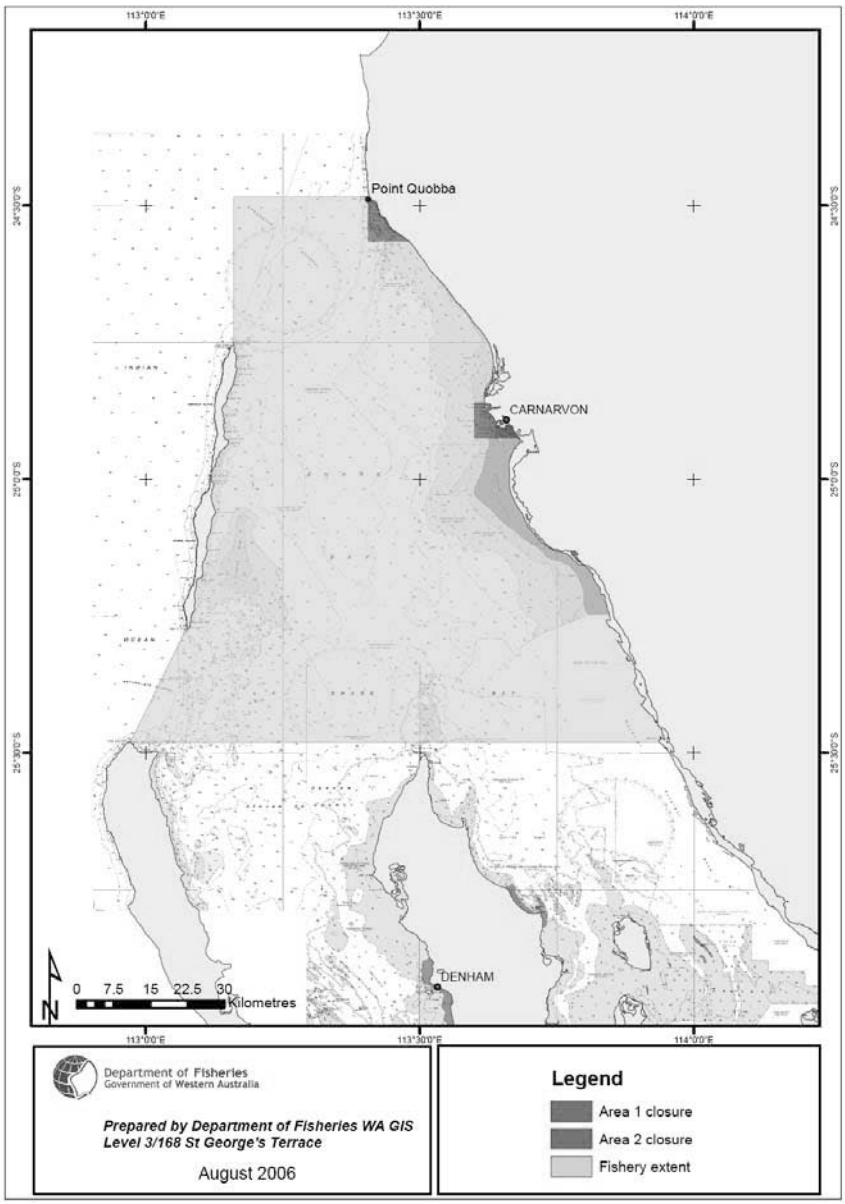
New management initiatives (2008/09)

The Shark Bay Crab Interim Management Plan ceases on 31 August 2010 and a review of the fishery will be required in 2010 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.

Both the Exmouth Gulf and Pilbara Developing Crab Fisheries were formally reviewed in mid-2007 by the Developing Fisheries Assessment Committee (DFAC) as part of the 'Developing New Fisheries' process. The Department of Fisheries is considering the recommendations of the DFAC and intends to make clear recommendations in 2009/10 regarding the future viability of a fishery in these regions.

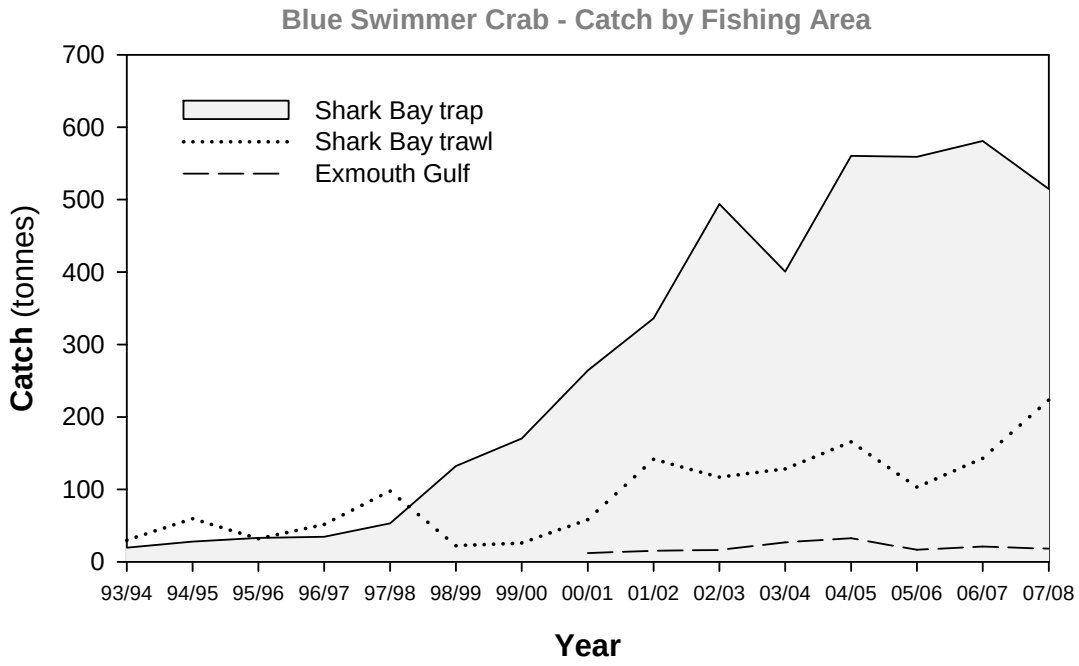
External Factors

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.



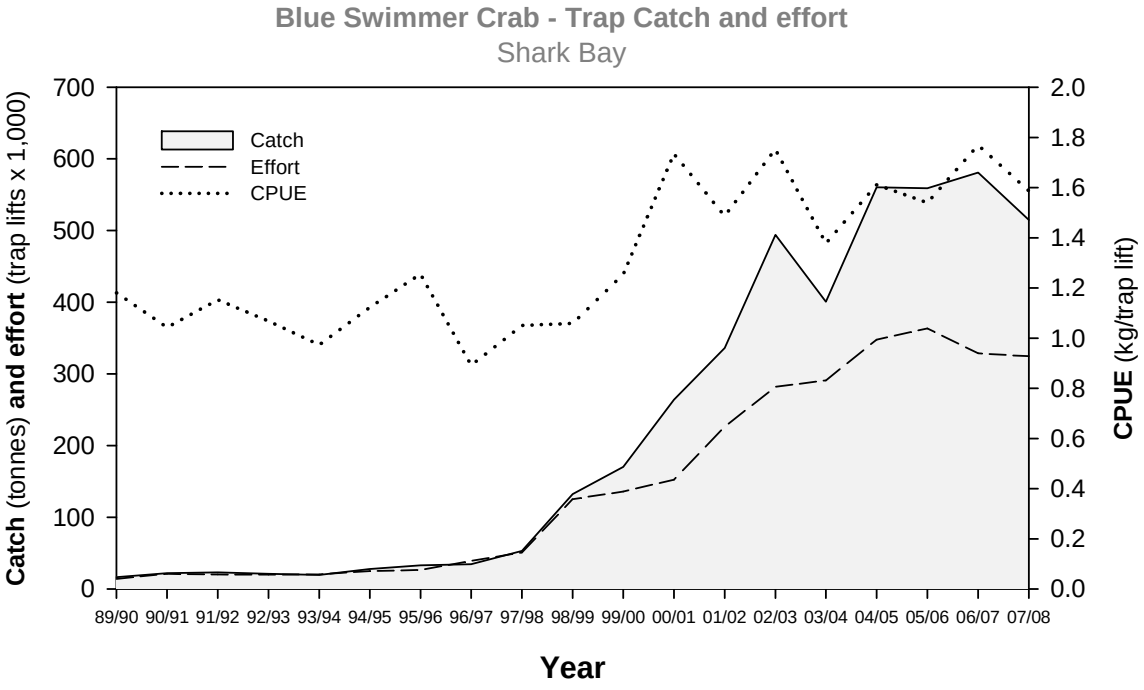
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 1

Extent of the Shark Bay Crab (Interim) Managed Fishery.



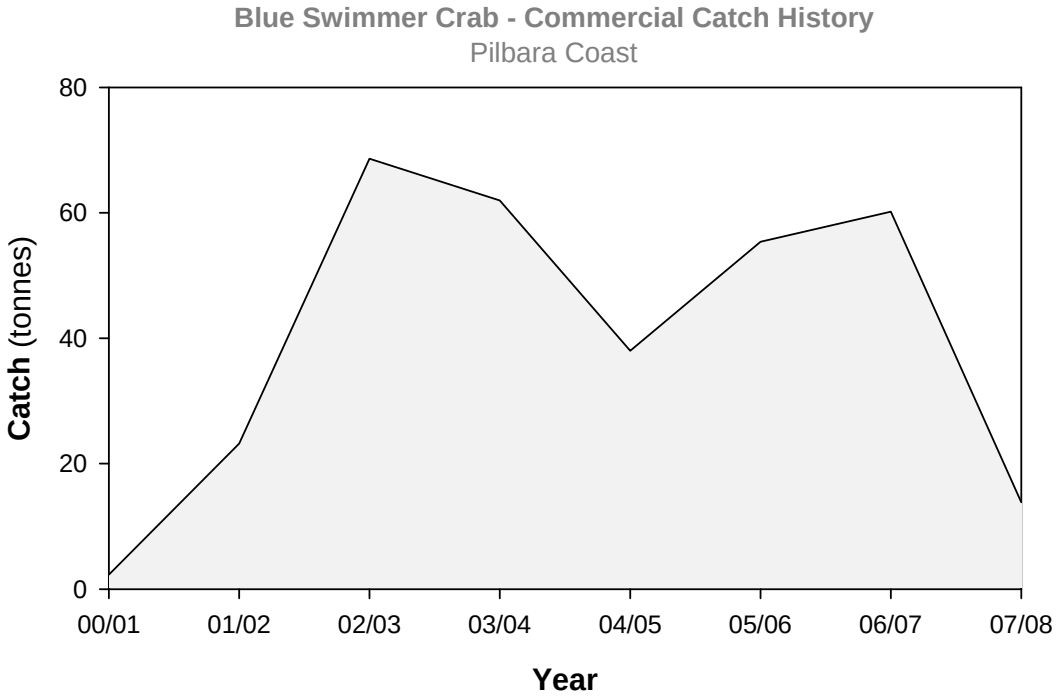
GASCOYNE COAST BLUE SWIMMER CRAB FIGURE 2

Commercial catch history for the blue swimmer crab (Portunus pelagicus) fisheries in the Gascoyne Coast bioregion of Western Australia between 1989/90 and 2007/08.



GASCOYNE 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 Shark Bay from 1989/90 using traps.



GAXCOYNE BLUE SWIMMER CRAB FIGURE 4

Commercial catch history for the blue swimmer crab (Portunus pelagicus) in the North Coast bioregion between 2000/01 and 2007/08.

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, tropical rock lobsters and marine finfish (see Appendix 4).

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 in 2009.

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. This work is ongoing into 2009.

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 2007/08 the three district offices supported a total of nine FMO positions allocated to deliver services to several client groups including commercial and recreational fisheries, marine reserves, pearling and aquaculture operations and fish habitat protection areas. The region covers approximately 2700 kilometers of the Western Australian (WA) coastline, some 13% of the WA coast. The various coastal landscapes represent some of the most remote, isolated, pristine and dangerous marine and terrestrial environments in the state.

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 continued to promote and support the Recreational Skippers Ticket and transfer to the new EPIRB units.

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), FMO's 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 supported by a risk assessment process and associated operational planning framework. Throughout the bioregion they 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-meter patrol vessel *Gnulli* and a 7.3-meter rigid inflatable boat to conduct at-sea inspections in Exmouth Gulf and within the Ningaloo Marine Reserve and Marine Park. In both Districts FMOs spend in excess of 50 days a year at sea on patrol duties. Large patrol vessels (greater than 20 m 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 2007/08. FMOs also conduct aerial surveillance, dive inspections, at-sea and on-land catch, licence, gear and marine safety inspections, and attended community events as well as school education programs.

The management of the Shark Bay Snapper Managed 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 CDR's. Recreational snapper tags in the Freycinet Estuary area continues to be another method for managing the 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 the officers of the Denham District in particular.

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 the *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 and management 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 other fisheries such as the snapper and mackerel fisheries will ensure that a higher and more effective rate of compliance is achieved.

Activities during 2007/08

During 2007/08 FMOs delivered a total of 5380 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 increase 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 2007/08. This was due to staff shortages for periods of time during the year. The ongoing effects of a stable work group have resulted in a better working relationship between fishers and FMOs, especially commercial fishers, however previous efforts might have been diminished because of the ongoing issue of staff shortages. Commercial and recreational fishers alike continue to provide positive 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 agency and continues to provide the most effective and efficient method for a planned and measurable approach to compliance delivery. The OCP deliver agreed outcomes and provided a more accountable and realistic process for budget creation and the actual services that are to be delivered.

OCP are operating in the Exmouth Gulf Prawn Fishery, Shark Bay Prawn Fishery, Shark Bay Scallop Fishery, Shark Bay Crab Interim Managed Fishery, Shark Bay Snapper Managed Fishery, Gascoyne Aquaculture and Pearling Fishery and for the management of the Ningaloo Marine Reserve, Shark Bay Marine Reserve and Commonwealth Ningaloo Marine Park. A more targeted, effective and relevant compliance service in terms of both cost and activities was delivered using this planning process.

FMOs delivered compliance activities directed at commercial fisheries mostly through pre-season inspections, catch inspections and quota monitoring, as well as at-sea inspections and investigations resulting from suspected breaches 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 suspected breaches of closed waters detected through the VMS and other monitoring methods has risen considerably in 2007/08. However, compliance overall is assessed as being at an acceptable level across all the fisheries except for the Shark Bay Prawn Fishery where issues regarding VMS compliance remain a concern. Compliance staff assess that the commercial fishing industry continues to demonstrate a positive approach to complying with regulations and playing their part to ensure the sustainability of their fisheries. A total of 8 infringement warnings and 12 infringement notices were issued and 9 prosecutions were instigated from a total of 405 field contacts with commercial fishers. Field contacts were lower than 2006/07 because of the previously highlighted staff shortages.

The monitoring of marine reserve activities with respect to recreational fisheries has divided the recreational fishing compliance program from a stand-alone program into two distinct programs, 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 (46) was significantly down, however infringement notices issued (75) and prosecutions instigated (27) had increased considerably from the previous year. This was achieved from a total of 8,297 recreational fishing field contacts, which reflects the increased importance placed on recreational fishing and marine reserves in general across the Gascoyne. Recreational fisher contacts were approximately 12% lower in 2007/08 because of staff shortages, especially in the Ningaloo Marine Reserve, although the significant increase in prosecutions reflects the direct effects of better management and planning processes, a stable workforce with more expert knowledge of their sanctuary zones and offender profiles and greater emphasis on intelligence driven activities.

Two FMOs from "Mobile 1" were active in the Gascoyne in 2007/08. "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, 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 and the Gnarraloo Bay area.

During 2007/08, FMOs contributed to the marine safety compliance program within the bioregion and across the state. FMO's conducted 227 safety checks on recreational vessels, a significant 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 2007/08. As in previous years, with a population base of less than 12,000 people in the Gascoyne Region, all organizations (including emergency services) find it hard to attract people to the large number of volunteer organizations existing within the region. Solutions to this problem remain elusive but it will most likely require a permanent Education Officer in the Carnarvon Office to help attract, train and manage a VFLO program.

Initiatives in 2008/09

For the 2008/09-year a number of initiatives across the Gascoyne Bioregion have been planned. These include: -

- Expanding Marine Reserve services to the Muiron Islands Marine Management Area;
- Taking delivery of the replacement Patrol Vessel for the PV John Brockman;
- Commencing project design and specifications for replacement vessel for the PV Gnulli in Exmouth;
- Qualify Exmouth and Carnarvon FMO's as Wardens for the Commonwealth area of the Ningaloo Marine Park;
- Carry out risk assessments and examine offending profiles in the Shark Bay Prawn and Scallop fisheries;
- Developing further the management and compliance process in the Shark Bay Snapper Managed Fishery in respect to VMS and quota management;
- Provide increased education and compliance services for the newly expanded restricted fishing zone at the Point Quobba Fish Habitat Protection Area.

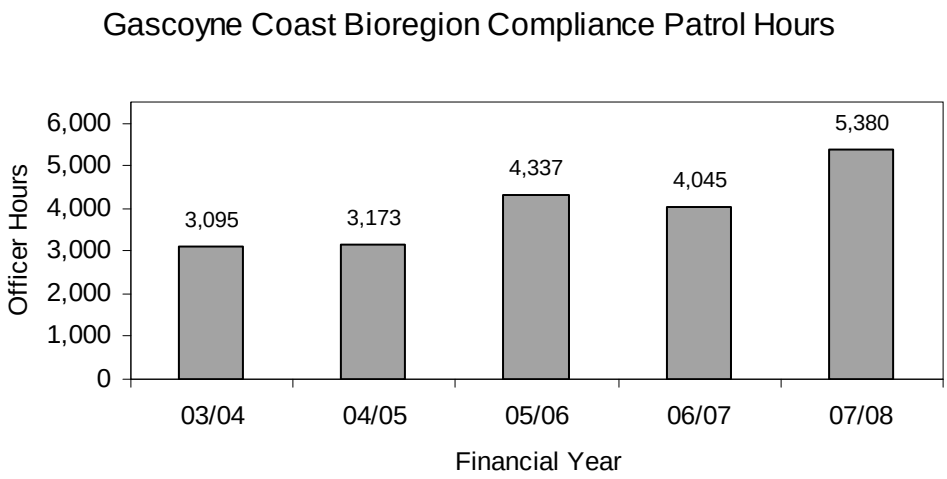
GASCOYNE COAST COMPLIANCE TABLE 1

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	5,380 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	405
District Office contacts	1,591
Infringement warnings	8
Infringement notices	12
Prosecutions	9
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	8,297
District Office contacts	3,459
Infringement warnings	46
Infringement notices	75
Prosecutions	27
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field Contacts by Fisheries & Marine Officers	944
District Office contacts	4,239
Fishwatch reports**	10

*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.



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 06/07 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.).

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.

SUMMARY OF FISHING ACTIVITY

The principal commercial fisheries in the North Coast bioregion focus on tropical finfish, particularly the high-value emperors, snappers and cods that 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.

ECOSYSTEM MANAGEMENT

Marine habitats within the North Coast Bioregion of Western Australia are experiencing increasing pressure through a range of activities including illegal foreign fishing; increasing recreational fishing at popular tourist destinations, and increased resource development activity The Department continues to engage with the Environmental Protection Authority through the environmental impact assessment process by providing advice on individual development proposals, which if implemented, have the potential to have an adverse impact on the marine environment. These include new (and upgraded) port developments in the Pilbara region, as well as off shore and near shore oil and gas extraction projects in the Kimberley and Pilbara region Major developments recently assessed for which the Department has played a key role include the Gorgon Gas Development at Barrow Island, and the proposed Kimberley LNG processing site.

The increase in international shipping movement and dredging activity associated with resource development in the Northern region 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 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 *Fish Resources Management Act 1994* and the *Biosecurity and Agriculture Management Act 2007*. Associated regulations and subsidiary legislation are currently being developed. Work has also been undertaken to develop monitoring designs for introduced marine species for the Port of Dampier. The design has been developed in conjunction with the Invasive Marine Pests Program within DAFF (Department of Agriculture Fisheries and Forestry). This work is expected to contribute to introduced aquatic organism incursion and fish kill incident response programs already in place.

Extensive fisheries closures in coastal and most offshore waters have been introduced to manage finfish trawling by Australian vessels (North Coast Habitat Protection Figure 1). However, trawling is still permitted in a number of locations (see specific commercial trawl fishery reports elsewhere in this volume). This activity is carefully managed to ensure that impacts are acceptable. The trawling is subject to Ecologically Sustainable Development (ESD) requirements in accordance with Australian Government 'Guidelines for the Ecologically Sustainable Management of Fisheries' under the *Environment Protection and Biodiversity Conservation Act 1999*.

In addition to the fisheries closures, the bioregion has a number of marine protected areas including the Montebello and Barrow Islands Rowley Shoals 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 proposed Dampier Archipelago marine conservation reserves are still under consideration by Government.

The Department of Fisheries also participated in marine conservation reserve planning process in the Pilbara Eighty Mile Beach area, coordinated by the Department of Environment and Conservation, which is yet to be considered by State Government. The Department also continues to work closely with the Rangelands Natural Resource Management Coordinating Group to develop strategies to minimize environmental effects in the marine environment.

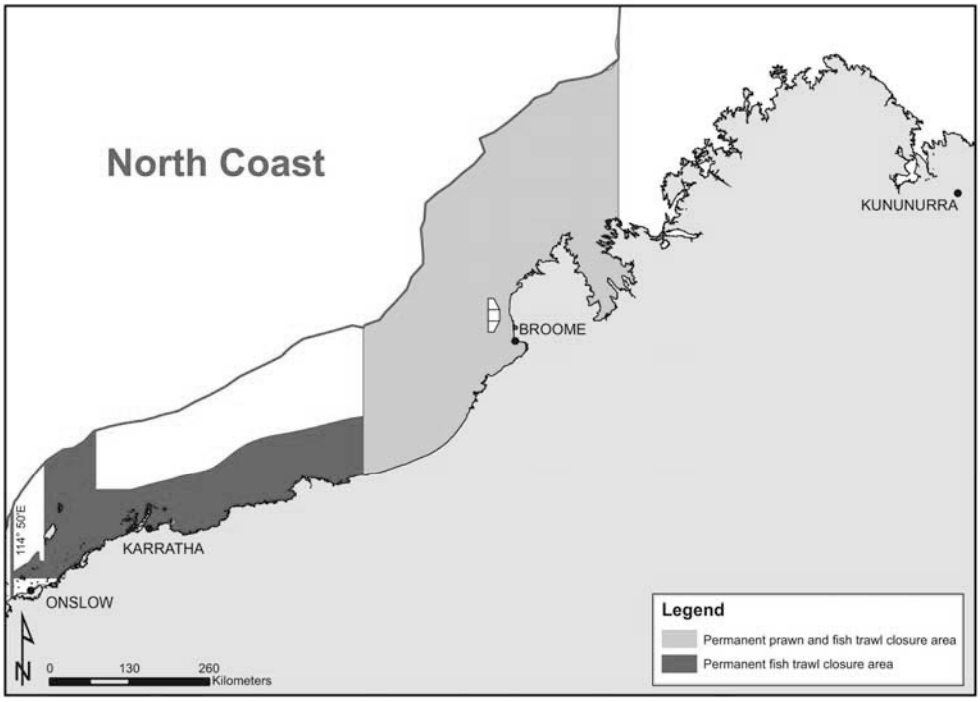
The Australian Government's Department of Environment, Water, Heritage and the Arts (DEWHA) is also undertaking a Marine Bioregional Planning process for Commonwealth waters between Shark Bay and the Northern Territory border, with a view to completing a draft North West Marine Bioregional Plan in late 2009.The Draft Plan will be released for a 3 month public review, and contain proposed marine protected areas.

The Department of Fisheries' Research Division's Biodiversity and Biosecurity Branch has recently commenced a pilot project aimed at establishing resource condition monitoring protocols for the Pilbara and Kimberley. The project to date has focussed on an extensive survey of the research literature relating to the coastal and marine environments in the Pilbara and Kimberley. The review of the literature has highlighted those areas of research that are lacking from the region. These "knowledge gaps" range in scope from fine scale life history trait studies of particular species; to large-scale oceanographic studies to identify major ocean current dynamics, and oceanic primary production from plankton.

The vast and remote coastline of the region dictates that remote sensing (satellite imagery and aerial photography) will be the primary tool for resource condition monitoring. Future directions of the project will concentrate on developing remote sensing as a monitoring tool, and developing a suite of resource condition indicators that accurately portray the health of the numerous marine and coastal environments, and set bench marks for which to assess environmental change, within the Pilbara and Kimberley.

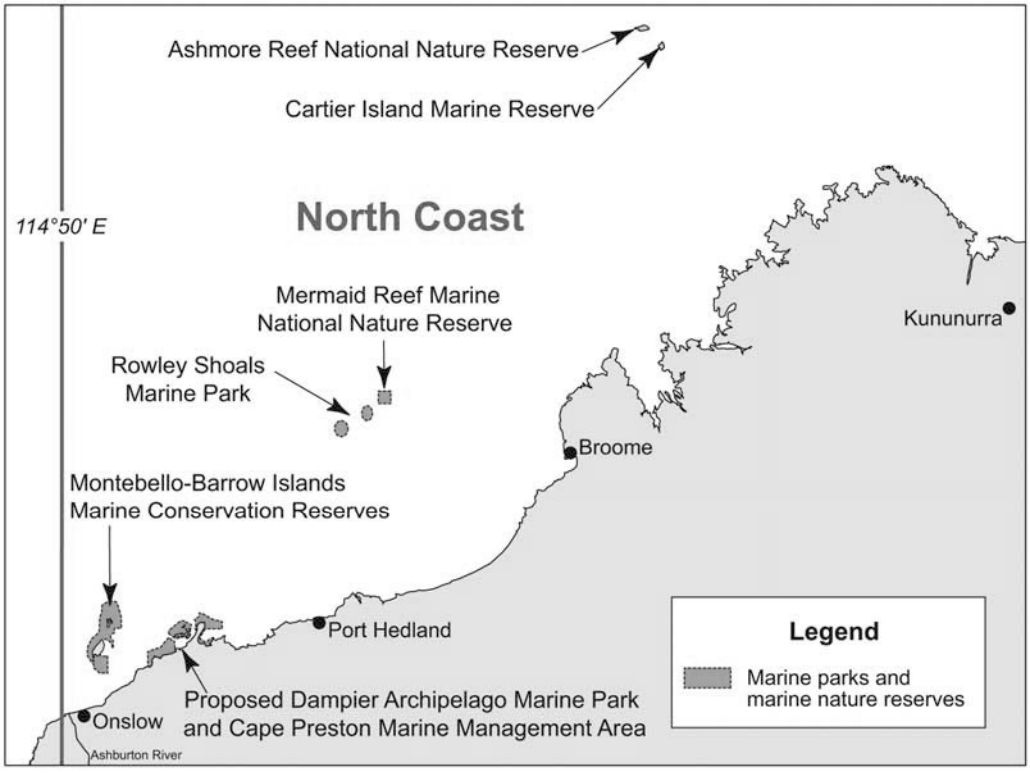
In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has an initiated Ecosystem Based Fisheries Management (EBFM) framework.

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 to ensure the sustainable management of fish stocks in the future. The EBFM risk assessment process for the West Coast Bioregion has been completed (see Table 1 for the West Coast Bioregion) and serves as an example of what will be undertaken for the North Coast Bioregion. 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.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 1

Map showing areas permanently closed to trawling in the North Coast bioregion.



NORTH COAST ECOSYSTEM MANAGEMENT FIGURE 2

Map showing current and proposed areas of protected fish habitat in the North Coast bioregion.

FISHERIES
Northern Prawn Managed Fisheries Status Report

E. Sporer, M. Kangas and S. Brown
Management input from R. Gould

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings

Onslow: 43 tonnes

Nickol Bay: 86 tonnes

Broome: Negligible

Kimberley: 168 tonnes

Fishery Description

There are a number of smaller prawn fisheries in the northern bioregion.

The Onslow (OPMF) and Nickol Bay (NBPMF) Prawn Managed Fisheries operate along the western part of the North-West Shelf and OPMF targets western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus spp*.) and whereas NBPMF primarily targets banana prawns (*Penaeus merguiensis*) using otter trawls.

The Broome Prawn Managed Fishery (BPMF) 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.

The Kimberley Prawn Managed Fishery (KPMF) 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

Onslow Prawn Fishery Management Plan 1991

Onslow Prawn Managed Fishery Licence

Nickol Bay Prawn Fishery Management Plan 1991

Nickol Bay Prawn Managed Fishery Licence

Broome Prawn Managed Fishery Management Plan 1999

Broome Prawn Managed Fishery Licence

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 the OPMF are divided into three fishing zones with associated size management fish grounds (SMFGs) and nursery areas for prawns 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 (Northern Prawn Figure 1).

The boundaries of the NBPMF 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'* (Northern Prawn Figure 2).

The boundaries of the BPMF are shown in Northern Prawn Figure 3.

The boundaries of the KPMF 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) (Northern Prawn Figure 4).

Management arrangements

Management controls for all the northern prawn fisheries are based on limited entry, seasonal and area closures, and gear controls including bycatch reduction devices.

The Departments' vessel monitoring system (VMS) monitors the activities of all boats.

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.

OPMF

The management arrangements in the OPMF involves a standardised net headrope allocation whereby each Managed Fishery Licence (MFL) has an equal allocation of net headrope length in each area. However there are different net sizes permitted between Areas. Area 1 boats are authorised to use two trawl nets each having a maximum headrope length of 6 fathoms (10.98 metres). In Area 2 and 3 a maximum headrope length of 16 fathoms (29.27 metres) is permitted in

either twin or quad gear configuration. Trawl net headrope amalgamation between MFLs has been permitted in the OPMF and being consistent with other trawl fisheries. The fleet is composed of trawlers up to 23 metres in length, operating under an exemption from the net size and boat unit rule specifically for Area 1 and the 375 hull unit rule for Areas 2 and 3.

The official season arrangements for the various areas in the OPMF 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 to 1 September
Mangrove Island SFMG	10 May to 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.

Different licence classes apply to the OPMF, allowing boats to trawl in specific zones. These classes are listed below, with figures in brackets indicating number of licensed boats:

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

Class B Areas 2 and 3 (three MFLs)

Class C Area 2 (12 Exmouth Gulf prawn MFLs)

Class D Area 3 (12 Nickol Bay prawn MFLs)

NBPMF: The NBPMF management arrangements provide for authorised boats to use standard otter trawl nets not exceeding 16 fathoms (29.27 metres in either twin or quad gear configuration) whereby each boat has an equal allocation and the maximum total headrope length for the entire fleet is 224 fathoms (409.78 metres). The 2008 season opened on 1 March with a closure on 20 November. The major fishing areas opened during these periods:

Nickol Bay	22 May – 31 August
	Day fishing only 22 May – 6 June)
Extended Nickol Bay SMFG	22 May – 20 November
Depuch SMFG	22 May – 31 August
	(Day fishing only 22 May – 6 June)
De Grey SMFG	22 May – 20 November

BPMF:The BPMF management arrangements provide for standard otter trawl nets not exceeding 40 fathoms (73.16 metres in either twin or quad gear configuration). Each boat has an equal allocation and the maximum total headrope length for the entire fleet is 200 fathoms (365.8 metres). The 2008 season arrangements opened the Fishery on 25 May and it officially closed at 0800 hrs 10 August, providing 74 fishing nights. Only one boat entered the BPMF fishery at the commencement of the season and one boat also fished at the end of the season, for a short time only.

KPMF:The KPMF management arrangements provide for the use of two otter trawl nets where the total headrope, length including bridles and sweeps does not exceed 32 fathoms (58.5metres) and mesh of trawl nets does not exceed 50 mm. Seasonal dates for the KPMF are generally aligned with those of the adjacent NPF. A significant number of vessels hold authorisations to operate in both the KPMF and the NPF. Opening and closing dates are aligned to prevent large shifts of fishing effort into the KPMF. In 2008 the KPMF opened only for the second part of the year on 1 August with a promulgated final season closure on 14 November. The total allowable effort cap system was in place for this period with 900 days allocated. These measures were implemented with an aim to harvest larger prawns in the second part of the season.

The total effort cap for the two parts of the fishery is 1500 days. Therefore consideration was given to extending the effort cap for the latter part of the season if the prawn abundance was high. However, fishing ceased before the promulgated closure date.

In addition, inshore closures to protect small prawns were implemented for the whole season after industry consultation for Collier Bay, Brunswick Bay-York Sound, Admiralty Gulf and Napier Broome Bay.

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

Research summary

Research programs are focused to underpin the sustainable management of these small fisheries involves stock monitoring and assessment utilising information from daily logbooks (including AFMA logbooks for some NPF boats licensed to operate in the Kimberley fishery), utilising monthly return data provided by industry and information from boat skippers. For the NBPMF and KPMF rainfall records are also used to update the rainfall-catch relationship for banana prawns. In the OPMF a field-based consultative process is undertaken whereby industry and the Departments' Research Division decide on the extent of an area to be fished within the areas that are officially opened. For the BPMF a De Lury depletion analysis is usually undertaken which assists in the assessment of the king prawn stocks within the permitted fishing area.

Retained Species

Commercial production (season 2008):

Onslow: 33 tonnes

Nickol Bay: 86 tonnes

Broome: Negligible

Kimberley: 168 tonnes

Landings

OPMF : The total landings of major penaeids in the OPMF for the 2008 season were 33 t, including 3.7 t of king prawns, 24.9 t of tiger prawns, 2.2 t of endeavour prawns and 1.7 t of banana prawns. Tiger and banana prawns were within the acceptable catch range whereas king and endeavour prawns were below the acceptable catch range. The landings of tiger prawns in 2008 was an increase on the very low catch recorded in 2007 (Northern Prawn Figure 5). The low landings overall in 2007 and 2008 are exacerbated by extremely low effort caused by the current economic conditions.

Recorded landings of by-product species in the OPMF included 1 t of bugs (*Thenus orientalis*) with the landings of all other species being negligible.

NBPMF : The total landings of major penaeids for the NBPMF were 85.9 t, comprising 85.1 t of banana prawns, 0.1 t of king prawns, and 0.7 t of tiger prawns and no reported landings of endeavour prawns. The recorded landings of banana prawns in 2008 were below the projected catch range (110 to 210 t, Northern Prawn Figure 6) but within the acceptable catch range. The king and tiger prawn landings were extremely low and below the target ranges for these species (Northern Prawn Figure 7). Recorded byproduct landings for 2008 were extremely low.

BPMF : Recorded landings in the BPMF were negligible for both target and byproduct species (Northern Prawn Figure 8).

KPMF : The total recorded landings in the KPMF were 167.7 t, comprising 156.1 t of banana prawns, 9.7 t of tiger prawns, 1.9 t of endeavour prawns (Northern Prawn Figure 9). All prawn species catches were below their target catch ranges. The banana prawn catch was also below the projected catch range (210 to 330 t) calculated using the relationship between summer rainfall and catches. Only the second part of the season was fished (with the aim to increase the size of prawn) with fairly low effort, possibly reducing total catch. Negligible quantities of byproduct were reported as landed.

Recreational component: Nil

Fishing effort/access level

OPMF: In Area 1, one boat was exempted to fish with larger nets using a total net head-rope length of 20 fathoms (four 5-fathom nets) instead of the permitted 16 fathoms total net headrope length because of economic conditions and low abundance of prawns in recent years. This required the amalgamation of net allocations from two boats, licensed to fish all areas, 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 2008, as in 2007.

One hundred and fifty five days of fishing were recorded in 2008, which is higher than in 2007 (53 days) but still low compared to the number of days recorded since 2000.

NBPMF: Only three boats fished during the 2008 season for an aggregated total of 116 boat days fished (compared to 159 days in 2007), a very low level of effort.

BPMF: No effective effort was recorded in the BPMF for the 2008 season with trawling only being exploratory.

KPMF: Only 18 boats operated in the fishery during 2008. The total number of days fished was 499 (cf 521 days in 2007), well under the 900 boat days allocated for the second part and a third of the total boat days effort (1500) allocated.

Stock Assessment

Assessment complete: Yes

Assessment method: Catch (Rainfall catch relationship for NBPMF and KPMF for banana prawns, DeLury depletion analysis for BPMF (when appropriate))

Breeding stock levels: Adequate

Projected catch next season (2009):

NBPMF: 200t banana prawns

KPMF: 290t banana prawns

For the northern prawn fishery stocks, their short life cycle, high fecundity and dispersed nature prevent fishing from reducing breeding biomass to critical levels. 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.

OPMF: The 2008 season king prawn catch (3.7 t) is extremely low compared to the mean catch of 32.8 t for 1985 to 2007. The king prawn catches have remained lower than the average since 1997 except for two years. In the last few years the decline in effort may also be contributing to the low catches.

The total recorded landings of tiger prawns were 24.9 t, an increase compared to the 2007 fishing season. This still represents landings below the 50 t average catch since 1985 in this fishery. The low landings for 2007 and 2008 are exacerbated by extremely low effort caused by the economic conditions in prawn fisheries.

The banana prawn total catch (<2 t) was low but was expected because of the low local summer rainfall for most of the period December to March with the majority falling in March.

NBPMF: The recorded landings of 85 t of banana prawns in 2008 was low and below the projected catch range (110 to 210 t). The king and tiger prawn landings were extremely low and below the target ranges for these species. Whether this is due to low stock levels or very limited targeting on these species is not known at this stage. The endeavour prawns are not a target species because of low value and abundance in this fishery and since 1995, 8 tonnes is the highest recorded landing and therefore endeavour prawn catch cannot be used as a performance measure or judged against a historical catch range.

The catch projection for banana prawns in Nickol Bay is based on the summer rainfall level between December and March (Northern Prawn Figure 6). The total rainfall between December 2008 and March 2009 (at Roebourne) was 313 mm and the predicted catch is around 200 tonnes with a range of 160 –240 tonnes of banana prawns.

BPMF : Negligible fishing occurred in this fishery during

2008 so no stock assessment was completed.

KPMF: The breeding stock indicators in KPMF (catches within specified ranges) for banana, tiger and endeavour prawns were below the acceptable ranges. This may be due to lower effort and changes to the management strategy with fishing only occurring in the second part of the season.

The relationship identified between the early season rainfall and catches of banana prawns (the dominant species taken in this area) provides a degree of forecasting. The projected catch based on the rainfall (604.8 mm) in Kalumburu and Derby in January and February 2009 is 290 tonnes with a range of 230-350 tonnes.

The main performance measures for the OPMF, NBPMF and KPMF relate to maintenance of breeding stocks for each of the major target prawn species. In 2008 the breeding stock indicators in the OPFM (catches within specified ranges, as set out in the 'Fishery Governance' section) for tiger and banana prawns were met whereas king and endeavour prawns were below the acceptable catch range. The overall low catches were in part due to low stock abundance as well as very low effort.

The breeding stock indicator for banana prawns in the NBPMF was met but was below the projected catch range. The king and tiger prawn landings were extremely low and below the target ranges for these species. This is likely to be a result of the low effort and very limited targeting of these species this year. King prawn catches were low throughout the northern bioregion in 2008.

An assessment of breeding stock could not be made for the BPMF due to negligible fishing effort.

The breeding stock indicators in KPMF (catches within specified ranges) for banana, tiger and endeavour prawns were below the acceptable ranges. This may be due to lower effort and changes to the management strategy.

Non-Retained Species

Bycatch species impact: Low

Bycatch from the northern prawn fisheries is typical of tropical trawl fisheries (i.e. from 2:1 up to about 5:1 relative to the target species), but the effort levels and spatial coverage are too low to impact bycatch species' populations. The introduction of fish escapement devices (FEDs) within all the nets towed by each vessel should have reduced this risk even further. The NBPMF and KPMF fishery operates predominantly by specifically targeting schools of banana prawns. This results in relatively low effort and minimal bycatch compared with other trawl fisheries. The impact on bycatch in the BPMF was negligible due to extremely low effort.

Protected species interaction: OPMF: Low

NBPMF, BPMF, KPMF: Negligible

The northern prawn fisheries has on some occasions, previously caught turtles and sea snakes, which are generally returned to the sea alive, but the overall low effort level and targeted coverage suggest that such interactions would not have been significant. Bycatch reduction devices ('grids') and FEDs are now fully implemented 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

For all the northern prawn fisheries and in particular the OPMF and BPMF the limited spatial coverage of the fisheries and low levels of catch, it is unlikely to have any significant ecological consequences. In addition for the NBPMF and the KPMF 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: BPMF: Negligible

OPMF, NBPMF, KPMF: Low

In 2008 the area fished in all four fisheries was less than 1-2% of the overall fishery. The fisheries are generally restricted to clean sand and mud bottoms, where trawling has minimal long-term physical impact.

Social Effects

Estimated employment in these fisheries for 2008 was 60 to 80 skippers and crew with additional people involved in local processing.

Economic Effects

Estimated annual value (to fishers) for year 2008:

OPMF: $0.4 million

NBPMF: $0.7 million

BPMF: Negligible

KPMF: $1.3 million

Fishery Governance

OPMF Target catch range: 60 – 180 tonnes

Current fishing level: Acceptable

Under normal 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

NBPMF 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

BPMF 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.

KPMF 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

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.

New management initiatives (2009): Nil

Alternative management arrangements (to the interim effort cap currently in place) will be pursued during 2010/11 for the KPMF to improve fishing efficiency and to optimise the value of stocks whilst ensuring sustainability.

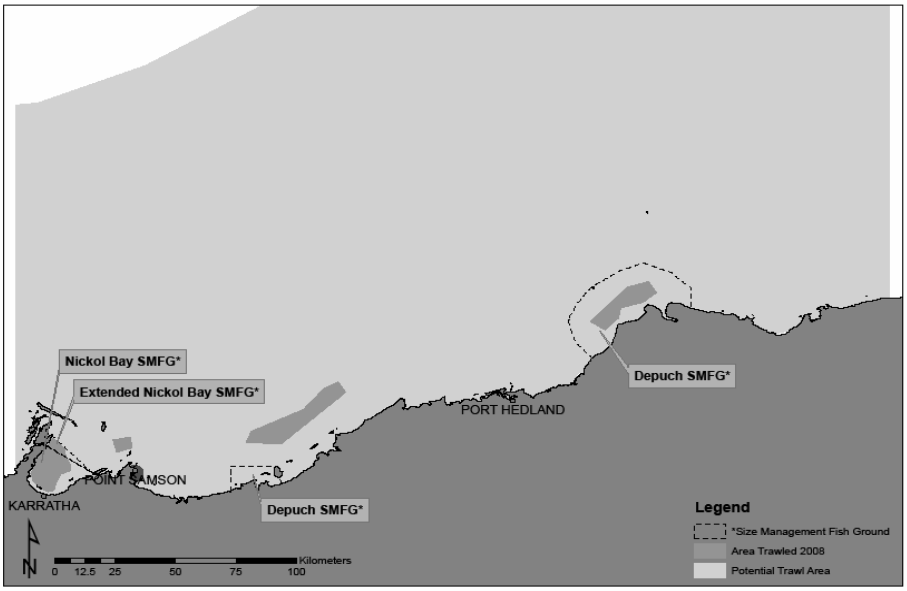
External Factors

Banana prawns are rainfall dependent and can be highly variable annually in the KPMF, NBPMF and for the OPMF where banana prawns may be in some years be taken predominantly off the mouth of the Ashburton River.

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

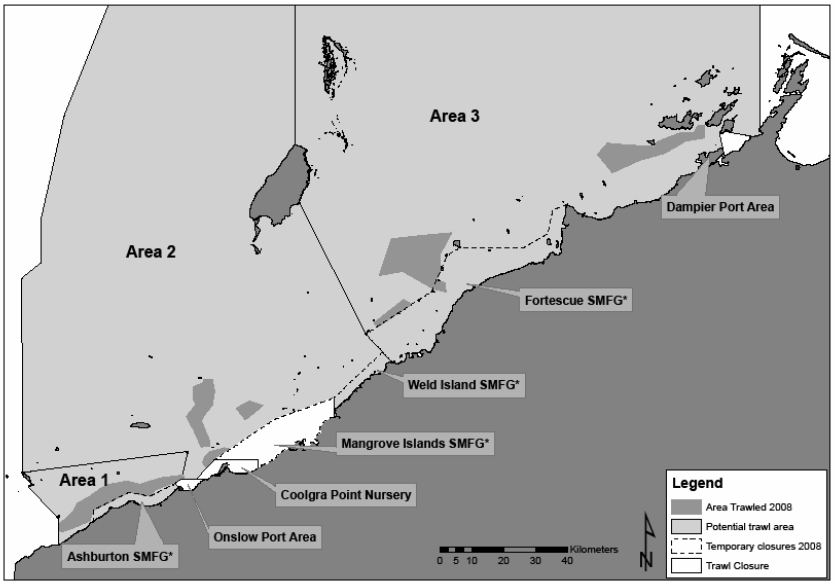
In the BPMF one factor influencing catches is the timing of the season which is set by the mid-season closure for the Northern Prawn Fishery, and, since the permitted fishing area is small, in some years the timing of prawn recruitment and the prawn migration patterns may not result in high abundances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

The KPMF fishing season also been set to mirror dates used in the NPF to prevent the KPMF from attracting too much fishing effort from the NPF



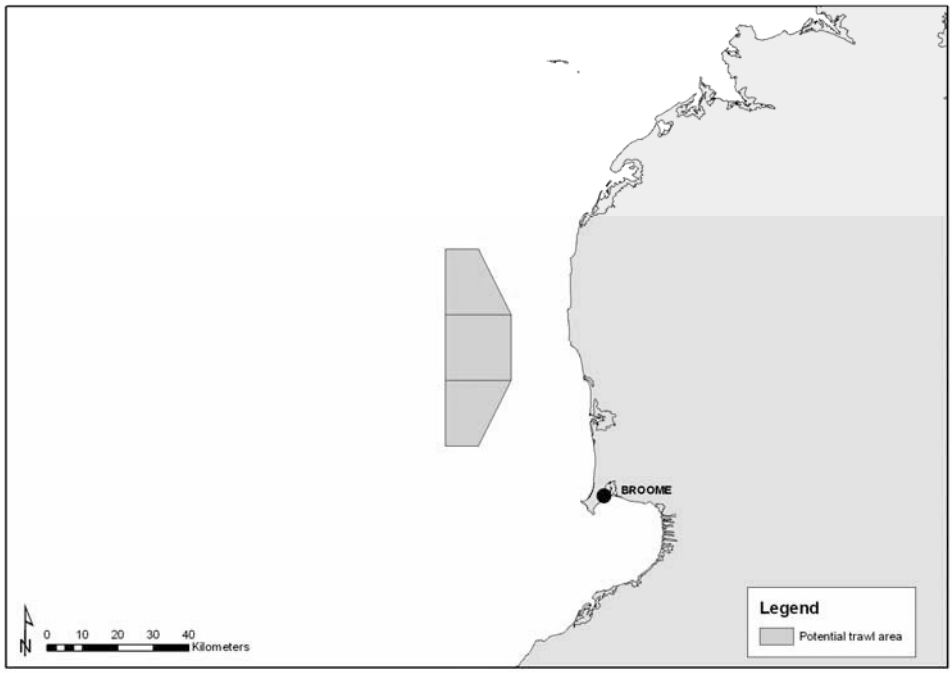
NORTHEN PRAWN FIGURE 1

Boundaries of the Onslow Prawn Managed Fishery indicating trawl closures and size management fish grounds and area trawled in 2008.



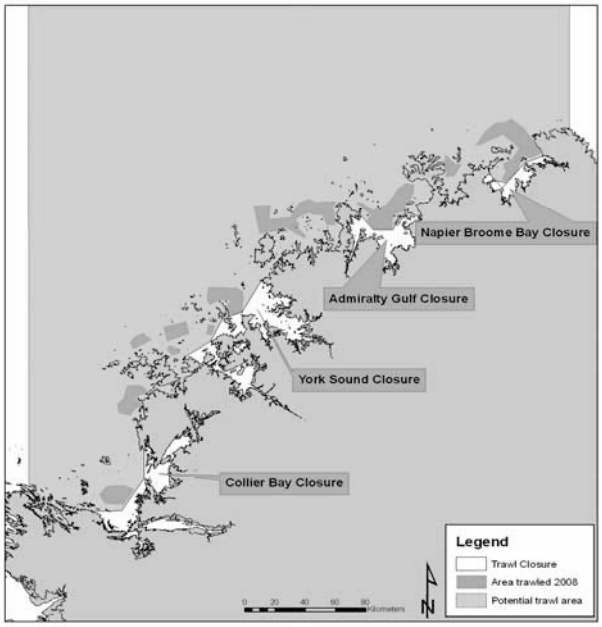
NORTHERN BAY PRAWN FIGURE 2

Boundaries of the Nickol Bay Prawn Managed Fishery indicating nursery areas and size management fish grounds and areas trawled in 2008.



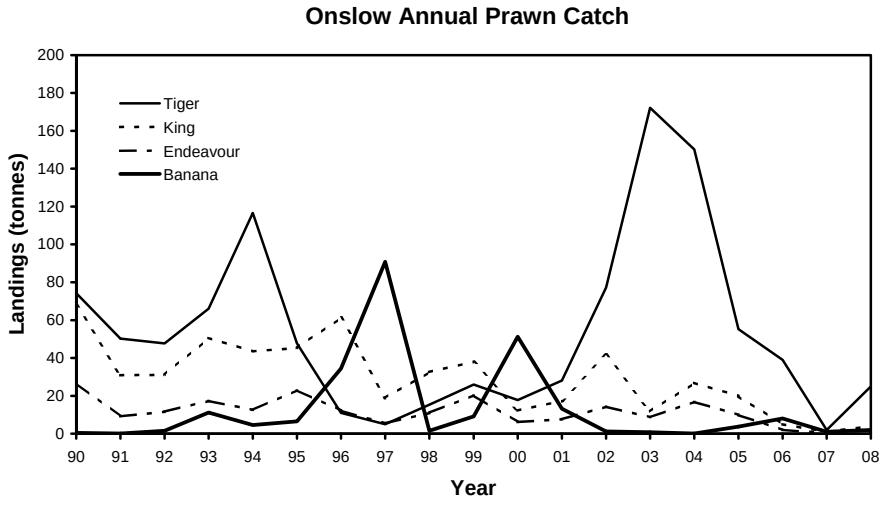
NORTHERN PRAWN FIGURE 3

Boundaries of the Broome Prawn Managed Fishery. Negligible area was trawled in 2008.



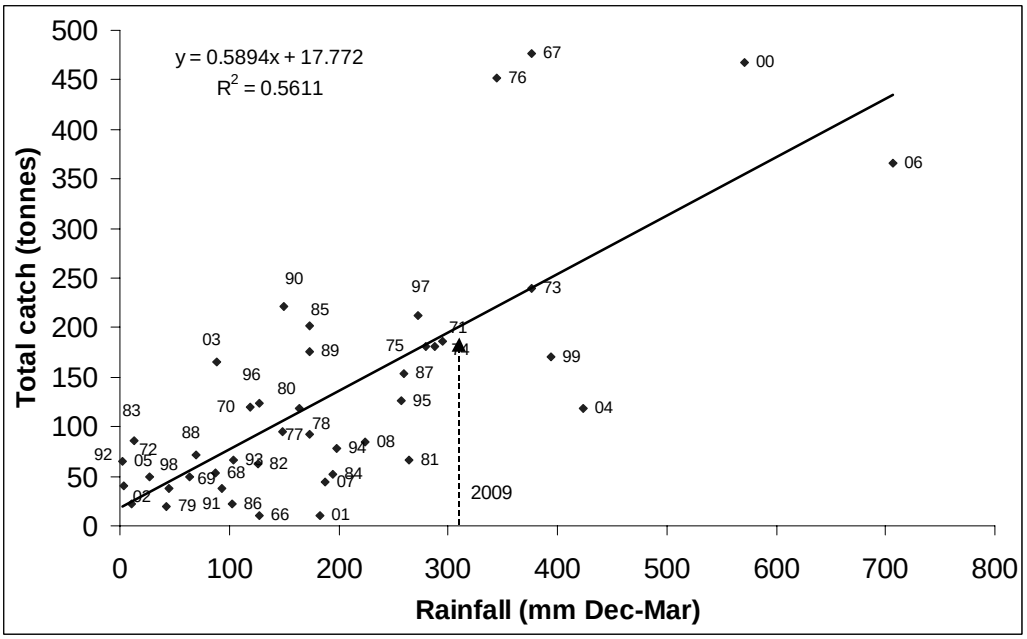
NORTHERN PRAWN FIGURE 4

Areas fished in the Kimberley Prawn Managed Fishery in 2008 and the inshore trawl closures implemented.



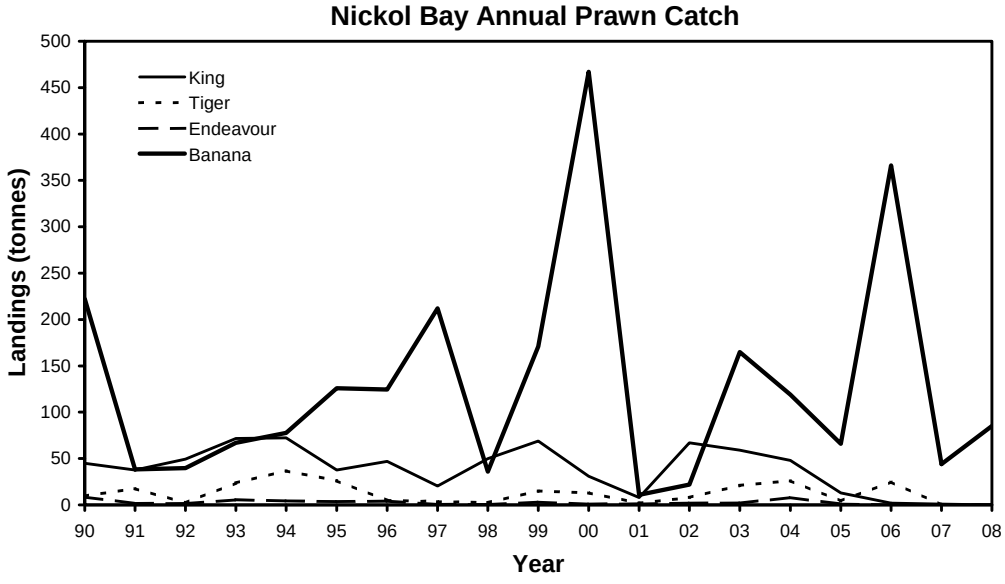
NORTHERN PRAWN FIGURE 5

Annual landings for the Onslow Prawn Managed Fishery, 1990 – 2008.



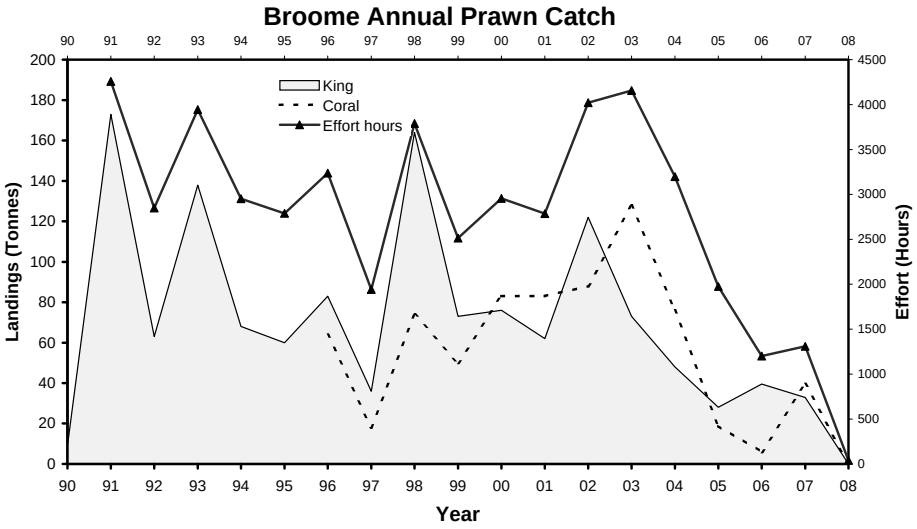
NORTHERN PRAWN FIGURE 6

Relationship between banana prawn landings in Nickol Bay and rainfall between December And March for 1966 – 2008, with rainfall level for 2009 indicated.



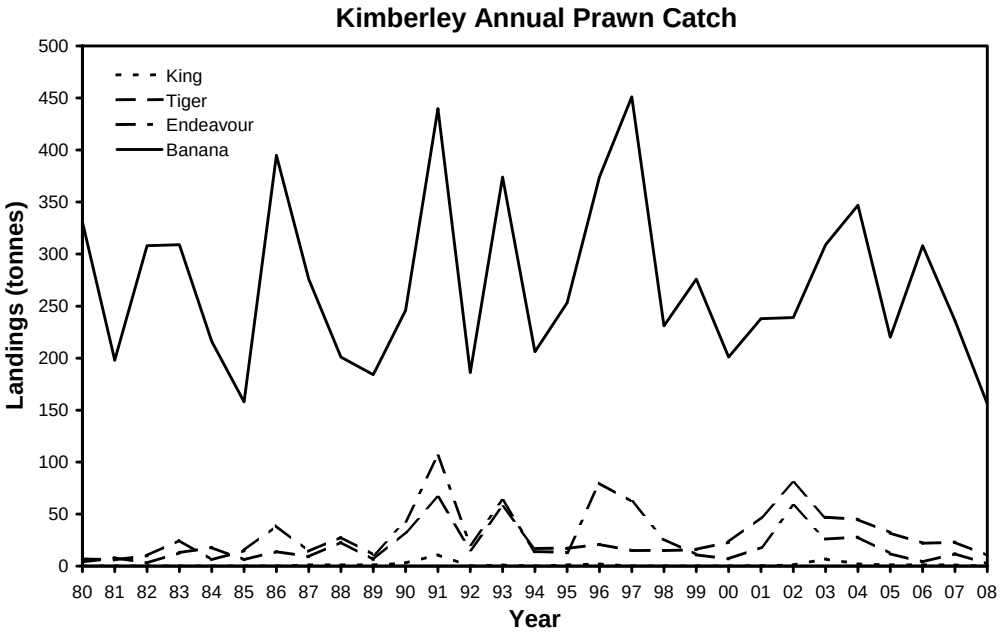
NORTHERN PRAWN FIGURE 7

Annual landings for the Nickol Bay Prawn Managed Fishery, 1990 – 2008.



NORTHERN PRAWN FIGURE 8

Annual landings and fishing effort for the Broome Prawn Managed Fishery, 1990 – 2008.



NORTHERN PRAWN FIGURE 9

Annual landings for the Kimberley Prawn Managed Fishery, 1980 – 2008.

North Coast Nearshore and Estuarine Fishery Status Report

S.J. Newman, C. Skepper, G. Mitsopoulos and R. McAuley
Management input from R. Green

Main Features

Status	Current Landings
	Total – 165 t
Stock levels – Acceptable	Barramundi – 54.8 t
	Threadfin – 101.2 t
Fishing Levels - Acceptable	Recreational – 2-10% of total (last estimate 2000)
	Charter – ~10 t (barramundi and threadfin)

Fishery Description

Commercial

The only managed fishery currently operating in this region is the Kimberley Gillnet and Barramundi Managed Fishery (KGBF) which extends from the WA/NT border (129ºE) to the top of Eighty Mile Beach, south of Broome (19ºS). 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)*. The main areas of the fishery are the river systems and tidal creek systems of the Cambridge Gulf, the Ria coast of the northern Kimberley, King Sound, Roebuck Bay and the northern end of Eighty Mile Beach to 19ºS.

Two exemption holders fished along the Eighty Mile Beach section of the Pilbara Coast in early 2008 before their exemptions were withdrawn. The catches from these exemption holders are not considered further.

Recreational

Recreational fishing activities are concentrated around key population centres, with a peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Kimberley Gillnet and Barramundi Managed Fishery Management Plan 1989

Kimberley Gillnet and Barramundi Managed Fishery Licence.

Recreational

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995 and subsidiary legislation.

Consultation processes

Commercial

Department–industry meeting.

Recreational

Recreational Fishing Advisory Committee; West Kimberley Regional Recreational Fishing Advisory Committee (Broome)

East Kimberley Regional Recreational Fishing Advisory Committee (Kununurra).

Boundaries

Commercial

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 principal fishing areas from the Broome coast to Cambridge Gulf in the KGBF are illustrated in Kimberley Gillnet Figure 1.

Recreational

The North Coast bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21º46'S latitude and east of 114º50'E longitude).

Management arrangements

Commercial

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. Up until April 2008, 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 of the *Accord for Future Management of Barramundi Resource 2000-2005*, additional management arrangements were introduced for the commercial, charter and recreational sectors to facilitate improved management and conservation of barramundi resources in the Kimberley region. These arrangements include commercial fishing area closures around major town sites and recreationally important fishing locations, namely Broome Jetty to Crab Creek, Jacks Creek, Yardogarra Creek, Thangoo Creek, Cape Bossut to False Cape Bossut, Derby Jetty, the Fitzroy River north of 17º27′ S and the lower Ord River upstream of Adolphus Island.

In March 2007, representatives from the commercial, recreational and charter fishing sectors agreed to a revised agreement, the *Accord for the Future Management of Barramundi and Threadfin 2007-2012*. The new Accord includes a number of recommendations for improved management and conservation of barramundi and threadfin stocks in the Kimberley region. The Department of Fisheries plans to develop a community awareness and education package to facilitate the release of outcomes from the Accord process, in order to support the recommended legislative changes for the improved management of these stocks.

Recreational

As a precautionary measure to ensure that breeding stock levels of barramundi are maintained, special fishing rules are in place for three key fishing areas: Fitzroy River area and King Sound (bag and possession limit of 2 fish); Broome area (bag limit of 1 fish, possession limit of 2 fish); and the Ord River area (bag and possession limit of 1 fish). Fish species in the North Coast bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management. The bag and size limits are species-specific or species group specific. Recreational set and haul netting is prohibited in all waters of the North Coast bioregion with the exception of haul netting in the waters of the Dampier Archipelago (between Cape Preston and Cape Lambert) with the following restrictions: haul nets must not exceed 30 metres in length; mullet are the only species to be retained and all other species must be returned to the water.

Research summary

The biological characteristics required for fisheries management for both the threadfin species have been completed (Pember et al. 2005). These data may be used to provide a stock assessment of threadfin salmon in the KGBF and Pilbara in the future. The bycatch of elasmobranchs in the KGBF and the Pilbara coast fishing area was examined during 2002 and 2003 (McAuley et al. 2005).

CAES data are used to assess the status of barramundi stocks targeted by this fishery. This status report is compiled annually and provided to industry and regional management.

Retained Species

Commercial landings (season 2008):

All species 165.6 tonnes

Barramundi 54.8 tonnes

Threadfin salmon 101.2 tonnes

The principal species landed are two species of threadfin (the king threadfin and the blue threadfin), and barramundi. Small quantities of elasmobranchs (sharks and rays), black jewfish *(Protonibea diacanthus)* and tripletail *(Lobotes surinamensis)* are also landed.

The composition of the elasmobranch catch varies considerably between fishing areas. It mainly consists of whaler shark species (Carcharhinidae), including pigeye sharks *(Carcharhinus amboinensis)*, blacktip whalers (mainly *C. tilstoni*) and various species of rays, including sawfish (Pristidae), although the latter were totally protected in December 2005 and may no longer be retained.

There are four principal fishing areas within the KGBF: Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River) and the Broome coast (Roebuck Bay). Each of these principal fishing areas is considered separately because of their differing histories of development, effort application, and recreational fishing interest and unit stock considerations.

The total reported catch of all species in the KGBF in 2008 was 166 t (Kimberley Gillnet Figure 2). Recent annual catches of the major target species by the KGBF are reported in Kimberley Gillnet Table 1. The composition of the KGBF catch in 2008 is summarised in Kimberley Gillnet Table 2. The total landings of barramundi from all four prescribed fishing areas within the KGBF were 54.8 t for 2008 (Kimberley Gillnet Figure 3), almost double that reported in the KGBF in 2007. This increase in catch is related to an increase in fishing effort across the fishery from the transfer of licenses. Catch rates for barramundi are slightly higher than 2007, but lower than 2006 and indicate increased targeting of barramundi by the new operators.

The 2008 landings of threadfin salmon in the KGBF were 101.2 t (Kimberley Gillnet Table 1, Kimberley Gillnet Figure 4), similar to those reported in the high catch years of 1999 and 2003.

Recreational catch estimate (last estimate 2000):

2-10% 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 2008 was estimated to be approximately 4.2 t of

barramundi and less than 1.0 t of threadfin salmon.

Fishing effort/access level

Commercial

Procedures to validate and standardise reported fishing effort in the KGBF (and Pilbara gillnet sector) were developed by McAuley et al. (2005). These procedures are used to assess the fishery. The fishery's 'effective effort' is calculated from the validated data as the total length of net set per gillnet hour (km gn-hr-1). During 2008, the total effective effort across the four prescribed fishing areas was 1542.6 km gn hr. This level of effort is the highest level reported since 2004 (1811 km gn-hr-1; Kimberley Gillnet Figure 2).

Recreational

Not assessed.

Stock Assessment

Assessment complete: Barramundi – Yes
Threadfin salmon – Yes

Assessment method: Catch Rate

Breeding stock levels: Barramundi – Acceptable
Threadfin salmon - Acceptable

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 2008 is higher than that reported in 2007 (Kimberley Gillnet Figure 3). The barramundi catch level in 2008 was much higher than that reported in 2007 and is related to increased levels of effort in the fishery, in particular increased levels of catch and effort in the Cambridge Gulf sector of the fishery.

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.

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. While the catch rate in 2008 is lower than that reported in 2007 it is still relatively high (Kimberley Gillnet Figure 3). The increase in threadfin catch in the fishery is due to a marked increase in the threadfin effort in the Cambridge Gulf region due to the presence of new operators in the fishery.

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. 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 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 spatial density of fishing effort relative to the widespread distribution of these species and the size-selectivity of the permitted mesh sizes, 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 (gillnets) does take some protected estuarine crocodiles *(Crocodylus porosus)* and sawfish (Family Pristidae). These species are generally released alive or avoided as far as is practicable. Because of the low effort levels and the low spatial intensity of fishing effort, these impacts are unlikely to pose a significant threat to the sustainability of the stocks of these species.

Catches of the speartooth shark *(Glyphis glyphis)* or the northern river shark *(Glyphis garricki)*, which are listed under the *Environment Protection and Biodiversity Conservation Act 1999* as critically endangered and endangered, respectively are rare in the KGBF. 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 fishing operations of the KGBF are unlikely to pose a significant threat to the sustainability of the stocks 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

Commercial

During 2008, six vessels fished in the KGBF with an average crew level of approximately 2.5 people, indicating that at least 15 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.

Recreational

A significant number of recreational and charter anglers also fished across the region.

Economic Effects

Estimated annual commercial value (to fishers) for year 2008: $1039 Million

The KGBF landed a total of 166 t of fish in 2008, for a catch

value of approximately $1,038,700. 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.

Fishery Governance

Current Fishing (or Effort) Level — Acceptable

The fishery is operating above the target catch range for the key indicator species (barrmundi) for the first time in three years 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, although they will need to be monitored in future years due to the increased levels of barramundi catch in 2008.

Target commercial 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 2008 is above the target range.

New management initiatives (2009/10)

In March 2007, representatives from the commercial, recreational and charter fishing sectors agreed to a revised agreement, the *Accord for the Future Management of Barramundi and Threadfin 2007-2012*. The new Accord includes a number of recommendations for improved management and conservation of barramundi and threadfin stocks in the Kimberley region. The Department of Fisheries plans to develop a community awareness and education package to facilitate the release of outcomes of the Accord process, in order to support the recommended legislative changes for the improved management of these stocks.

The Department plans to review the KGBF management plan 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 population growth associated with 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 increased exploitation pressure from recreational fishers (driven in the main by population growth resulting from gas and mining developments), and are likely to need specific management arrangements in the future.

KIMBERLEY GILLNET TABLE 1

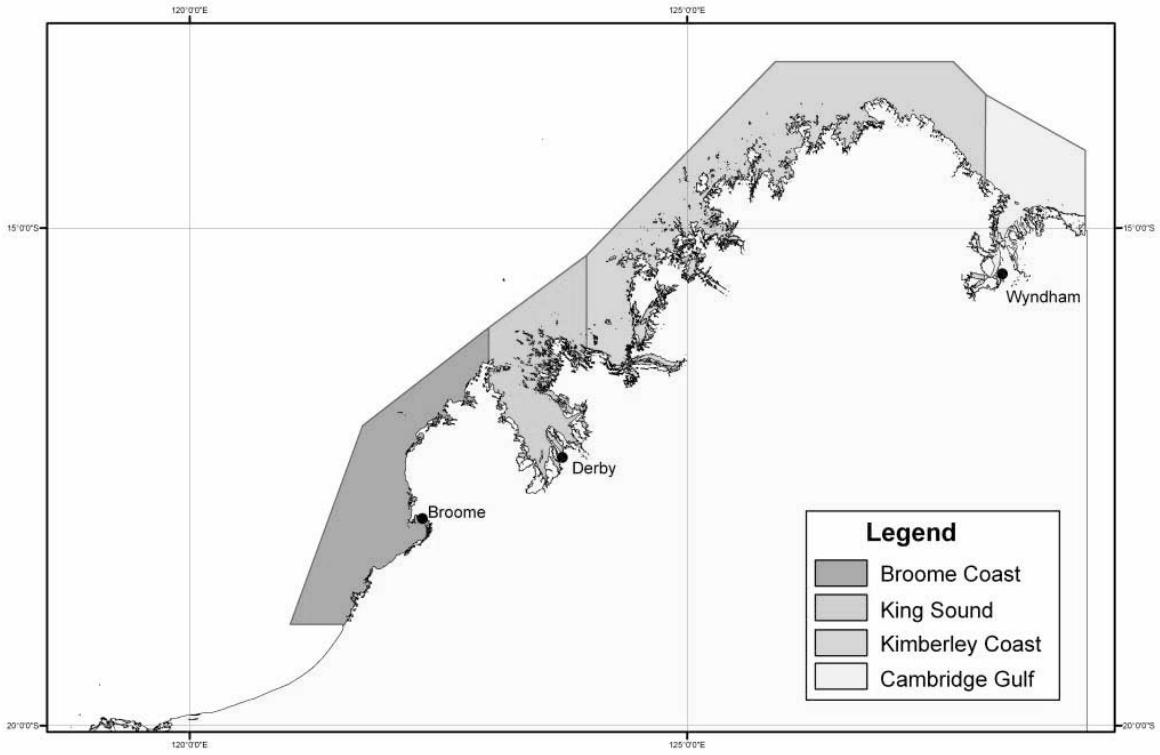
Recent annual catches of the major target species by the KGBF.

Species	**Kimberley Gillnet Annual Catch (tonnes)**									
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Barramundi	41.2	42.9	38.8	39.5	45.0	53.5	35.6	36.3	27.2	54.8
Threadfin salmon	109.8	66.7	50.9	76.4	94.1	75.8	70.6	67.7	78.5	101.2
Total	160.4	120.7	100.5	124.4	148.0	136.1	117.8	109.9	111.4	165.6

KIMBERLEY GILLNET TABLE 2

Summary of the reported catch (t) in the KGBF in 2008 and the percentage composition of each of the major species retained.

Species	Catch (tonnes)	Composition %
Threadfin salmon	101.2	61.1
Barramundi	54.8	33.1
Tripletail	5.3	3.2
Black jewfish	1.7	1.1
Sharks and rays	0.7	0.4
Other fish	1.9	1.1
Total	165.6	100



KIMBERLEY GILLNET FIGURE 1

Location of the principal fishing areas for barramundi and threadfin (Cambridge Gulf (including Ord River), Kimberley coast (six small river systems), King Sound (including Fitzroy River) and the Broome coast (Roebuck Bay)) within the KGBF. Note: this map is indicative only

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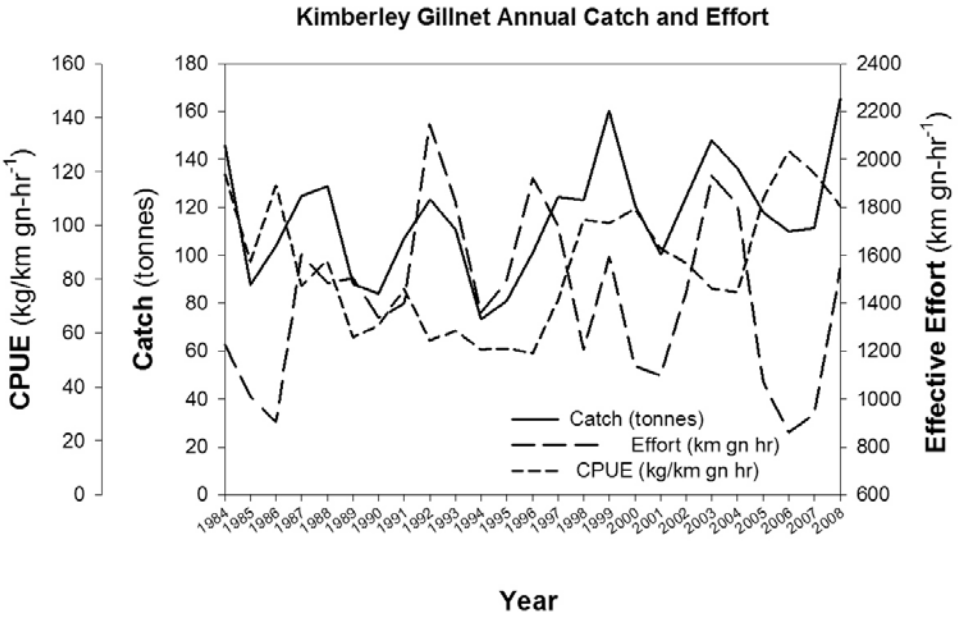
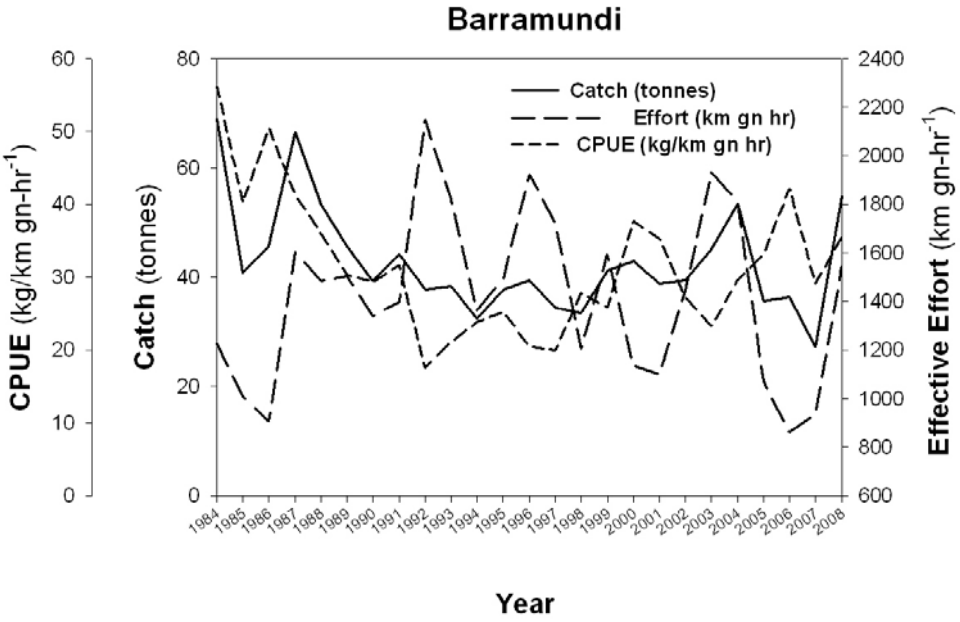


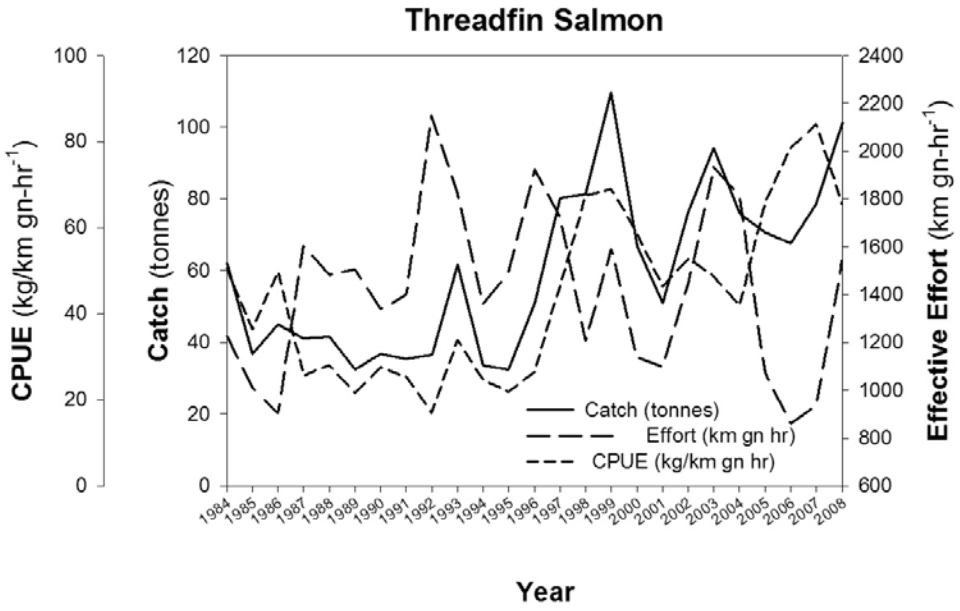
KIMBERLEY GILLNET FIGURE 2

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 2008.



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 2008.



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 2008.

North Coast Demersal Fisheries Status Report

S.J. Newman, P. Stephenson, C. Skepper, G. Mitsopoulos and B. Rome
Management input from R. Green and S. Blazeski

Main Features

Status

Pilbara:

Stock level – Acceptable

Fishing Level – Trap Fishery – Acceptable
– Trawl Fishery – Acceptable
(although review required)

Kimberley:

Stock level – Acceptable

Fishing Level – Unacceptable

Current Landings

Pilbara: Total – 1804 t
Red emperor – 153 t
Rankin cod – 70 t
Bluespotted emperor – 249 t
Pilbara Fish Trawl Fishery – 1210 t
Pilbara Fish Trap – 508 t
Pilbara Line – 86 t
Recreational – 1% of total (2008)
Charter – 19 t

Kimberley (NDSF): Total – 1010 t
Red emperor – 173 t
Goldband snapper – 457 t
Recreational – <1% of total (2008)
Charter – 3 t

Fishery Description

The demersal fisheries in this region target, to varying levels, some or all of the following species, bluespotted emperor (*Lethrinus punctulatus*), threadfin bream (Nemipteridae), brownstripe snapper (*Lutjanus vitta*), crimson snapper (*Lutjanus erythropterus*), red emperor (*Lutjanus sebae*), saddletail snapper (*Lutjanus malabaricus*), goldband snapper (*Pristipomoides multidens*), spangled emperor (*Lethrinus nebulosus*), frypan snapper (*Argyrops spinifer*) and Rankin cod (*Epinephelus multinotatus*).

Commercial

Pilbara: The Pilbara Demersal Finfish Fisheries are characterised by the Pilbara Fish Trawl (Interim) Managed Fishery, the Pilbara Trap Managed Fishery and the Pilbara Line Fishery. The trawl fishery dominates the landed catch of demersal finfish in the Pilbara targeting all 10 species, with a subset of the main species taken by the trap and then the line fishery.

Kimberley: 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. The main species landed are red emperor and goldband snapper.

Recreational

Recreational fishing activities are concentrated in inshore areas around key population centres, with a peak in activity during the dry season (winter months).

Governing legislation/fishing authority

Commercial

Pilbara

Pilbara Trap Limited Entry Fishery Notice 1992

North Coast Shark Fishing (Professional) Notice 1993 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).

Kimberley:

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 other subsidiary legislation.

Consultation processes

Commercial

Pilbara

Department–industry meetings for the fish trawl, trap and line fisheries.

Kimberley:

Department–industry meeting for the NDSF and an annual Broome Consultative Forum.

Recreational

Recreational Fishing Advisory Committee

Pilbara Regional Recreational Fishing Advisory Committee (Karratha)

West Kimberley Regional Recreational Fishing Advisory Committee (Broome)

Boundaries

Commercial

Pilbara

The Pilbara Trawl Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath (North Coast Figure 1).

The Fishery consists of two zones, Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas. Areas 1 to 6 each cover 1,300, 1,800, 880, 1,500, 2,300 and 7,200 square nautical miles respectively. The total area available for trawling is 14,980 square nautical miles, around 40% of this is utilised. 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 (North Coast Figure 1) lies north of latitude 21°44'S and between longitudes 114°9′36½E 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*.

The Pilbara Line fishing boat licensees are permitted to operate anywhere within "Pilbara waters". This means all waters bounded by a line commencing at the intersection of 21°56′S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia; thence west along the parallel to the intersection of 21°56′S latitude and the boundary of the Australian Fishing Zone. The exact latitudes and longitudes delineating the Fishery are listed in the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*.

Kimberley

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 (North Coast Figure 2). The fishery is further divided into two fishing areas, an inshore sector (Area 1) and an offshore sector (Area 2) (see

North Coast Figure 2). 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. Zone A is an inshore developmental area and Zone C is an offshore deepslope developmental area representing waters deeper than 200m. The inshore waters in the vicinity of Broome are closed to commercial fishing. The closed area extends from Cape Bossut to Cape Coulomb, inside a line that approximates, as closely as possible, the 30 m bathymetric contour. This closure was put in place to reduce the potential for conflict between commercial fishers and recreational fishers. This closure is represented in North Coast Figure 2 as the area closed to trap fishing. There is also an additional area around Broome in which commercial fishing is prohibited (North Coast Figure 2). These two commercial closure areas overlap to some degree.

Recreational

The north coast bioregion, which encompasses the Pilbara and Kimberley regions, extends from the Ashburton River south of Onslow to the WA/NT border (all land and water north of 21º46'S latitude and east of 114º50'E longitude), with the exception of some areas within Marine Parks.

Management arrangements

Commercial

Pilbara

The Trawl Fishery 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 (which has been closed to trawling since 1998), Area 3 of Zone 2, Area 6 of Zone 2 (which has been closed since the commencement of the plan except for the two periods of research trawling in 1998 and 1999), and the area inshore of the 50 m depth isobath. There is also a voluntary trawl closure at Glomar Shoals and in 2008, industry also initiated a voluntary closure to fishing in a significant proportion of Area 1. Since the implementation of the management framework, effort has been reduced and redistributed on the basis of annual assessments of the main target species. The Fishery is managed through a combination of area closures, gear restrictions, and 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).

There are a limited number of vessels operating in the Fishery. Currently, 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 Trap Fishery is also 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). There has also been a closure to trapping in Area 3 since 1998. A review of the Fishery was undertaken in 1996 and based on performance criteria, the number of licences was halved. In April 1997 this Fishery converted to trap units. The capacity of the Fishery is currently limited to 5867 trap units, however, the Management Plan allows the Chief Executive Officer to alter the value of these units. Each unit equals 1 trap, with licences being fully transferable and units may be transferred within the Fishery.

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 at the time. 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 2008.

The Line Fishery continues to be restricted by the *Prohibition on Fishing by Line from Fishing Boats (Pilbara Waters) Order 2006*. 9 vessels are exempted from this prohibition for any nominated 5-month block period within the year.

Comprehensive Ecologically Sustainable Development (ESD) assessments were submitted in 2004 for both the Pilbara Trap and Trawl Fisheries. 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 October 2009 (with a view for a further extension) provided progress continues in the development of strategies to mitigate catches of protected species.

Kimberley

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 Licences. The offshore area (Area 2) of the NDSF has separate allocations for each Zone (Zone A, Zone B and Zone C). An Exemption provides for additional effort in Zone C (50 standard fishing days per 160 unit 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 2008, 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 2008, the notional TAC for Zone A was 200 t of demersal scalefish and the total effort allocation was 616 standard fishing days. Access to Zone C is by exemption. Access to the offshore sector (Area 2) of the NDSF is currently limited to 11 licences under an individually transferable effort (ITE) system. This allows the effort quota to be operated by a lesser number of

vessels. For example, during 2008, 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 m3. There is no restriction on the number of traps that can be fished per vessel. However, as each licensee is allocated an annual effort quota in 'standard fishing days' based on the use of 20 traps (or 5 lines) per day, if the number of traps (or lines) being fished increases, the number of allowable fishing days declines. The number of days fished, as recorded by the vessel monitoring system, is converted to standard fishing days. A comprehensive 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.

Recreational

Demersal fish in the North Coast bioregion are assigned to a number of risk categories for the purposes of recreational fisheries management. The bag and size limits are species-specific of species group specific.

Demersal fish, particularly the icon species such as coral trout and red emperor, are considered prime recreational target species. As such, resource-sharing issues will be a consideration in future management arrangements across this bioregion.

Research summary

Pilbara

Monitoring of the Pilbara fishery includes the collection of spatial data on effort and catch of 10 major target species in the fish trawl and fish trap fisheries from logbooks, VMS data, and weighed catches from unload data. Otoliths are collected each year as part of the observer program for one of the indicator species, red emperor, Rankin cod, bluespotted emperor, and goldband snapper on a rotational basis.

The status of the Pilbara stocks is determined annually using catch and catch rates of the 10 major species, and every three to four years using the age-composition data collected in the previous years within an age-structured model.

Discussions are in progress on developing a collaborative project with CSIRO to update the work conducted by CSIRO in the 1980's on the North West Shelf benthos abundance and scalefish species composition.

Kimberley

The status of the demersal fish stocks in the NDSF is determined annually using catch and catch rates of the major species or species groups, and every three to four years using an age-based stock assessment model to assess the status of the two indicator species, red emperor and goldband snapper based on age-composition data collected in the previous years. Ongoing monitoring of this fishery is being undertaken using both CAES and VMS data.

An FRDC-funded research project commenced in late 2006. This project 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, and the sustainable catch from this zone is likely to be low.

Retained Species

Commercial landings (season 2008):

Pilbara Fish Trawl 1,210 tonnes

Pilbara Fish Trap 508 tonnes

Pilbara Line 86 tonnes

Kimberley (NDSF) 1010 tonnes

Pilbara

Catches of the major species for 2008 are shown in North Coast Table 1. The catches by different fishing methods for the years 1985 to 2008 are shown in North Coast Table 2.

The fish trawl catch decreased in 2008 and is below the target catch range. The decrease was due to a decreased catch and catch rate of some species. The major target species landed in 2008 (2007 catch in brackets) were bluespotted emperor 152 t (215 t), rosy threadfin bream 142 t (250 t), brownstripe snapper 47 t (112 t), crimson snapper 107t (214 t), red emperor 55 t (75 t), saddletail snapper 57 t (55 t), goldband snapper 78 t (85 t), spangled emperor 10 t (13 t) and Rankin cod 15 t (26 t). The total retained by-product was 37 t (36 t) including shark, bugs, cuttlefish, and squid.

The trap fishery catch increased slightly from 460 t in 2007 to 508 t in 2008. Major species taken by the trap fishery in 2008 (2007 figures in brackets) were bluespotted emperor 97 t (61 t), red emperor 97 t (111 t), Rankin cod 54 t (84 t), crimson snapper 34 t (56 t) spangled emperor 29 t (22 t) and goldband snapper 25 t (28 t). The trap catch was marginally outside the 400-500 t target catch range with the increase due to a change in the species composition of the catch.

Demersal scalefish catches taken by line fishing in 2008 were similar to that reported in 2007. The major species taken by the line fishery was goldband snapper 24 t, which comprised 28% of the total line catch (North Coast Table 1).

Kimberley

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 (North Coast Figure 8). Following 1996 catch levels decreased and were relatively stable in the period from 1998 to 2003; the catch began to increase in 2004. The total catch of demersal scalefish in the NDSF in 2008 was higher than that reported in 2007 due to an increased level of catch from Zone B of the fishery (North Coast Table 7).

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 North Coast Table 7. The species composition of the landed catch in 2008 is similar to that reported in 2007. In 2008 the catch of red emperor was stable (North Coast Figure 9), however, there was an increase in the landed catch of

goldband snapper up from 393 t in 2007 to 457 t in 2008 (North Coast Figure 10), as well as an increase in the cods/groupers catch, up from 121 t in 2007 to 148 t in 2008 (North Coast Figure 11). The composition of the cod/grouper catch complex is dominated by one species, the Rankin cod (*Epinephelus multinotatus*). The catch of Rankin cod increased from 2007 to 2008. The catch of the major species by zone in the NDSF is described in North Coast Table 8.

The 2008 catch of goldband snapper was above the acceptable levels for the fifth consecutive year (see 'Fishery Governance' section). Similarly, the 2008 level of catch of the cod/grouper complex was also above the acceptable level. The 2008 level of catch of red emperor was below the acceptable level.

The commercial catches of key species and species groups from across the North Coast bioregion and their relative contribution to catches within the Pilbara and Kimberley sectors in 2008 are summarised in North Coast Table 10.

Recreational catch estimate (season 2008):

Pilbara 1%

Kimberley <1%

Pilbara

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 spatial separation between the user groups. The recreational and charter sectors do not catch significant quantities of most species targeted by the commercial Pilbara fish trawl, trap and line fisheries. The reported charter vessel catch of demersal scalefish in the offshore waters of the Pilbara (depth > 30 m) in 2008 is estimated to be 1% (~19 t) of the commercial catch. Due to the increasing population in the Pilbara from mining developments, catches are likely to increase in the future.

Kimberley

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. The reported charter vessel catch of demersal scalefish in the offshore waters of the NDSF (depth > 30 m) in 2008 is estimated to be less than 1% (~3 t) 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

Pilbara

The fishing effort in the trap and line sectors of the commercial fishery is based on the monthly catch and effort returns (North Coast Table 3). The trawl fishery effort is 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 and the percentage of the allocation used over the period 1998–2008 are shown in North Coast Table 4. While the effort allocation are on a financial year basis (July 1 to June 30) the effort is reported here in calendar years. Note, that 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 2000–2008 are shown in North Coast Table 5. In 2008, the trap boats were allocated 6,188 trap days (capacity is set in trap days with a value per unit of 1 unit = 1 trap day), with 97% of the units used as calculated from the VMS. This number of units equates to 476 days allocated and 461 days fished with an average of 11.5 traps per day.

In 2008, line fishers reported operating for 326 days, compared with 385 days in 2007.

Kimberley

The seven fish trap vessels that fished in the NDSF in 2008 reported using between 20 and 48 fish traps per day. No line fishing was undertaken in Zone B of the NDSF in 2008. The history of effort allocation in the NDSF since the introduction of the ITE management system in 1998 is detailed in North Coast Table 9.

The effort allocated in Zone B in 2008 was 104 fishing boat days per licence, or a total of 1,144 standard fishing days (i.e. using 20 traps) (North Coast Table 9). The number of standard fishing days (SFDs) recorded using VMS data was 1,028 SFDs (90%).

The effort allocated in Zone A in 2008 was 66 fishing boat days per 160 unit licence, or a total of 616 standard fishing days (i.e. using 20 traps). The number of standard fishing days (SFDs) recorded using VMS data was 90, indicating that 85% 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 unutilized effort available.

Stock Assessment

Assessment complete: Pilbara – Yes

Kimberley – Yes

Assessment method: Pilbara – Age Structured Model

Kimberley – Age Structured Model

Breeding stock levels:

Pilbara – Trap Fishery -– Acceptable

– Trawl Fishery – Acceptable

Kimberley – Acceptable

Pilbara

The catch rates shown in North Coast Figures 3 to 6 are derived using logbook catch data and scaling this up with the unload data, so the catch matches the reported unloads and the

spatial component is obtained from the logbooks. The effort data used was the duration of the trawl shots. This is a new analysis as the previous 10 years of catch rate analysis used VMS data as the effort measure. The fish trawl shot time was considered more reliable for this assessment. The catch and effort was pooled for each vessel and month and an ANOVA used to determine the annual catch rate and 95% confidence intervals with a natural log transformation. A moderate efficiency measure, the same as previous assessments, was included in the graphs but not the analysis.

There has been a decrease in the total catch rate and also the catch rate for several species including Rankin cod, red emperor, bluespotted emperor and crimson snapper (North Coast Figures 3-6). The opposite was observed in the trap fishery with increased catch rates of Rankin cod and red emperor.

A comprehensive assessment was conducted for red emperor and Rankin cod using an age-structured model to integrate catch and effort data, biological information and age composition data (including ages from fish collected in 2006, North Coast Figure 7). The assessment indicated that the spawning biomass for these indicator species of the Pilbara Demersal Fishery as a whole was above the target level indicating satisfactory breeding stock levels.

The estimates of fishing mortality for red emperor in the trawl fishery in 2007 in Areas 1, 2, 4, and 5 were 0.135, 0.164, 0.098, 0.085 respectively. In Area 1 and 2, the level is above the target level of natural mortality (0.12). The estimate of fishing mortality from Rankin cod otoliths collected in 2006 was 0.12, less than the natural mortality (0.14).

The high rate of fishing mortality of red emperor in the east of the fishery, and the declining catch rates of several species including the indicator species red emperor and Rankin cod imply that reductions in effort may be required across the trawl fishery and that a review should be undertaken in 2009 to further assess management implications.

Pilbara: 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 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.

Kimberley

The catch per unit of effort from the fishery provides an indicator of variations in stock abundance, but changes in vessel efficiency must be taken into account using these data.

During 2008, Zone B catch rates for the indicator species were 147 kg/std day for red emperor, 434 kg/std day for goldband snapper and 126 kg/std day for cods/groupers. In the case of both goldband snapper and cods/groupers, the catch rates in 2008 were higher than those recorded in 2007, whereas the catch rate for red emperor was about the same.

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 2009 fishing season is outlined in the 'Target catch range' section below.

The levels of catch of goldband snapper and the cods/groupers exceeded 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 2007 and 2006. Whilst increased efficiency and/or stock levels will increase catch rates, these increases in catch levels need to be assessed to determine if there has been any change in species targeting and/or increased exploitation of any particular species. A review of the stock assessment of the key target species in the NDSF is in progress.

The spawning biomass of the key target species in the NDSF has been estimated by an age-structured stock assessment model in relation to the accepted international reference point for these types of species of 40% of virgin biomass.

The 2002 assessment of breeding stock levels for the two key species was generated from the stock assessment model that incorporated the historical catch history and catch rate data. 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.

The updated model outputs from the 2008 assessment are currently under review.

NDSF: 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 2008, the catches of goldband snapper and the cods/groupers exceeded the performance indicator of a 20% increase in catch above the average catch of the preceding four years. The 2008 level of catch of red emperor was below the performance indicator. As abundance has probably been maintained at higher levels, 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 that is currently in progress.

Non-Retained Species

Bycatch species impact: Pilbara – Moderate

Kimberley – Low

Pilbara

Bycatch in the fish trawl fishery continues to be monitored with an observer program coverage target of 22% of all fish trawl shots. The fish trap and line fisheries have minimal bycatch (see Kimberley below).

Kimberley

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: Pilbara – Moderate
Kimberley – Negligible

Pilbara

The fish trawl fishery has an incidental capture of bottle nosed 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 Commonwealth Department of Environment, Water, Heritage and the Arts. The reported catch of protected species in 2008 is shown in North Coast Table 6. The bycatch of dolphins and turtles was considerably lower in 2008 than in 2007 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 fish trawl fishery on the stocks of these protected species is likely to be 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 (see Kimberley below).

Pilbara: 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 2008, the dolphin mortality rate was 3.3 per 1000 shots; this is the lowest level for 4 years. The present catch rate is half that in 2005 when grids were used and one-tenth that in 2005 when grids were not being used. The turtle catch rate was very low at 1.1 per 1000 shots. Sygnathid, sawfish, and seasnake catches were all below their maximum levels and therefore their catch level is considered acceptable (North Coast Table 6).

Kimberley

Trap fishing across the continental shelf 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 that limits its capacity to pass through the entrance funnel into the traps.

Ecosystem Effects

Food chain effects: Pilbara – Low
Kimberley – Not assessed

Pilbara

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 fish 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 fish trawl, fish 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: Pilbara – Moderate
Kimberley – Low

Pilbara

Impacts to the habitat are limited to those of the fish trawl fishery, which is restricted to around 7% of the North West Shelf (North Coast Figure 1). Area 3 and the waters inside 50 m are permanently closed to fish trawling, Zone 1 is currently closed to fish trawling, and Area 6 has had no fish trawl effort allocation since 1998.

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.

Pilbara: The performance measure for the fish 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. Plots of trawl activity from VMS data indicate the actual area trawled being less than this as some of this area is too rough to be trawled.

Kimberley

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 the fish species targeted have been observed on video to be able to exit traps.

Social Effects

Pilbara

It is estimated that 22 fishers on 4 vessels were directly employed during 2008 in the Pilbara Fish Trawl Fishery, and 6 fishers on 2 vessels in the trap fishery. The level of employment in the line-fishing sector is not available. At least 30 people were directly employed in the Pilbara demersal scalefish fisheries.

Kimberley

Seven vessels fished in the 2008-fishing season, with generally around three crew per vessel, indicating that at least 21 people were directly employed in the NDSF.

Economic Effects

Estimated annual commercial value (to fishers) for year 2008: $13.1 Million

Pilbara – $7.4 Million

Kimberley – $5.7 Million

Pilbara

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 few years. The fish trawl demersal finfish catch is dominated by lower-valued species such as bluespotted emperor and threadfin bream, and its value in 2008 was $4.4 million. The fish 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 $2.7 million (fish trap) and $0.25 million (line). The fish trawl fishery also has a small amount of 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 few years due to the increased value of the Australian dollar.

Kimberley

The NDSF principally targets the higher-value species such as the goldband snapper and red emperor. The fishery landed a total of 1010 t of demersal scalefish in 2008, for a catch value of approximately $5.7 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

Current Fishing (or Effort) Level

Pilbara – Trap Fishery – Acceptable

– Trawl Fishery – Acceptable

(although review required)

Kimberley – Unacceptable

Pilbara

The stock assessment models indicated the breeding stock levels are adequate for the indicator species red emperor and Rankin cod but the current effort levels in the trawl fishery may require revision.

Kimberley

The effort allocated in 2008 translated into a level of catch above the notional TAC and above the target commercial catch range with 10% of the effort unutilised. Catches have exceeded the trigger levels for two of the indicator species/species groups. A stock assessment review of the fishery is in progress.

Target commercial catch range:

Pilbara Fish Trawl 2,000–2,800 tonnes

Pilbara Fish Trap 400–500 tonnes

Pilbara Line 50–115 tonnes

Kimberley (NDSF) 600–1000 tonnes

Pilbara

In the fish trawl fishery, the total catch was below the target catch range. The target catch range for the trawl fishery will be revised in 2009 in association with a review of the status of the indicator species. In the fish trap fishery, the target catch range has been adjusted due to an increased stock size with the current fish trap catch being slightly above the revised catch range. The line catch is within the acceptable catch range.

Kimberley

A stock assessment review of the fishery is in progress and these results will be finalized during 2009. For the 2009 calendar year, the total allowable effort in Zone B of the fishery has been set at 1,144 standard fishing days, distributed equally among each of the 11 licences in the fishery. At this level of effort and at recent catch rates, the catch is expected to be in the range 600–1,000 t. A further 616 standard fishing days has been allocated to fishers to facilitate the exploration and development of Zone A of the fishery 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 2008, across the fishery (all zones) the acceptable level of catch (average + 20%) for red emperor was less than 204 t, for goldband snapper less than 433 t, and for the cods/groupers less than 139 t. The goldband snapper and the cods/groupers performance measures were exceeded in 2008, with the red emperor catch below the trigger level.

New management initiatives (2009)

Pilbara

The Interim Management Plan has recently been extended a further two years to June 2011. Such an extension will provide for the conclusion of the current Fisheries Research and Development Corporation (FRDC) Project 2008/048 ‘Reducing dolphin bycatch in the Pilbara finfish trawl fishery’, and assessment regarding the long-term future of the Pilbara Fish Trawl Fishery, including consideration of moving the fishery to “managed” fishery status.

The harvest rates are variable in different areas of the trawl fishery and effort levels for each area are assessed on an annual basis with risk levels of target species consistently monitored and information on bycatch/protected species regularly recorded. Acceptable catch ranges and management responses are devised according to assessment.

The harvest rates are variable in different areas of the trawl fishery and effort levels will be reduced in the west of the fishery where they are highest.

Kimberley

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. An independent review of the stock assessment of the key target species in the NDSF is in progress. The outcomes of the review will be considered in future management arrangements.

External Factors

Pilbara

The available fishing area 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.

Kimberley

The impacts of environmental variation on the fishery are not considered to be large as the target species are long-lived. 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.

NORTH COAST TABLE 1

Commercial catches (tonnes) and the percentages of each major species taken by trawl, trap and line in the Pilbara in 2008.

Species		Trawl catch		Trap catch		Line catch		Total catch
		tonnes	%	tonnes	%	tonnes	%	tonnes
Bluespotted emperor	*Lethrinus punctulatus*	152	61%	97	39%	–	–	249
Crimson snapper	*Lutjanus erythropterus*	107	72%	34	23%	7	5%	148
Rosy threadfin bream	*Nemipterus furcosus*	142	99%	1	1%	–	–	143
Brownstripe emperor	*Lutjanus vitta*	47	84%	9	16%	–	–	56
Goldband snapper	*Pristipomoides multidens*	78	61%	25	20%	24	19%	127
Red emperor	*Lutjanus sebae*	55	36%	97	63%	1	1%	153
Saddletail snapper	*Lutjanus malabaricus*	57	64%	29	32%	4	4%	90
Spangled emperor	*Lethrinus nebulosus*	10	25%	29	73%	1	2%	40
Frypan snapper	*Argyrops spinifer*	53	95%	3	5%	0	0%	56
Rankin cod	*Epinephelus multinotatus*	15	22%	54	77%	1	1%	70
Other demersal scalefish		494	73%	130	19%	48	7%	672
All demersal scalefish		**1,210**	**67%**	**508**	**28%**	**86**	**5%**	**1,804**

NORTH COAST 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.

	DEMERSAL SCALEFISH				BY-PRODUCT*
YEAR	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
2008	**86**	**508**	**1,210**	**1,804**	**37**

* By-product in 2008 consists of shark, cuttlefish, squid, bugs, and tropical lobster.

NORTH COAST 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	1014	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
2008	**326**	**461**	**711**	**11,966**

NORTH COAST 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 % of time used exceeded the allocation due to the licensing year changing to 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%
2008	**time allocation**	**4,797**	**3,796**	**0**	**3,528**	**5,140**	**17,261**
TRAWL	**time used**	**5,840**	**3,788**	**0**	**3,258**	**4,495**	**17,381**
	% of time used	**122%**	**100%**	**–**	**92%**	**87%**	**101%**

NORTH COAST 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%
2008	**time allocation**	**476**
TRAP	**time used**	**461**
	% of time used	**97%**

NORTH COAST TABLE 6

Reported by-catch of protected species by skippers in the Pilbara trawl fishery in 2008.

	Number Alive	Number Dead*	Total Reported
bottlenosed dolphins	5	11	17
pipefish	30	124	155
sawfish, green	16	3	21
sawfish, narrow	27	6	33
seahorses	4	6	10
sea-snakes	81	30	112
turtles, green	6	0	6
turtles, loggerhead	0	0	0
turtles, olive ridley	0	0	0

*Where the condition was not reported, the animal was considered deceased.

NORTH COAST TABLE 7

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)**					
	2003	**2004**	**2005**	**2006**	**2007**	**2008**
Goldband snapper (*Pristipomoides* spp.)	226	283	429	336	393	457
Red emperor (*Lutjanus sebae*)	118	144	192	166	176	173
Scarlet perch (*Lutjanus malabaricus*)	48	68	92	79	96	104
Spangled emperor (*Lethrinus nebulosus*)	39	33	21	28	14	18
Cod/grouper (Serranidae)	74	103	110	129	121	148
Other species	47	59	78	63	108	110
Total demersal scalefish catch	**552**	**690**	**922**	**801**	**908**	**1010**

NORTH COAST TABLE 8

Catches of major target and by-product species or species groups by zone in the NDSF in 2007 and 2008.

Species	**NDSF annual catch (tonnes)**			
	2007		**2008**	
	Zone A & C	**Zone B**	**Zone A & C**	**Zone B**
Goldband snapper (*Pristipomoides* spp.)	20.2	373.0	13.7	443.0
Red emperor (*Lutjanus sebae*)	19.6	156.9	20.0	152.6
Scarlet perch (*Lutjanus malabaricus*)	7.2	89.0	5.3	99.0
Spangled emperor (*Lethrinus nebulosus*)	0.4	14.1	1.4	17.0
Rankin cod (*Epinephelus multinotatus*)	8.2	32.3	9.4	47.6
Other Cods/groupers (Serranidae)	7.7	73.1	9.8	81.7
Other species	27.7	78.3	20.4	88.9
Total demersal scalefish catch	**91**	**817**	**80**	**930**

NORTH COAST TABLE 9

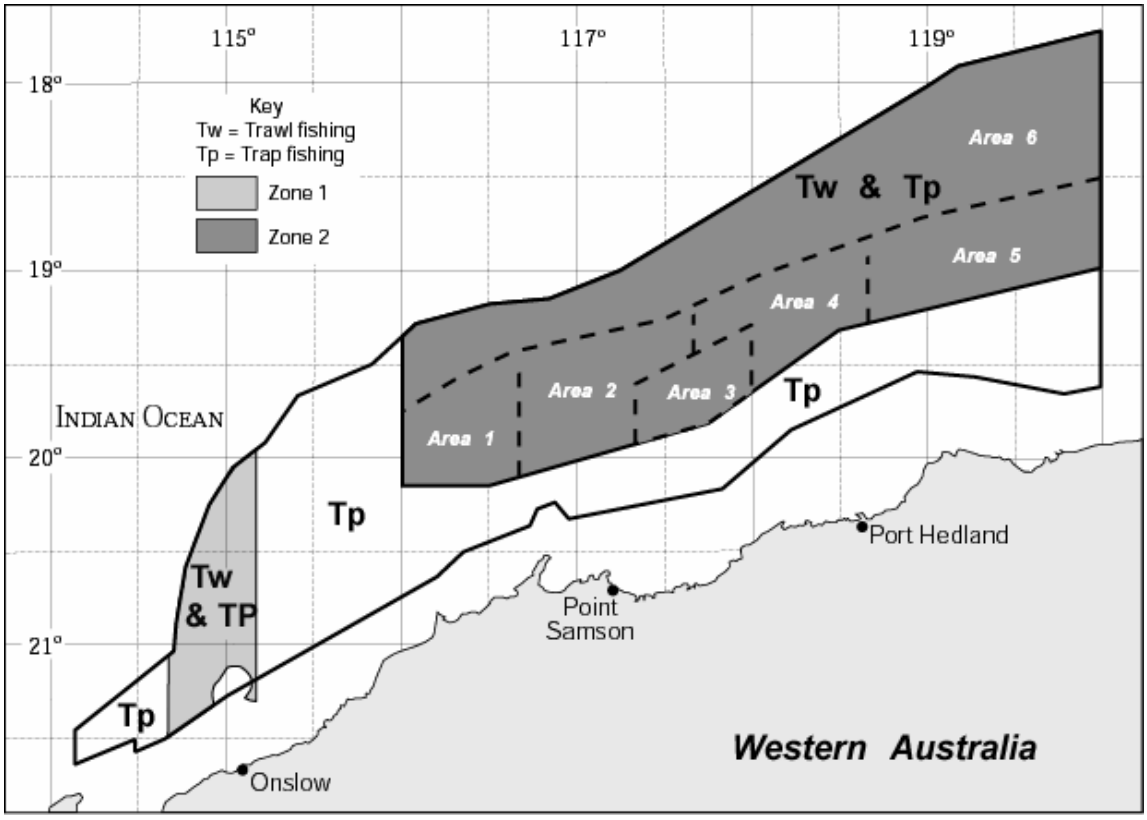
Total catches (t) of demersal finfish and effort (days) by line and trap vessels in the NDSF since the introduction of full management arrangements in 1998.

Year	Total allowable effort (days)	Line catch (t)	Line effort (days)	Trap catch (t)	Trap effort (days)	Total catch (t)
1998	1,684	45	78	497	916	542
1999	1,716	91	228	486	992	577
2000	1,562	67	155	409	890	476
2001	1,672	47	136	462	928	509
2002	1,760	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
2007	1,144	0	0	908	1,235	908
2008	**1,144**	**7**	**--**	**1,003**	**1,150**	**1,010**
(Estimated Catch: Zone A = 69t, Zone B = 930t; Estimated Effort: Zone A = 90 SFDs, Zone B = 1,028 SFDs)						

NORTH COAST TABLE 10

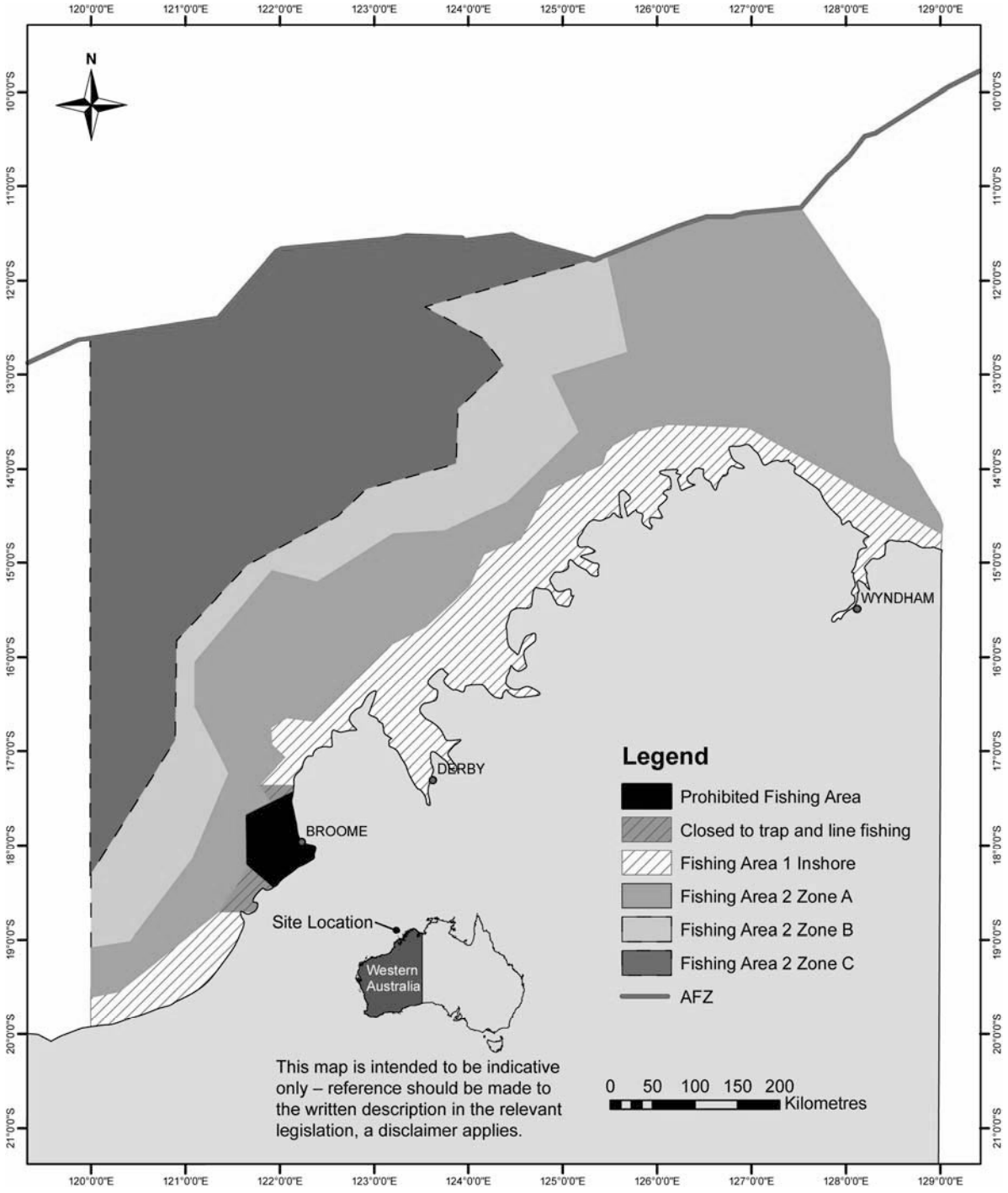
Summary of the commercial catches and the relative contribution (% composition) of each of the major species taken within the Pilbara and Kimberley sectors of the North Coast bioregion in 2008.

Species	Pilbara catch		Kimberley (NDSF) catch		Total catch		
	tonnes	%	tonnes	%	tonnes		
Red emperor			153	47%	173	53%	326
Saddletail snapper			90	46%	104	54%	194
Crimson snapper			148	93%	12	7%	160
Brownstripe snapper			56	93%	4	7%	60
Goldband snapper			127	22%	457	78%	584
Spangled emperor			40	69%	18	31%	58
Bluespotted emperor			249	93%	19	7%	268
Rankin cod			70	55%	57	45%	127
Frypan snapper			56	100%	<1	0%	56
Rosy threadfin bream			143	100%	0	0%	143
Other demersal scalefish				672	91%	166	9%
			838				
Total all demersal scalefish	***1804***	***64%***	***1010***	***36%***	***2814***		



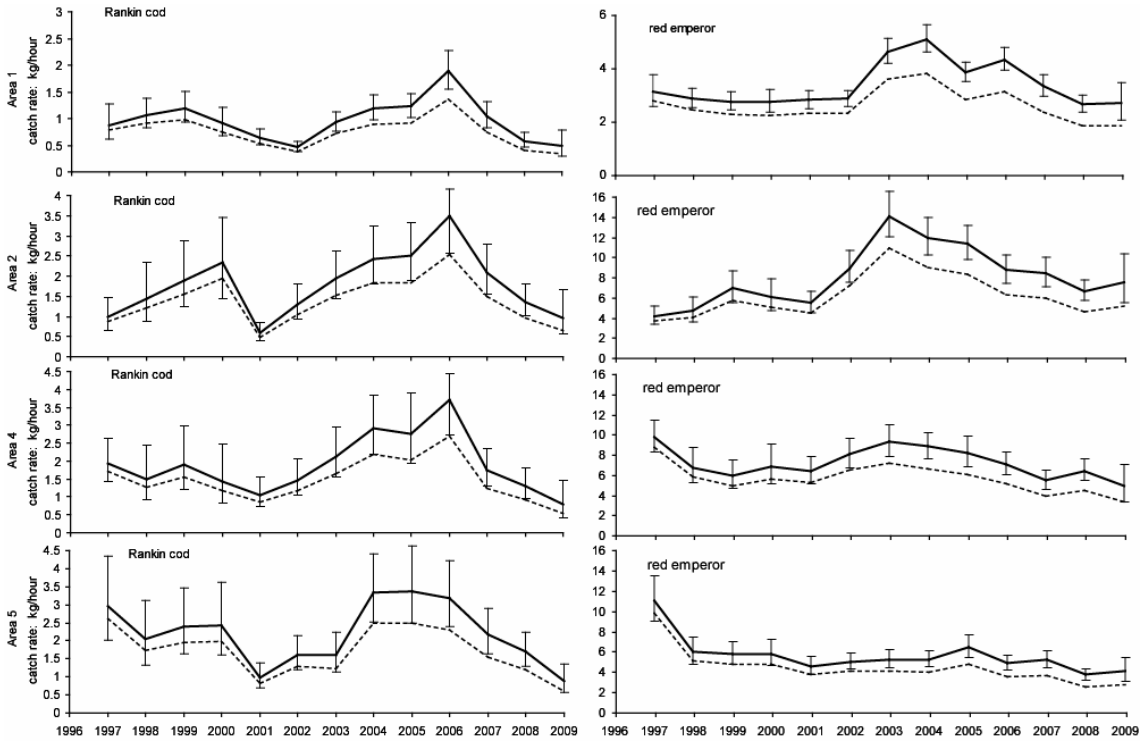
NORTH COAST FIGURE 1

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.



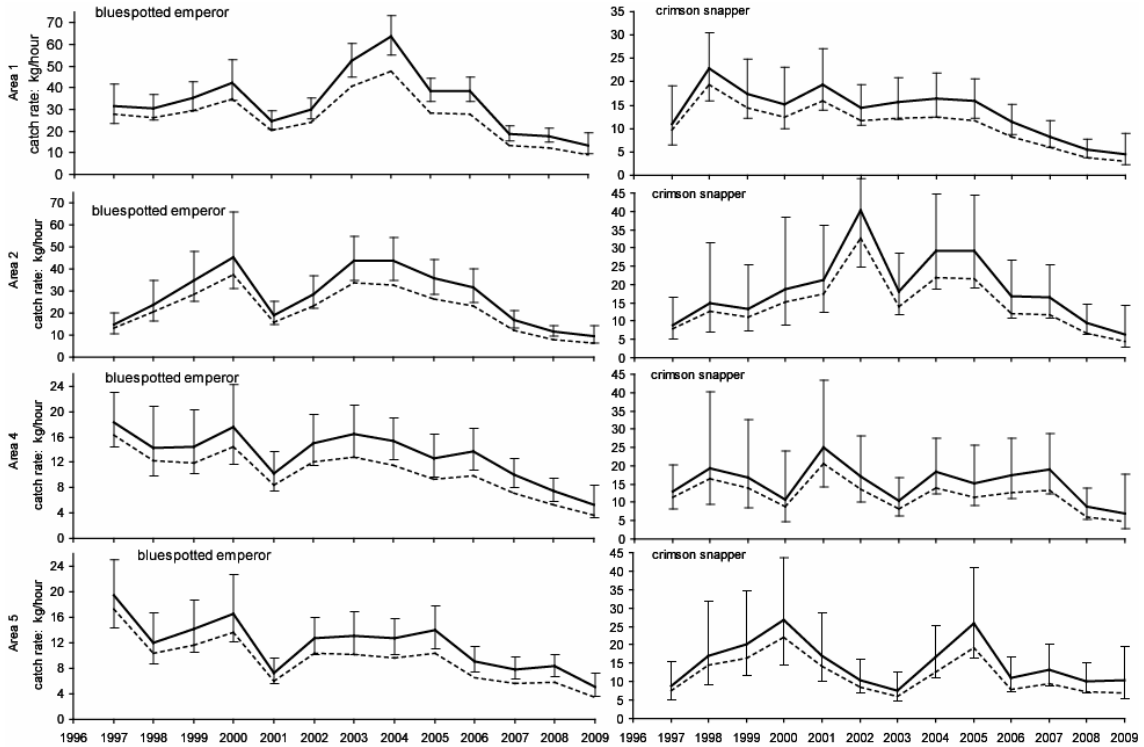
NORTH COAST FIGURE 2

Location of the Northern Demersal Scalefish Managed Fishery in the Kimberley region of Western Australia. Access areas and boundaries within the fishery are shown.



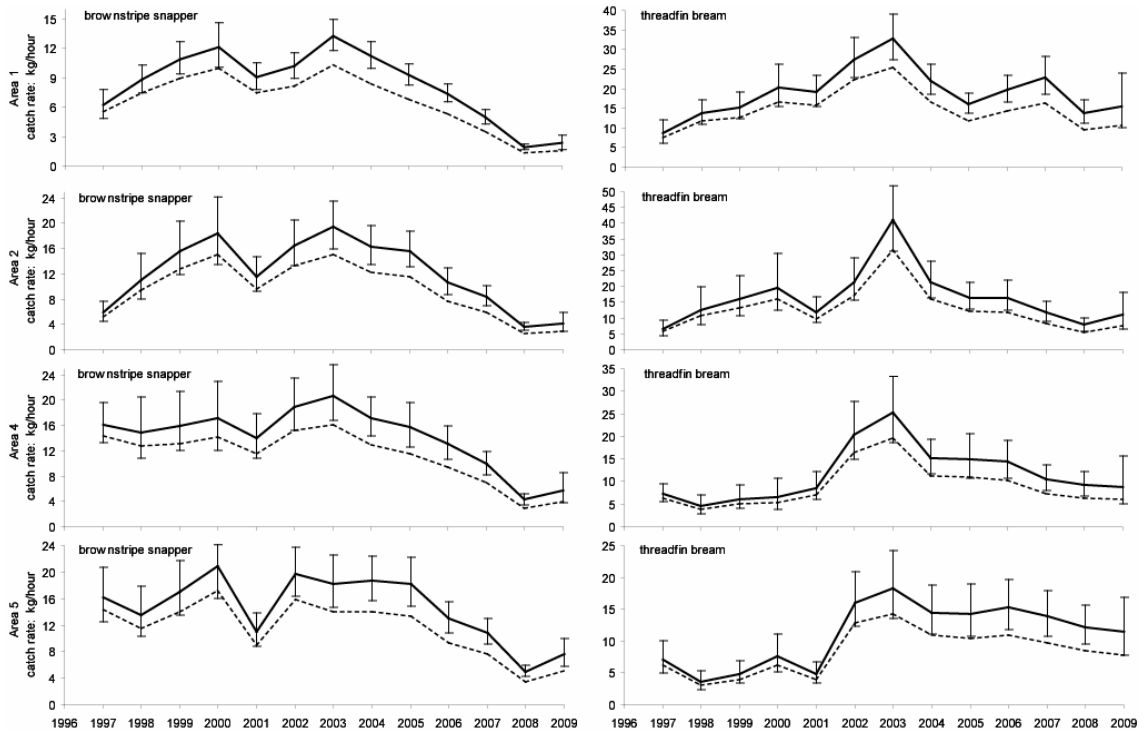
NORTH COAST FIGURE 3

Catch per unit effort (kg/hour) for Rankin cod and red emperor in Area 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1997–2009 (first 4 months). The dotted line is catch rate incorporating efficiency increase.



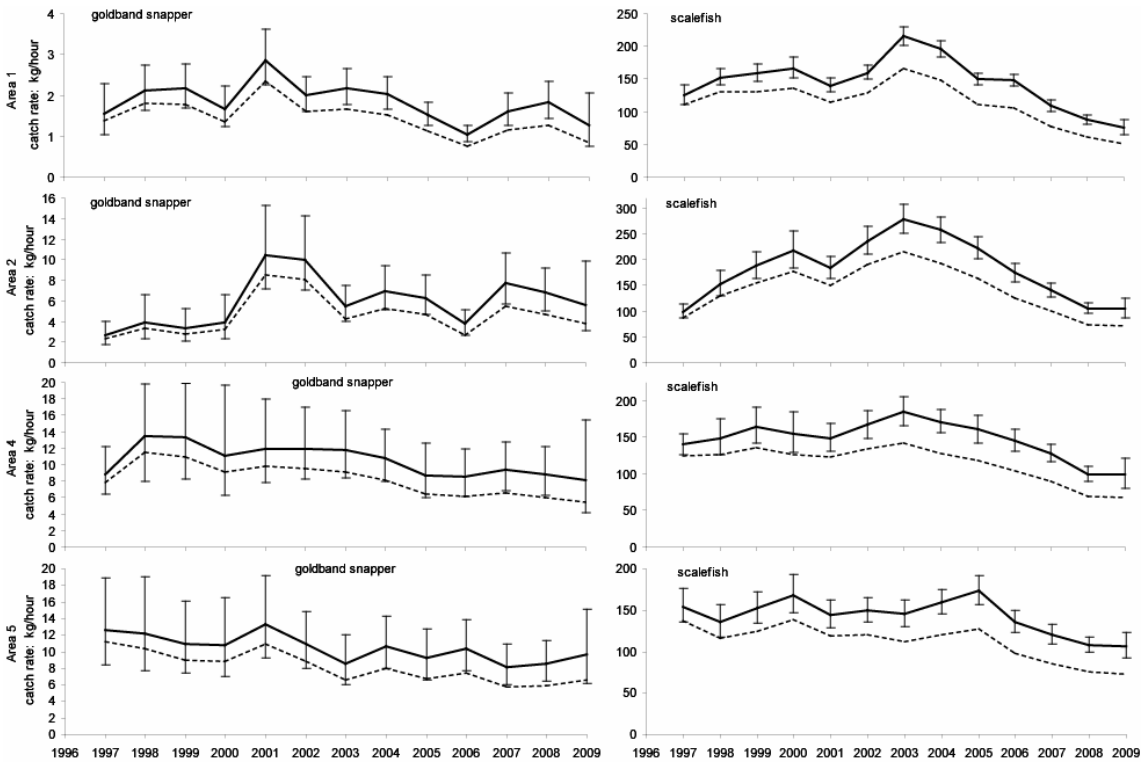
NORTH COAST FIGURE 4

Catch per unit effort (kg/hour) for bluespotted emperor and crimson snapper in Area 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1997–2009 (first 4 months). The dotted line is catch rate incorporating with efficiency increase.



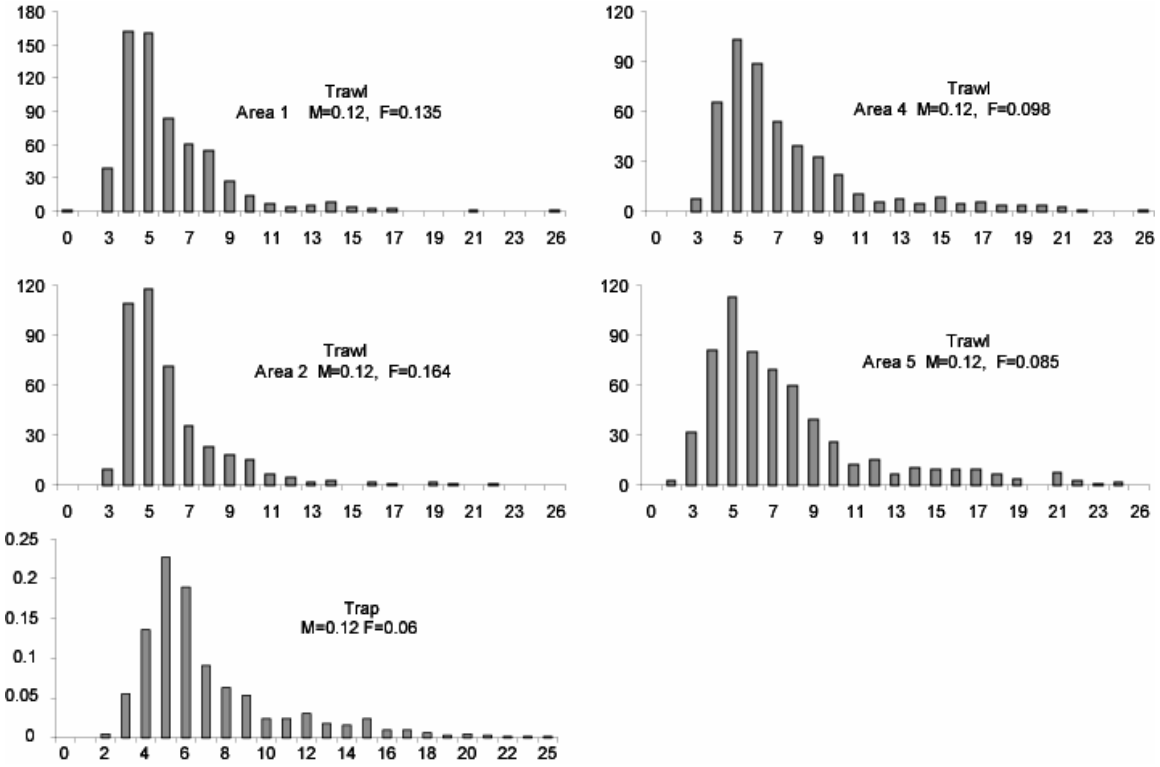
NORTH COAST FIGURE 5

Catch per unit effort (kg/hour) for brownstripe snapper and threadfin bream in Area 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1997–2009 (first 4 months). The dotted line is catch rate incorporating efficiency increase.



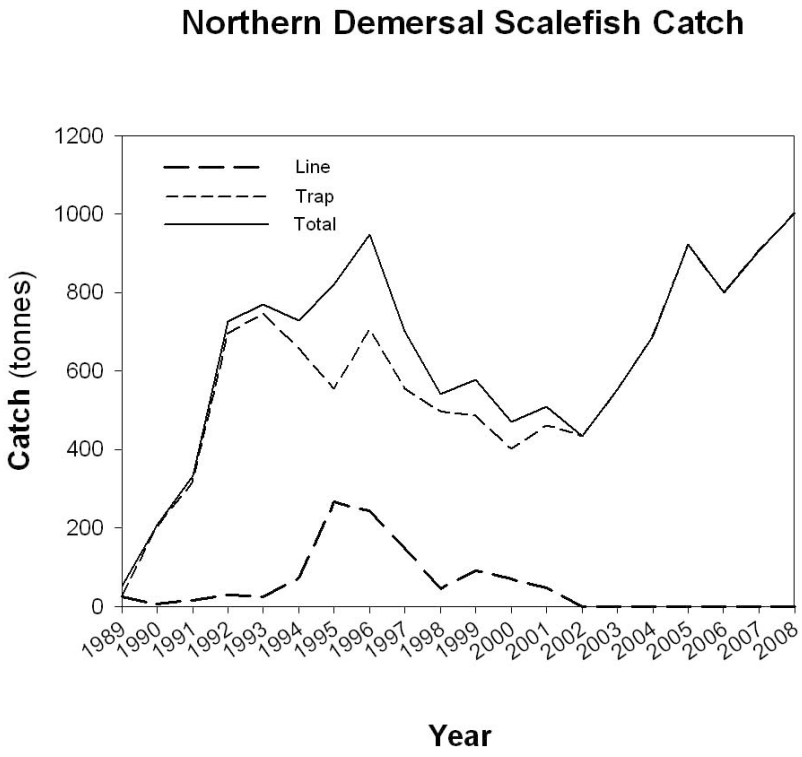
NORTH COAST FIGURE 6

Catch per unit effort (kg/hour) for goldband snapper and all scalefish in Area 1, 2, 4 and 5 of the Pilbara Trawl Fishery from 1997–2009 (first 4 months). The dotted line is catch rate incorporating efficiency increase.



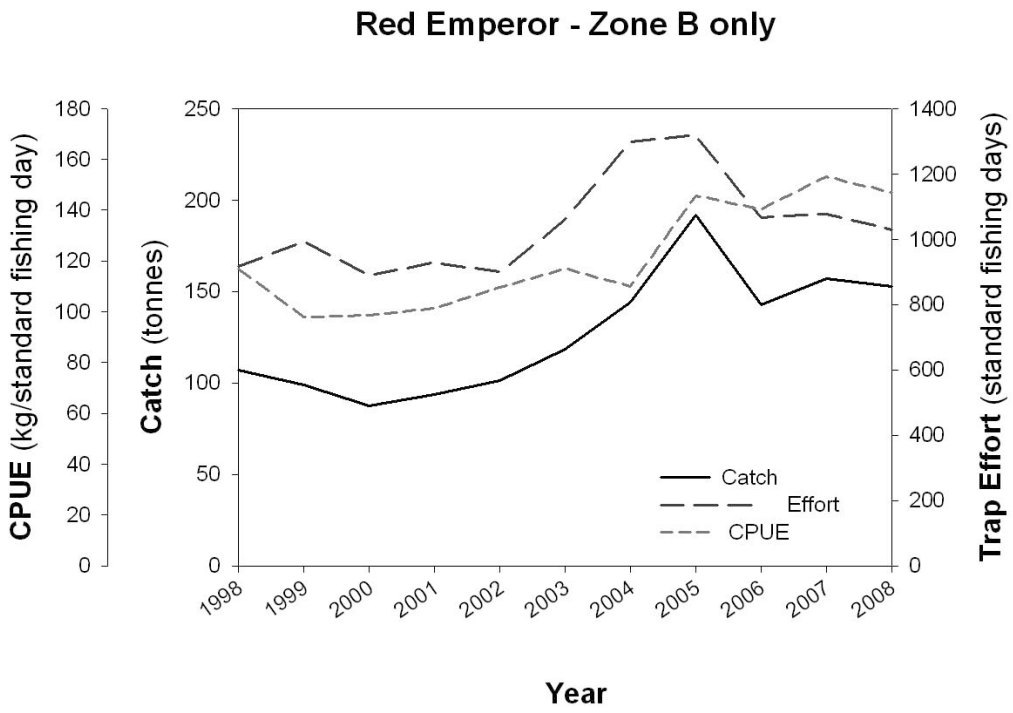
NORTH COAST FIGURE 7

Red emperor age-composition from otoliths collected in 2007 from the trawl fishery catch in Areas 1, 2, 3, and 5 and from the trap catch across the whole fishery.



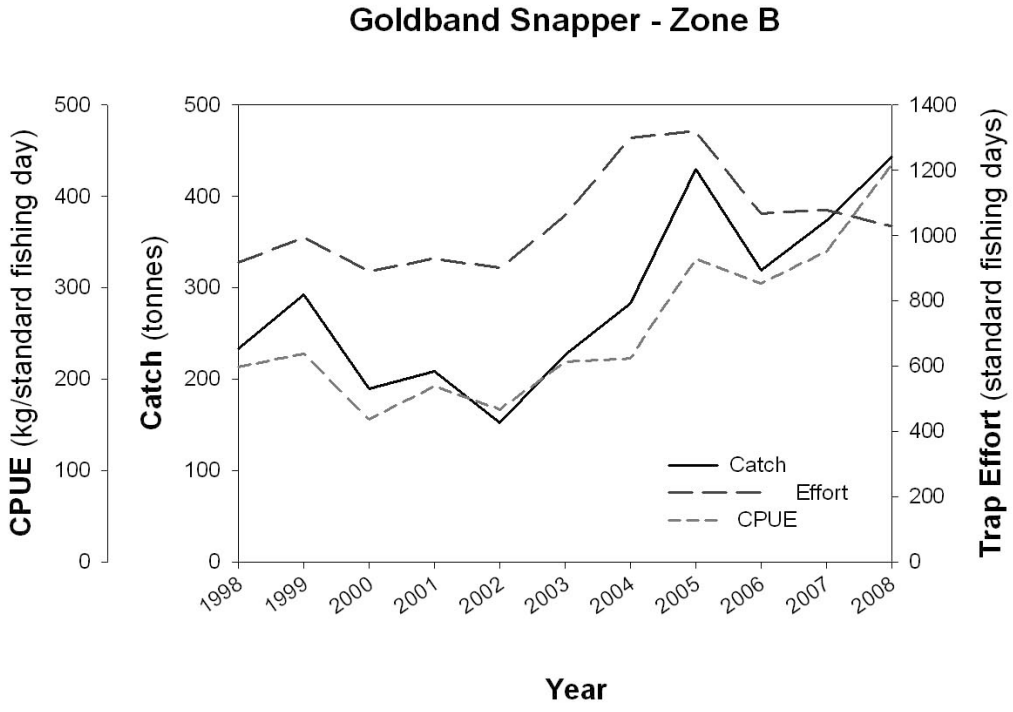
NORTH COAST FIGURE 8

Catch levels of demersal finfish in the NDSF by line and trap, 1989–2008.



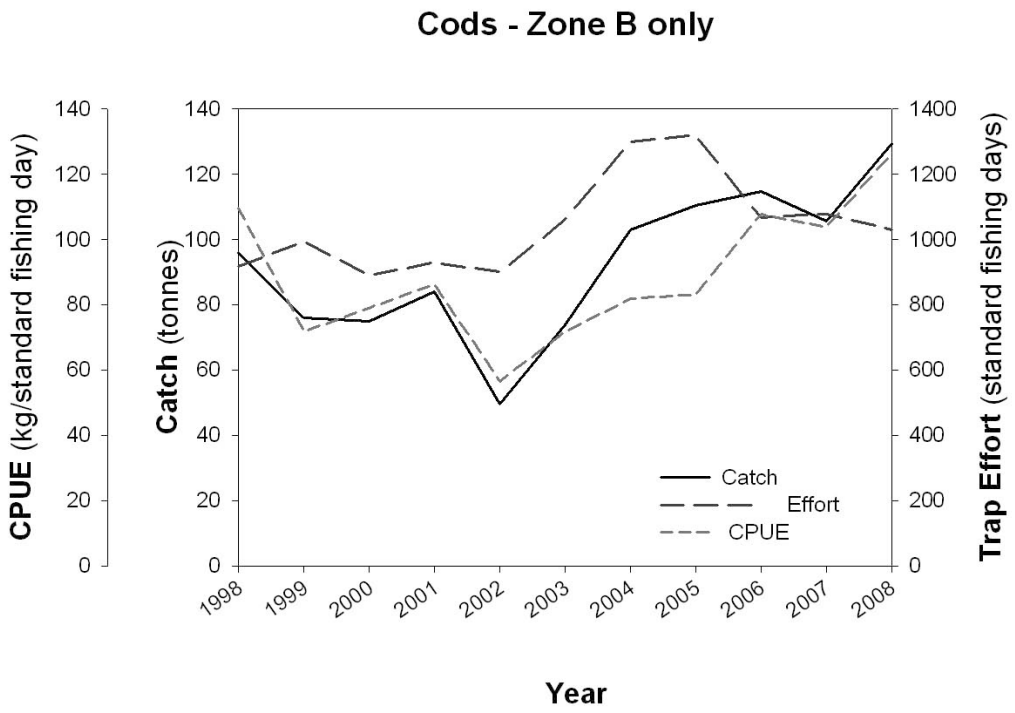
NORTH COAST FIGURE 9

Catch, effort and catch per unit of effort of red emperor in the NDSF by trap, 1998–2008.



NORTH COAST FIGURE 10

Catch, effort and catch per unit of effort of goldband snapper in the NDSF by trap, 1998–2008.



NORTH COAST FIGURE 11

Catch, effort and catch per unit of effort of all cods in the NDSF by trap, 1998–2008.

Mackerel Managed Fishery Report: Statistics Only

B. Molony and E. Lai
Management input from N. Moore

Fishery Description

Commercial

This fishery uses mainly near-surface trolling gear from small vessels in coastal areas around reefs, shoals and headlands to target mainly Spanish mackerel *(Scomberomorus commerson)*. Jig fishing is also used to capture grey mackerel *(S. semifasciatus)*, the other major species. Other species from the genera Scomberomorus, Grammatorcynus and Acanthocybium also contribute to commercial catches.

Recreational

Recreational fishers target similar species using a range gears including trolls, shore-based drift fishing with balloons and spearguns.

Boundaries

Commercial

From the West Coast Bioregion to the WA/NT border, with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Catches are reported for four areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 - Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).

Recreational

The fishery operates between the West Coast Bioregion and the WA/NT border, with most activity occurring between Perth and Dampier.

Management arrangements

Commercial

The fishery is subject to an interim management plan, which commenced in August 2004, with fishing commencing under the plan in 2005. In the 2007 and 2008 fishing seasons, the Chief Executive Officer determined 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. Boats operating in the fishery are monitored by VMS and the master of an authorised boat is required to submit logbook returns and catch and disposal records. Seasonal closures were removed in May 2008, as they were no longer a necessary tool to maintain sustainable and efficient management of the fishery after

quotas were put in place in 2006. A management plan amendment in May 2008 permits the heading of broad-barred Spanish mackerel as compliance experience over the last two seasons indicates this will not be detrimental to the integrity of the quota management system. The amendment also modifies the minimum operating holding from a percentage of units to a real number.

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.

Landings and Effort (Season 2008)

Spanish mackerel: 323.4 tonnes

Grey mackerel: 17.7 tonnes

Other mackerel: 1.4 tonnes

Commercial

Estimates of catches are monitored through the mandatory logbook systems. The majority of the catch is taken in the Kimberly region, reflecting the tropical distribution of mackerel species (Spanish mackerel Figure 1). The total catch of Spanish mackerel in the 2008 season was estimated at 323.4 tonnes. This is similar to the total catch taken in 2007. An additional 19.4 tonnes of other mackerel were landed in 2008 which is higher than in 2007. Each of these estimates does not include fish that are caught and released or fish damaged by sharks.

Recreational

Estimates of catches are only available through creel surveys which occur periodically (Table 1). Estimates of catch share reflect the proportion of the total catches taken by recreational anglers. These estimates do not include fish that are caught and released or fish damaged by sharks. Reported catches of Spanish mackerel by recreational charter boats are relatively minor.

Fishery Governance

Target commercial catch range: 246 – 410 tonnes

The total catch in 2008 was 323.3 t, was within the acceptable catch range. Within each zone, the reported catches were within the acceptable catch range for the Kimberley of 194 tonnes (110 – 205 t) and Gascoyne/West Coast 56.5 tonnes (56 – 79 t) areas. The catch in the Pilbara area of 72.4 tonnes (80 – 126 t) was slightly below the acceptable range.

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 2008 was within the target catch range and overall catch rates have been increasing since 2000.

Current Fishing (or Effort) Level — Acceptable

Fishing effort throughout the fishery appears has stabilised since 2006 following declines due to management changes. This is reflected by an increasing catch rate in the fishery.

New management initiatives (2009/10)

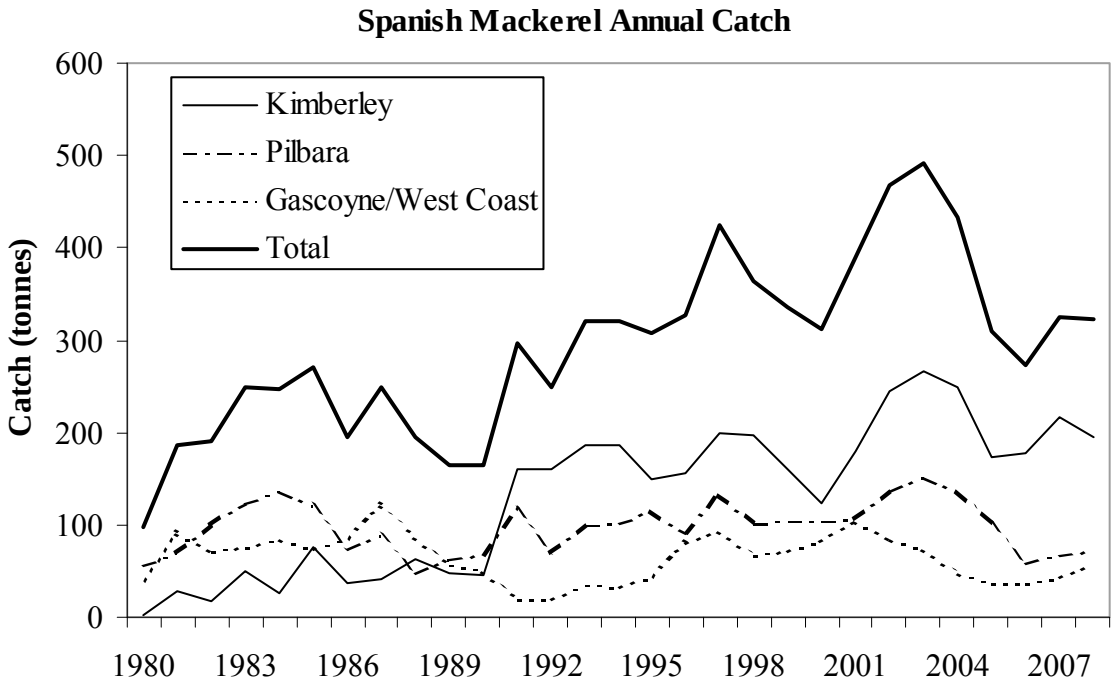
In December 2009 the current plan will expire and consideration will be given to moving the fishery to full management plan status.

The fishery was exempt from the export controls of the *Environment Protection and Biodiversity Conservation Act 1999* for a period of five years. The fishery will undergo an ESD reassessment during 2009.

SPANISH MACKEREL TABLE 1

Recreational catch estimates of Spanish mackerel in Western Australia

Bioregion	Year	Retained catch	Share	Source
Pilbara (including Broome)	1999/2000	Spanish: 28 t Other: 11 t	21 % 15 %	Williamson et al. (2006)
Gascoyne	1998/1999	Spanish: 48 t Other: 8 t	42 % 10 %	Sumner et al. (2002)
West Coast	2005/2006	Spanish: 7 t Other: <1 t	45 % < 3 %	Sumner et al. (2008)



SPANISH MACKEREL FIGURE 1

Annual catch of Spanish mackerel in Western Australia

Northern Shark Fisheries Status Report

R. McAuley

Management input by Lindsay Joll

Main Features

Status

Stock level - Sandbar shark: Depleted

Blacktip sharks: Uncertain

Fishing Level - Not assessed

Current Landings

Total - Not assessed

Northern Shark Fisheries - Not assessed

Catch by other commercial fisheries – 7 t

Recreational - Not assessed

Charter – Not assessed

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 relatively small amount of pelagic gillnetting occurring in the JANSF. The northern shark fisheries have targeted a variety of species including sandbar *(Carcharhinus plumbeus)*, blacktip (various Carcharhinus spp.), tiger *(Galeocerdo cuvier)*, hammerhead (Sphyrnidae) and lemon sharks *(Negaprion acutidens)*. Due to the small number of active vessels in the fishery and commonality of the primary fishing method and target species, data from the two fisheries are combined and the WANCSF and JANSF 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

Other written authorities

Ministerial Exemption (WANCSF)

Consultation processes

WA Demersal Net and Hook Fisheries Management Advisory Committee (not currently operational)

Department–Northern Shark Industry Association meetings

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 (Northern Shark Figure 1).

Management arrangements

The northern shark fisheries are input-controlled, with limited numbers of authorised operators permitted to fish in each fishery. A comprehensive package of new 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 new management measures for the JANSF is still the subject of discussion between the Western Australian and Commonwealth Governments, which share 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 approximately 40% of the fishery's previous area under a Ministerial Exemption. This exemption entitles the use of longlines with metal snoods and pelagic gillnets. Longlines are restricted to a maximum of 1,000 hooks and gillnets are limited to 2 kilometres maximum length, 160 – 185 mm stretched mesh size and a maximum drop of 100 meshes. Additionally, gillnets must be attached to vessels at all times and may not come into contact with the seabed.

The WANCSF is now zoned into 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 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. Proposed JANSF management arrangements are essentially identical to those for the WANCSF, except for total access levels of 400 gillnet and 200 longline fishing days. However, implementation of those arrangements has been a matter of ongoing dialogue between the State and Commonwealth. In April 2008 the JANSF's export approval under the EPBC Act was revoked due to the lack of formal management arrangements and concerns about the fishery's ecological sustainability. Therefore, product from this fishery can no longer be legally exported.

Research summary

Demonstrating the ecological sustainability of the northern shark fisheries is contingent on establishing robust estimates of sustainable harvest levels for target, byproduct and bycatch species. In particular, issues associated with blacktip shark, sandbar shark and mackerel catches, as well as Threatened, Endangered and Protected (TEP) species interactions require evaluation. Further research to estimate key biological parameters and fishing mortality rates for numerous species would therefore be required as a high priority if the proposed transition to pelagic gillnets was to proceed.

To support these requirements and to facilitate the new and pending fishery management arrangements, 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 fishers and some discrepancies have been identified in the reported daily/trip logbook data for 2006/07 and 2007/08. Therefore, until new data validation procedures are developed, catch and effort statistics for the 2006/07 and 2007/08 seasons cannot be reported with sufficient levels of confidence.

Retained Species

Commercial landings (season 2007/08):

Northern Shark Fisheries: Not available

Other Fisheries: Not available

Sharks are incidentally caught by other commercial fisheries that operate in waters off the north coast. However, the number of fisheries authorised to retain shark catches was limited in 2006 when sharks and rays were commercially protected throughout the State. During 2007/08, vessels licensed in authorised managed fisheries in the area between North West Cape and the WA/NT border reported catches of sharks and rays totaling 3 t, the same as 2006/07 and 21 t less than 2005/06. The causes of these recent reductions in these non-target fisheries' shark catches are varied. The commercial protection of sharks and rays has eliminated retention in unauthorised fisheries and the introduction of Bycatch Reduction Devices (BRDs) in the Pilbara Fish Trawl Fishery between 2002 and 2006 has significantly reduced shark and ray catches. However operators in that fishery are still permitted to land sharks and rays (other than totally protected species) that are not excluded by BRDs. However, despite the general prohibition on retention of shark and ray catches, 4 t of sharks and rays were reportedly caught by 'wetline' methods (i.e. taken by vessels not operating in managed fisheries) off the north coast during 2006/07.

Nevertheless, the retained shark catch by all State-managed sectors in the north coast bioregion during 2006/07 and 2007/08 was far less than previous years. It is expected that landings will remain at these low levels or be further reduced in the future.

Recreational catch estimate: Not assessed

Commercial Fishing effort/access level

There were three active licenses in the northern shark fisheries during 2007/08. In June 2005, northern shark fishing effort was restricted to: 100 longline days and 200 gillnet days in the WANCSF and proposed at 200 longline days and 400 gillnet days in the JANSF. Of the 300 permitted fishing days in the WANCSF, no more than 100 days fishing (with either gear type) are allowed in the southern zone (Broome and Cape Leveque). Furthermore, the southern zone of the WANCSF is closed to fishing between 1 February and 30 September.

Total fishing effort in the northern shark fisheries during 2006/07 and 2007/08 was therefore significantly lower than pre-2005/06 levels but cannot be reported due to confidentiality arrangements (once daily logbook data have been validated and compiled).

Stock Assessment

Assessment complete: Yes (indicator species)

Assessment method: Sandbar shark Direct Survey

Blacktip sharks Catch

Breeding stock levels: Depleted (sandbar)

Uncertain (blacktip)

Non-Retained Species

Bycatch species impact: Not assessed

The northern shark fisheries previously had a small scalefish catch that was generally retained for sale. However, if the potential shift of fishing effort to gillnets occurs, the risks to the sustainability of mackerel stocks will need to be quantified as a matter high priority and, if necessary, additional measures to manage this bycatch will need to be developed. There has also been some discarded bycatch of unsaleable sharks, rays and scalefish in these fisheries. Although these risks were previously rated as a low to negligible risk by the ESD risk assessment process, they will require reassessment if pelagic gillnet fishing effort escalates.

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 potential 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 intended 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 garricki and G. glyphis*, previously known as *Glyphis sp. C* and *Glyphis sp. A*, respectively) 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 and sub-tropical 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 proposed gillnet effort is small relative to the fisheries' operational area and historical levels of gillnet effort in the area. At the potential levels of effort, the risk of interaction is expected to remain low.

Billfish: The limited observed bycatch of billfish by demersal longlines 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 new management arrangements.

Cetaceans: As almost all northern shark fishery effort prior to 2005/06 was applied by demersal longlines, the risk of interaction with cetaceans was previously assessed as negligible. Although there is a perception that the proposed increase in the use of gillnets may result in higher levels of interaction with cetaceans, there are no empirical data from domestic pelagic gillnet fisheries to estimate capture rates. However, in a precautionary context, the risk of cetacean interactions might be considered higher than previously assessed.

Ecosystem Effects

Food chain effects: Negligible

Given the potentially smaller shark catches intended under the proposed new management arrangements, the associated risk of detrimental food chain effects is likely to remain negligible. However, given the long stock-recovery times expected from previous periods of over-exploitation, unassessed residual food chain effects may persist for decades. It may also be necessary to reassess this risk if higher levels of fishing effort resume and the new quantities and composition of catches can be determined.

Habitat effects: Negligible

The principal types of fishing gear that may be used to target sharks in the region are set so that they either do not or only intermittently come into contact with the seabed, and their physical impact on the seabed is therefore minimal. The potential shift of fishing effort into gillnets may therefore 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 the proposed shift in gear type are likely to reduce the risk of habitat effects further.

Social Effects

Direct: Northern shark fishing vessels have employed between 3 and 7 crew (5 on average). However, since 2006/07 only two or three fishing vessels have operated for a few months each year and the fishery therefore 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 need to be conserved.

Economic Effects

Estimated annual value (to fishers)

For year 2007/08 Not assessed

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. Based on preliminary inspection of daily logbook data collected from the fisheries since 2005/06, effort apparently declined in 2006/07 before increasing to slightly more than its 2005/06 level in 2007/08.

Although total shark catches appear to have declined significantly from their 2004/05 peak (Northern Shark Figure 3), preliminary inspection of daily logbook data from the fisheries suggests that the 2007/08 catch of sandbar sharks may have far exceeded the upper target limit of 20 tonnes.

Current fishing (or effort) level: Unknown

Total fishing effort was considerably less than the levels prescribed by the new management arrangements. However,

as breeding biomass of the sandbar stock is likely to be at the minimal acceptable limit reference point (40% of unfished biomass) and continuing to decline (see Demersal Gillnet and Longline Fisheries Status Report), the preliminary estimate of sandbar shark catch in 2007/08 is unacceptable.

New management initiatives (2008/09)

Some elements of the new management arrangements agreed with industry in 2005 are still the subject of discussion between Commonwealth and State governments. It is hoped that these issues will be resolved in 2008/09.

External Factors

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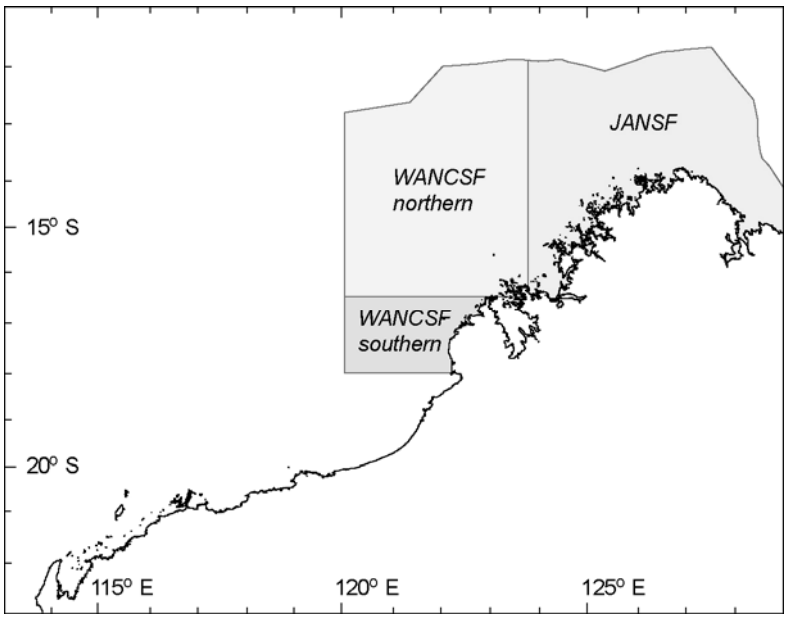
The northern shark fisheries share their target stocks of blacktip sharks with the Joint Authority target-shark fisheries operating in Northern Territory and Queensland waters. Similarly the fisheries' previous target species (sandbar shark) is the primary component of catches by the West Coast Demersal Gillnet and Demersal Longline Fishery (see Demersal Gillnet and Longline Fisheries Status Report, pp. 225-230). Possibly most importantly though, the rapid escalation of illegal foreign shark fishing in northern Australian waters prior to 2007, 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

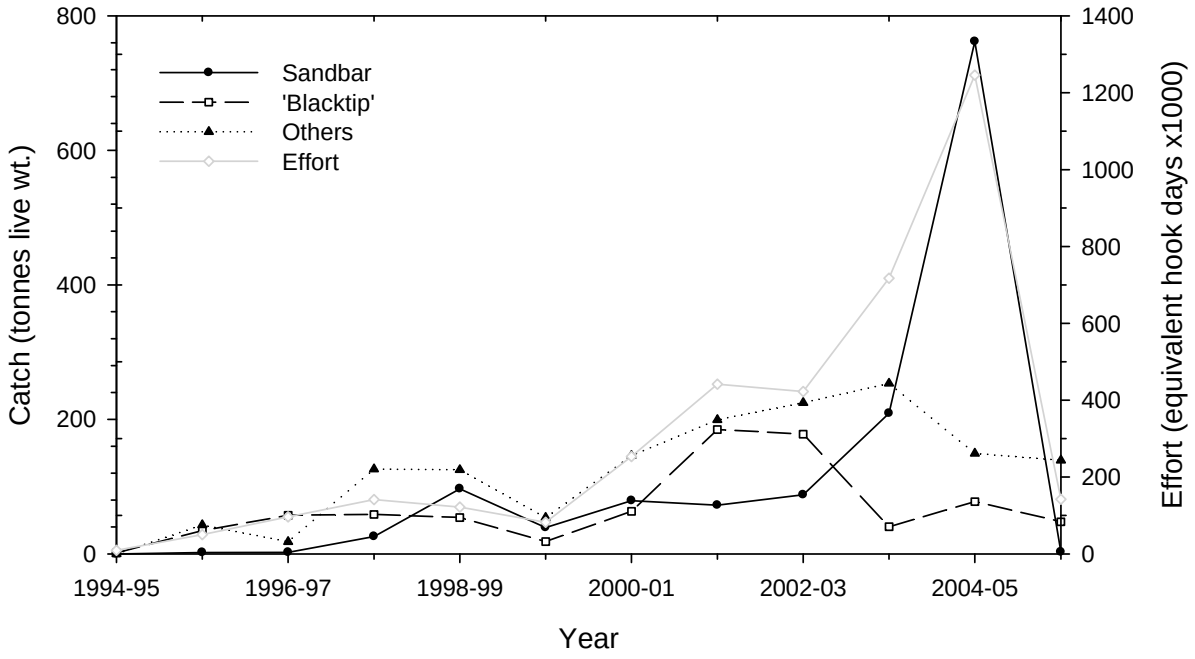
Northern shark fisheries' (WANCSF and JANSF) elasmobranch catch from 2001/02 to 2005/06. Data for 2006/07 are not reported due to confidentiality of records from fewer than five vessels.

		Catch (tonnes)				
Species		**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2005/06**
Sandbar shark	*Carcharhinus plumbeus*	72	88	209	762	<1
Hammerhead sharks	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
Dusky shark	*Carcharhinus obscurus*	6	7	17	36	<1
Shovelnose/fiddler rays	Rhinobatidae, Rhynchobatidae	11	11	8	32	5
Grey reef shark	*Carcharhinus amblyrhynchos*	6	7	9	8	1
Other sharks/rays		45	19	156	46	18
TOTAL		456	490	591	1,294	190



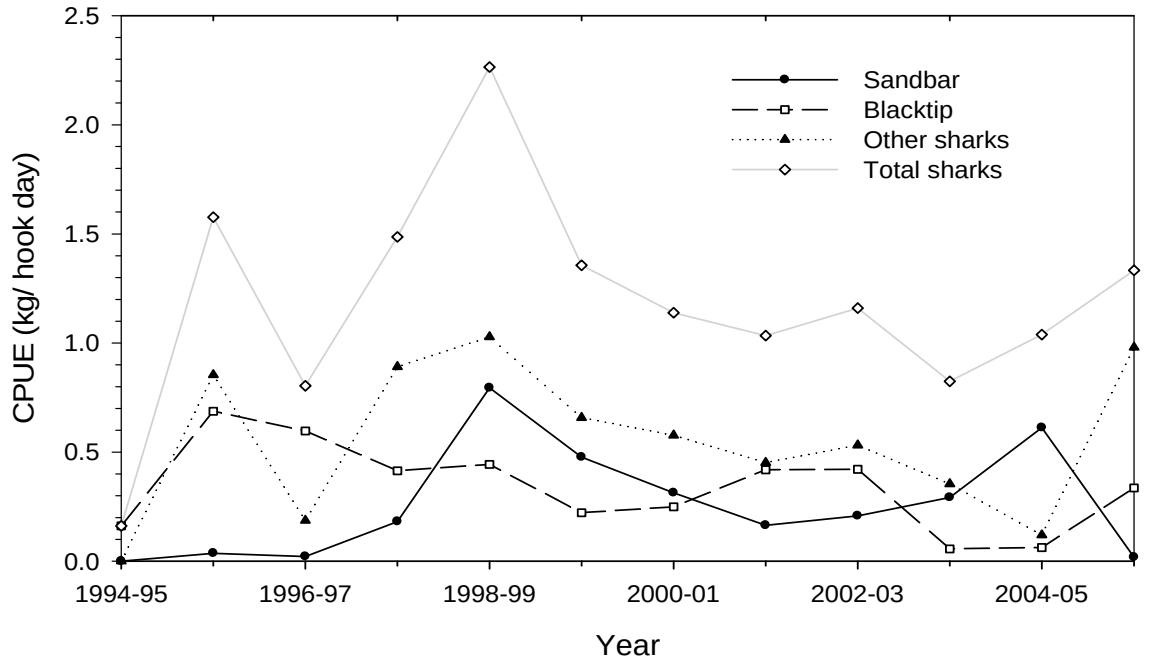
NORTHERN SHARK FIGURE 1

Management boundaries of the WA tropical shark fisheries



NORTHERN SHARK FIGURE 2

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 3

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.

Pearl Oyster Managed Fishery Status Report

Prepared by A. Hart and D. Murphy
Management input by J. Froud

Main Features

Status

Stock level - Acceptable and at record high levels

Fishing level - Acceptable

Current Landings

Commercial Pearl Oyster Catch

Total - Shell numbers (All Zones) - 820,000 culture shells

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 ITQ units allocated across three management zones (Zone 1 – 115; Zone 2 – 425; Zone 3 – 32) and 350 hatchery ITQ units allocated amongst 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 historically has been about 1,000 shell per unit when pearl stocks are at normal levels. In 2008 however, wild stock quota units for Zone 2/3 were valued at 1,800 shell (TAC: 822,600), as result of high stock levels (Pearl Table 1).

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 stock assessment research is focused on:

- Stock assessment using catch and effort statistics (taking into account discard rates) and recruitment and length-frequency sampling to estimate the total allowable catch.
- Development of an index of recruitment for predicting future years catch levels using the relative number of piggy back spat.
- Decision rules for determining the TAC
- Environmental drivers (e.g. rainfall) of pearl oyster abundance

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 was completed in 2008. The overall objective was to determine whether the incidence of *Cliona* sp. is increasing in wild stocks over time, however the project found no clear evidence that this was occurring.

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 by 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:

- Investigate aspects of oyster oodema disease (OOD) in *Pinctada maxima*, to assist in mitigating the impacts and understand pathways to disease and disease response in pearl oysters.
- demonstrate that the pearling industry operates in a manner acceptable to public standards for access to the marine environment;
- 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

Retained Species

Commercial landings (season 2008): 820,207 oysters

In 2008, the number of wild-caught pearl oysters was 820,207 (Pearl Tables 1 and 2). The TAC for the pearl oyster fishery was 877,600 oysters, thus a total of 93.5% of the TAC was caught. In comparison, 600,658 oysters were caught in 2007.

The catch in Zone 2 was 808,933 oysters, increasing from 550,972 in 2007 and 10,092 oysters were caught in Zone 1 – a reduction from 49,686 in 2007 (Pearl Table 2). In 2008, the catch from Zone 3 was 1,182 oysters; this was exploratory fishing activity to assess the stocks previously closed (2007) to

fishing because of a low abundance of pearl oysters.

Fishing effort/access level

Total effort in all zones was 15,786 dive hours (Pearl Tables 1 and 2). The total effort for 2008 in Zone 2/3 was 15,387 dive hours – a 23% increase on the 2007 Zone 2/3 effort of 12,514 dive hours to achieve a 47% increase in catch due to increased quota allocation.

The total effort in Zone 1 during 2008 was 398 dive hours, which was a decrease of 81% over the 2007 effort of 2,138 hours (Pearl Table 2).

Stock Assessment

Assessment complete: Yes

Breeding stock levels: Acceptable

A stock assessment of the *Pinctada maxima* fishery was undertaken for the 2008 fishing season based on catch and effort statistics, recruitment (154,200 shell sampled for 'piggyback' spat to obtain estimates of age 0+ and 1+ relative abundance), length-frequency sampling (46,000 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 2009 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 2008, CPUE was 52.6 shells per dive hour – a 20% increase from the 2007 catch rate (44 shells/hour – Pearl Table 1) that occurred despite the 23% increase in fishing effort.

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 entered the commercially fished population in 2008 resulting in the second highest CPUE over 30 years and will continue in the 2009 fishing year.

The 2009 stock abundance in Zone 2 is predicted to be substantially higher than 2008, while rebuilding of stocks will occur in Zone 3. Consequently, TAC in Zone 2/3 has been increased further in 2009 to a total quota unit value of 2,200 oysters per quota unit (1,005,400), or 110% above baseline. (Pearl Table 1)

Zone 1: The Zone 1 fishery is still in a state of rebuilding, particularly in the middle sector after some heavy fishing years in the mid-1990s to early 2000s. In 2008, the Zone 1 CPUE was 25 shells per hour, which was a slight increase from the 2007 CPUE of 23 shells per hour (Pearl Table 2). Although the change in CPUE is small, it is still the second highest in the previous 15 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 2008. 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 53 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') has found categorically that pearl farming has negligible 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, mostly due to increased fleet efficiency and increased reliance on hatchery-produced shells. However in 2008 11 vessels have fished, this change was due to the increased effort in Zone 1 ie five vessels fishing over a widespread area, with a smaller amount of catch per vessel. Higher numbers of vessels could evolve further if the hatchery production sector of the industry is reduced and emphasis turns back to the wild fishery.

Most vessels presently operate 10 – 14 crew for 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.

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 2008: $90 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 $90 million in 2008.

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 877,600 oysters in 2008 (822,600 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 15,387 dive hours (Pearl Table 1), which was within the target range despite the increase in quota, indicating stocks are at a high abundance level.

Zone 1 of the pearl oyster fishery did not achieve its quota. 398 dive hours (Pearl Table 2), was below the target range, indicating minimal effort in Zone 1 with lower (but improving) stock abundance.

The overall pearl oyster fishery effort of 15,786 hours in 2008 with an increased TAC (Zone 2) indicates that stocks are at higher than average levels in Zone 2 and with no change in Zone 1 TAC, indicating a stabilisation of stocks in that zone.

Current effort level: Acceptable

Overall fishery effort level is at the lower end of the historical range, indicating a higher than average stock abundance.

New management initiatives (2009/10)

The Minister has approved that the Department may liaise with the pearling industry to explore options for the implementation of a more delegated model of co-management. Under such a model, the responsibility for completing certain tasks currently performed by the Department could instead be delegated to the pearling industry.

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 preliminary research points to an environmental factor (rainfall associated with cyclonic activity) being an external driver of the current high abundance. Further work is needed in this area. There are also two external factors that provide a potential threat to the future viability of the industry. First, in October 2008 the Global Financial Crisis effectively halted the world trade in pearls and the pearling industry faces substantial economic hardship in 2009/10. As a result, wild stock harvest is likely to be reduced in 2009. Secondly, the on-going issues of the OOD (oyster oedema disease) will continue to undermine hatchery-production capacity in some sectors of the Industry, however to date the disease does not appear to have affected wild stocks or any other marine organisms.

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		26.0
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	31.0
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	0	550,972	12,514	44.0	12.9	44.0
2008	822,600[2]	810,115	0	810,115	15,387	52.6	14.7	52.6
2009	1,005,400							

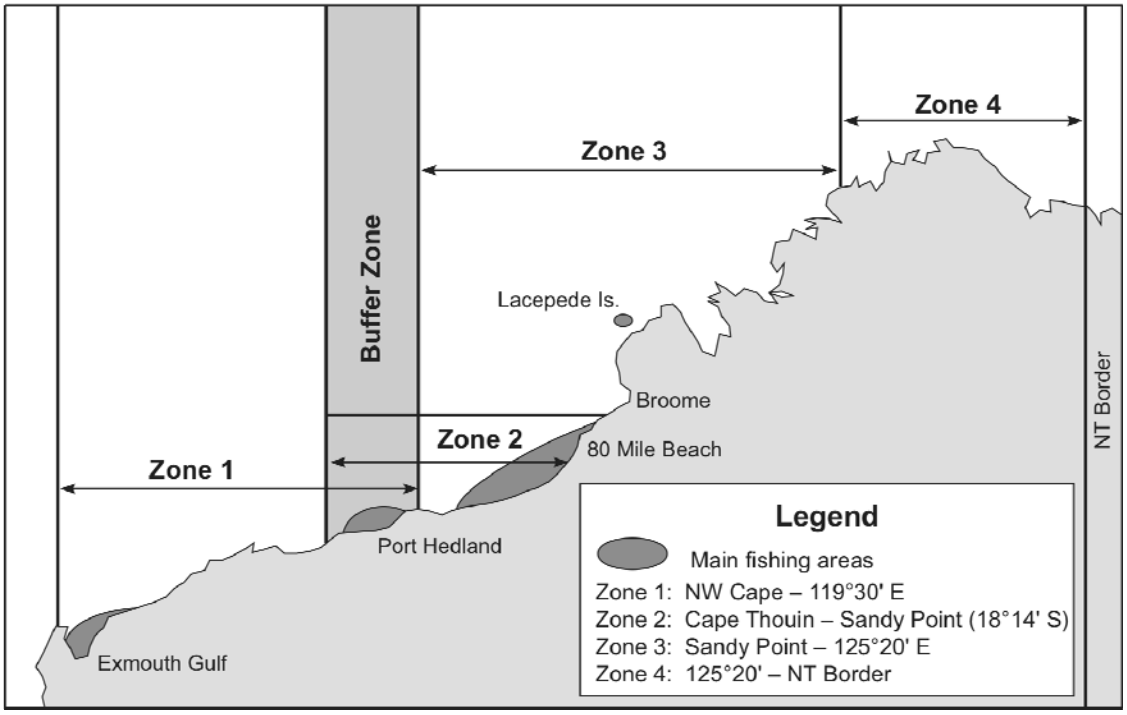
Notes: Total catches exceeding quota are a result of fisher shell tally error and the collection of broodstock shell being included as part of culture shell tallies. [1] 'MOP' is an abbreviation for mother-of-pearl; [2] wild stock quota in 2008 initially set at 639,800 (see SOF 2007 report), however a mid-season review increased It to 822,600 because of enhanced stock abundance

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]	0[5]	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	2,138	23.0
2008	55,000	10,092	398	25.3
2009	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.



PEARL FIGURE 1

Distribution of pearl oyster stocks and fishing zones in Western Australia.

Beche-de-mer Fishery Status Report

A. Hart and D. Murphy
Management input from R. Green

Main Features

Status	Current Landings
Stock level - Acceptable	Commercial Beche-de-mer Catch
Fishing level - Acceptable	Total - 196 tonnes (Live Weight)

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; prior to 2007 over 99% of the catch was sandfish *(Holothuria scabra)*. Since then, an additional species (deepwater redfish - *Actinopyga echinites*) has been targeted.

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 four, with a maximum number of six crew allowed on the vessel.

There are six 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 depth fished.

Retained Species

Commercial landings (season 2008):
196 tonnes (live weight)

Recreational catch estimate (season 2008): Nil

Landings

In 2008 the total beche-de-mer catch was 196 t live weight (Beche-de-mer Table 1), an increase over last years catch of 113 t mainly due to the continued development of the redfish fishery.

On a species-specific level, the 196 t catch was made up of 27 t (14%) *Holothuria scabra* and 169 t (86%) *Actinopyga echinites* (Beche-de-Mer Figure 1). This is the second year that *A. echinites* has been caught in high numbers and represents a new target species within the fishery. The catch of sandfish in the last two years has been the lowest since 1995.

Fishing effort/access level

Only 2 licensed vessels fished for beche-de-mer in 2008, the same as 2007. This represents 33% of the potential number of vessels that have an endorsement to fish.

Total effort was 564 crew days – about 44% higher than in 2007 and equivalent to the effort levels of 2005 (Beche-de-mer Table 1).

Stock Assessment

Assessment complete: Yes

Assessment method: Catch rate

Breeding stock levels: Adequate

The overall catch rate for beche-de-mer (diving only in 2008) was 348 kg/crew day, which is the highest in the history of the fishery. The principal reason for this was the continued development of a new target species (deepwater redfish), which had a CPUE of 364 kg/day. There was also a high catch rate in the existing sandfish fishery associated with reduced fishing for this species (Beche-de-mer Figure 1).

Estimates of Maximum Sustainable Yield (MSY) of sandfish were obtained for the entire WA fishery and Kimberley sub-regions using a biomass dynamics model. Current average catch of sandfish 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. The model is updated with new data every year.

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. The catch rate measure was met, however catch of 196 tonnes was outside this range, due to a new target species of deepwater redfish.

Target catch ranges and performance indicators will be reviewed as finer-scale species-specific information becomes available

Non-Retained Species

Bycatch species impact: Negligible

No bycatch species are 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 six endorsements and each with a maximum of six crew. In 2008, two vessels with a total of nine 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 2008: $627,000

The estimated annual value for 2008 was $627,000 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 196 tonnes is outside this target range. This is due to the increased catches in last two years on the new target species of deepwater redfish. This target catch range may need to be revised as more information is available on this species.

New management initiatives (2008/09)

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 species-specific management response and performance indicators to be developed.

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 species)	Live Wt (t) (Sandfish)	Live Wt (t) (Redfish)	Live Wt (t) (Teatfish)	Crew Days (all methods)
1995	93	93	0	0	737
1996	257	257	0	0	945
1997	382	371	9	2.8	1,852
1998	310	310	0	0	2,565
1999	176	176	0	0	1,757
2000	83	83	0	0	607
2001	90	88	2	0.2	663
2002	87	87	0	0	535
2003	122	121	1	0	1,019
2004	81	81	0	0.2	470
2005	78	75	0	0	545
2006	58	55	3	0.3	660
2007*	113	26	87	0	392
2008^	***196***[2]	***27***	***169***	***0***	***564***

[1] Sandfish represented 99% of catch until 2006

[2] Redfish represented 86% of catch in 2008

* Updated from previous reports due to additional returns.

^ Diving only method used in recent years

BECHE-DE-MER TABLE 2

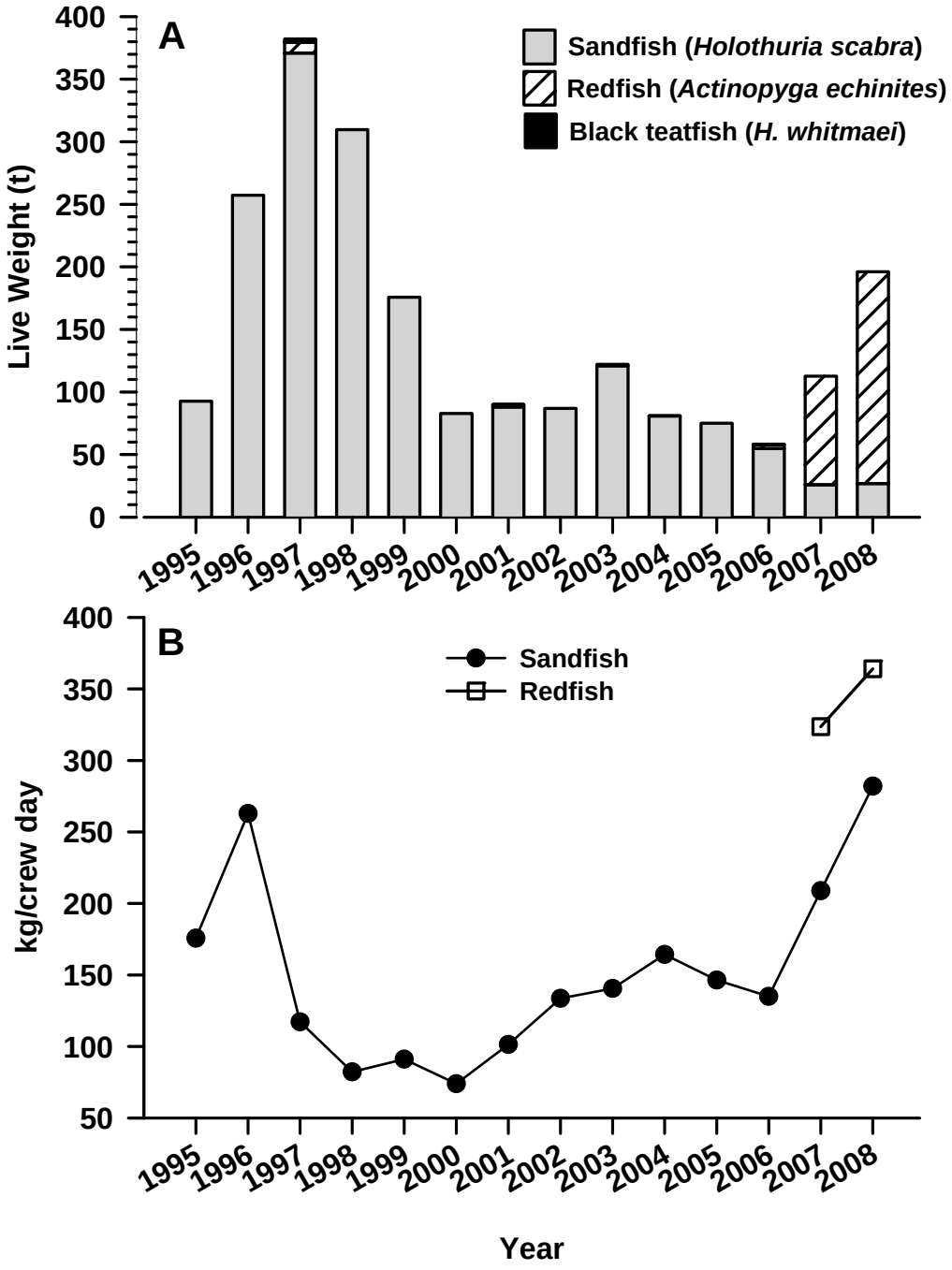
Estimates of Maximum Sustainable Yield (MSY) of sandfish in the Western Australian Beche-de-Mer fishery.

Area	MSY (t)	Current average catch (2005-2008) (t)	Parameter estimates*		
			r	K (t)	q
Entire Fishery	138	46	0.820	964	0.218
Kimberley region (Grid 1425 and 1426)	70	40	0.970	410	0.603

* 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

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 sector 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.

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 Department of Fisheries is currently working with the pearling industry to investigate the potential for increasing the level of industry self-management in the pearl oyster fishery.

The Department of Fisheries' Research Division's Fish Health Unit is actively involved in assisting the commercial hatcheries, in terms of disease control and the annual certification of hatchery facilities as required under the *Fish Resources Management Act 1994* and the *Enzootic Diseases Regulations 1970.*

A fish farm located in Cone Bay is currently producing barramundi and the operator is seeking approval to scale up to commercial size. The requisite approval by the EPA is expected by the end of the financial year.

The Department of Fisheries continues to oversee 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.

COMPLIANCE & COMMUNITY EDUCATION

The North Coast is one of the largest bioregions in WA – stretching from Onslow to the Western Australia/Northern Territory border with over 2600 kilometres of coastline.

The North Coast Bioregion has many biodiversity rich areas including the Rowley Shoals, Montebello Islands, Barrow Islands and hundreds of islands and atolls. These areas attract many people – especially for fishing.

Tourism is a major part of the coastal towns in the North Coast with over 600,000 additional people visiting the area each year. The transient population usually increases in the cooler months from May to October including international, interstate and intrastate tourists.

Many of the towns in this bioregion support mining communities where the majority of the population are fly in/ fly out. Surveys have shown that a large proportion of mining community and tourists take part in fishing while visiting the bioregion.

Two district offices located in Broome and Karratha provide compliance and education across the region with eight permanent Fisheries and Marine Officers and one Community Education officer. However during the peak season from May to October an additional two officer mobile patrol also operates in the area. Compliance is delivered to several sectors including commercial and recreational fisheries, pearling, aquaculture, fish habitat and bio-security.

The North Coast Region is sparsely populated in most areas with much of the terrain remote and difficult to access. Remote patrols are partaken for up to two weeks at a time to get to these areas. Specialised equipment is required for patrols including four wheel drive vehicles and a variety of vessels for inshore coastal and inland waters, when offshore patrols occur a 23 metre vessel is utilised. Underwater dive inspections also take place for pearling, vessels for introduced marine pests for biosecurity and habitat monitoring.

A range of compliance duties are carried out in the bioregion including complaint investigation, catch, licence, gear, processor, retail and transport inspections. These are carried out through roadside checks, dive inspections, land & sea patrols and aerial surveillance.

FMOs not only spend time on compliance but also dedicate time to community education by maintaining a presence at a variety of expos, fishing competitions and community fairs. Annual fairs are held throughout the bioregion with the Department represented every year at most events. In addition FMOs also coordinate and manage the Volunteer Fisheries Liaison Officer program – where trained community members educate the public on bag and size limits and a variety of other fishing rules.

Education of school-aged children is the primary role of the community and education officer. In-school and school holiday programs are the main method of reaching students in both the Pilbara and Kimberley.

Activities during 2007/08

During 2007/08, the North Coast bioregion's FMOs delivered a total of 2496 officer hours of active compliance patrol time - a small decrease from the previous year (North Coast Compliance Figure 1). FMOs also achieved 9,945 personal compliance contacts with the community and fishers.

FMOs undertook prosecution action as a result of compliance operations in 2007/08. This resulted in 39 infringement warnings and 35 infringements notices being issued, with 15 matters resulting in prosecution action.

The Bardi Marine Patrol program continued to operate from One Arm Point. One Arm Point is approximately 200 km north of Broome, on the northeastern tip of the Dampier Peninsula.

This program was initiated in response to the threats posed to Western Australia's fish resources by foreign vessels fishing illegally for trochus, beche de mer and shark.

A typical patrol consists of searching mangrove forest areas considered suitable for the 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 the Bardi Marine Rangers.

Compliance inspections were also carried out on Pearl oyster fishing and seeding operations, during transport of Pearl oysters and at various Pearl oyster lease sites. Considerable travel time is required to reach many of the lease sites, due to their remote locations.

Volunteer Fisheries Liaison Officer (VFLO) groups from across the bioregion were provided with training and support.

Initiatives in 2008/09

Pilbara based Fisheries Volunteers will go on an inland tour to mining communities including Tom Price, Pannawonica and Paraburdoo with the newly purchased education trailer. Schools and shopping centres will have access to the trailer where fisheries education messages will be communicated.

The North Coast bioregions FMOs will continue to use a risk assessment based approach to fisheries compliance to ensure areas and activities of a high risk of non-compliance are targeted.

The FMOs will continue with ongoing checks of bio-security of vessels entering the states waters for introduced marine pests.

The Fisheries mobile patrol unit will focus on compliance during peak fishing periods in this bioregion. Together with the district officers they will work together to increase coverage across the region to try and target people in remote areas.

The Department of Fisheries received a grant for the community education officer to tour the Pilbara schools to implement fisheries education programs. Schools in Onslow, Karratha and Dampier will receive hands-on, in-school education activities.

The community education officer will run a joint holiday program with DEC in Karratha over the October school holidays. Both departments will work together to communicate marine environment messages.

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 2007/08 financial year

PATROL HOURS DELIVERED TO THE BIOREGION	2,496 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries & Marine Officers	62
District Office contacts	611
Infringement warnings	2
Infringement notices	12
Prosecutions	13
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	5,557
District Office contacts	1,983
Infringement warnings	37
Infringement notices	23
Prosecutions	2
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY***	
Field contacts by Fisheries & Marine Officers	145
District Office contacts	1,587
Fishwatch reports***	18

* 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.

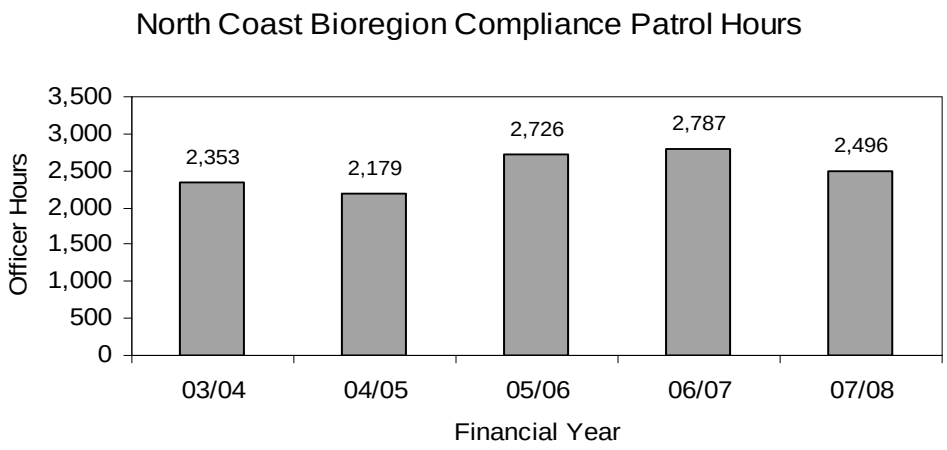
NORTH COAST COMPLIANCE TABLE 2

This table gives summary statistics for pearling compliance in all bioregions in the 2007/08 fishing season.

Total compliance hours*	1,674 Officer Hours
Field contacts by Pearling Officers	42
District Office contacts	153
Letters of Warning issued**	0
Prosecutions	0

* 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



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 2007/08 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.

*Does not include "on-patrol" hours delivered by PV Walcott (1,584 in 2007/08).

The total on-patrol hours for each of the Department's 3 large patrol vessels in 2007/08 is reported in the compliance summary of the most relevant bioregion: *PV Walcott* in North Coast, *PV MacLaughlan* and *PV Hamelin* in West Coast.

SOUTH COAST BIOREGION

SOUTH COAST BIOREGION

ABOUT THE BIOREGION

The continental shelf waters of the South Coast bioregion are generally temperate but low in nutrients, due to the seasonal winter presence of the tail of the tropical Leeuwin Current and limited terrestrial run-off. Sea surface temperatures typically range from approximately 15°C to 21°C, which is warmer than would normally be expected in these latitudes due to the influence of the Leeuwin Current. The effect of the Leeuwin Current, particularly west of Albany, limits the winter minimum temperatures away from terrestrial effects along the beaches to about 16 to 17°C.

Fish stocks in the region are predominantly temperate, with many species distributions extending right across southern Australia. The occasional more tropical species 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.

SUMMARY OF FISHING ACTIVITY

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.

ECOSYSTEM MANAGEMENT

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 Walpole–Nornalup Marine Park was declared on the 8th May 2009 and is the first marine protected area on the south coast. There are three existing fishing closures under s.43 of *the Fish Resources Management Act 1994* surrounding the wreck of the 'Perth' (Albany), wreck of the 'Sanko Harvest' (east of

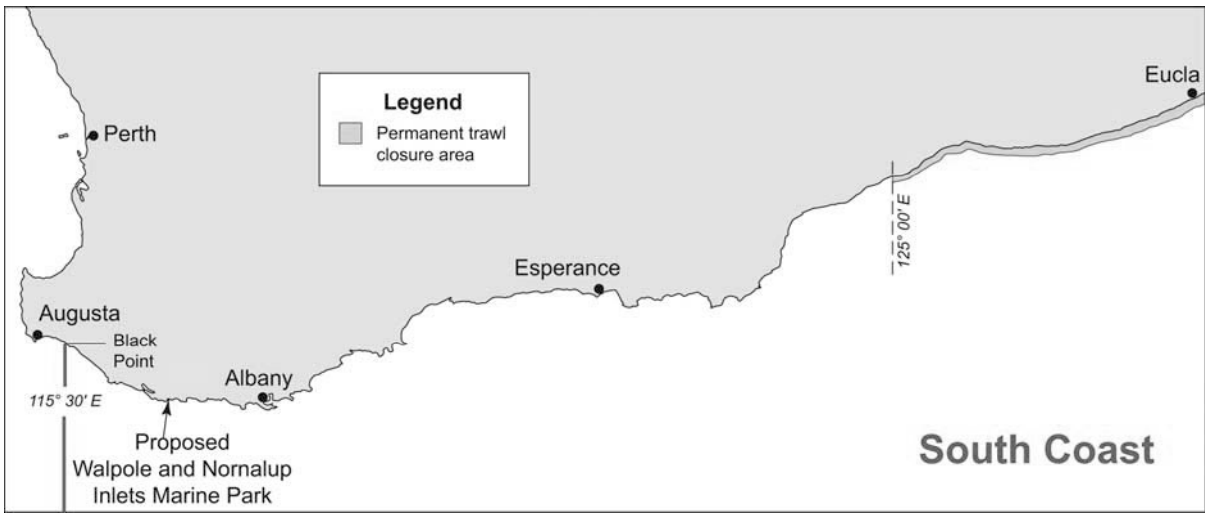
Esperance), and Esperance Jetty.

The Australian Government's Department of Environment Water, Heritage, Water and the Arts is 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. The Draft Plan is expected to be released for a 3 month public review period in late 2009, and this will include proposed 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.

In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has an initiated Ecosystem Based Fisheries Management (EBFM) framework.

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 to ensure the sustainable management of fish stocks in the future. The EBFM risk assessment process for the West Coast Bioregion has been completed (see Table 1 for the West Coast Bioregion) and serves as an example of what will be undertaken for the South Coast Bioregion. 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.



SOUTH COAST ECOSYSTEM MANAGEMENT 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: Statistic Only Report

R. Melville-Smith and A. Thomson
Management input by N. Chambers

Fishery Description

The 'south coast crustacean fisheries' are pot-based fisheries, which operate from Augusta 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).

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

Commercial

These commercial fisheries are managed primarily through input controls in the form of limited entry, pot numbers, size limits and seasonal closures.

In 2007/08, 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 licensed to fish for rock lobster in the Great Australian Bight and Albany zones. There were 24 licences that include condition 105 permitting them to fish for deep-sea crabs outside the Esperance sector.

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

Recreational fishers generally only target rock lobsters, very few target deep-sea crabs. They are restricted to the use of 2 pots per person and divers are only 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.

Landings and Effort

Commercial

Southern rock lobster	37 tonnes
Deep-sea crab	25 tonnes

The 2007/08 season total catch of southern rock lobsters was 37 t, a decrease of 30% from the 2006/07 season (South Coast Crustacean Table 1). A catch of 23 t of southern rock lobsters was taken in the ERLF in 2007/08 – a decrease of 34% on the catch taken in the 2006/07 season (35 t).

The combined catch for the GAB and Albany southern rock lobster fishery zones in 2007/08 was 14 t, a 22% decrease of the catch taken in 2006/07 (Figure 2). The catch in the Albany zone was 4 t, an increase of 100% compared to the 2006/07 season, however, the catch in the GAB zone decreased by 38% to 10 t.

As a secondary target of the rock lobster fishery, a total of 25 t of deep sea crabs was caught (South Coast Crustacean Table 1). In the Albany zone this included 1.2 t of giant crabs (an increase of 0.5 t over the 2006/07 season), 8.1 t of champagne crabs (an increase of 4.5 t over 2006/07 season) and 12.8 t of crystal crabs (an increase of 2.3 t over the 2006/07 season). In the ERLF, 2.1 t of giant crabs were landed (a decrease over the 2006/07 figure of 1.7 t).

The fishing effort in the Esperance fishery (ERLF) continued to decline in 2007/08 (south coast crustacean table 1). The effort increased in the Albany zone, however, it is not possible to split the effort targeting lobsters from that targeting deep-sea crabs.

Recreational

Southern rock lobsters	<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.

Fishery Governance

Target commercial catch range:

southern rock lobsters 50 – 80 tonnes

In 2007/08, the south coast catch of 37t was outside the target range. This target catch range will be reviewed as a part of the overall review of the management for this fishery which is about to begin.

Current Fishing (or Effort) Level Acceptable

Comparative catch and effort levels for the deep-sea crab and lobster catches are provided by management zone, In South Coast Crustacean Table 1 and for lobsters in Figure 2.

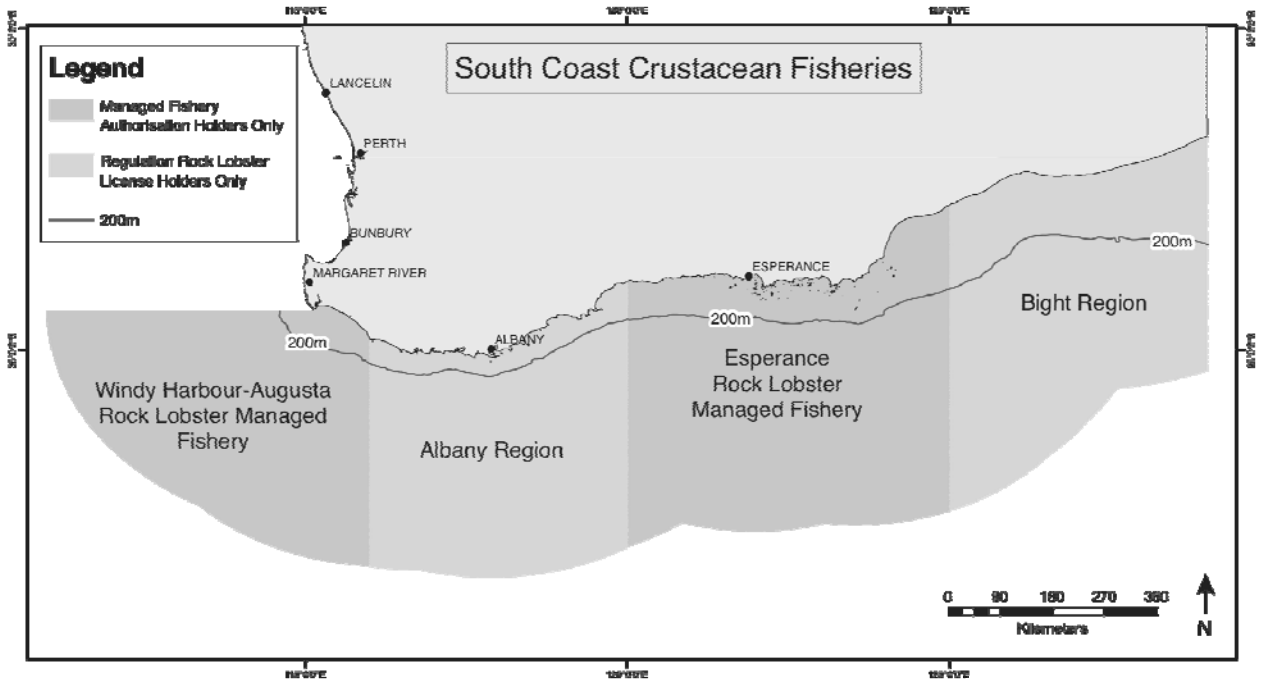
New management initiatives (2009/10)

In January 2009 the Department of Fisheries released Fisheries Management Paper 232, which is a discussion paper on the future management of crustacean fisheries on the south coast. The paper included a proposal that the existing rock lobster fisheries and the deep-sea crab fishery be managed under a management plan. This plan will include spatial and temporal closures and a zoning arrangement to mirror the access in the existing managed fisheries. Submission on the discussion paper closed in March 2009 and the new management arrangements should be finalised during 2010.

SOUTH COAST CRUSTACEAN TABLE 1

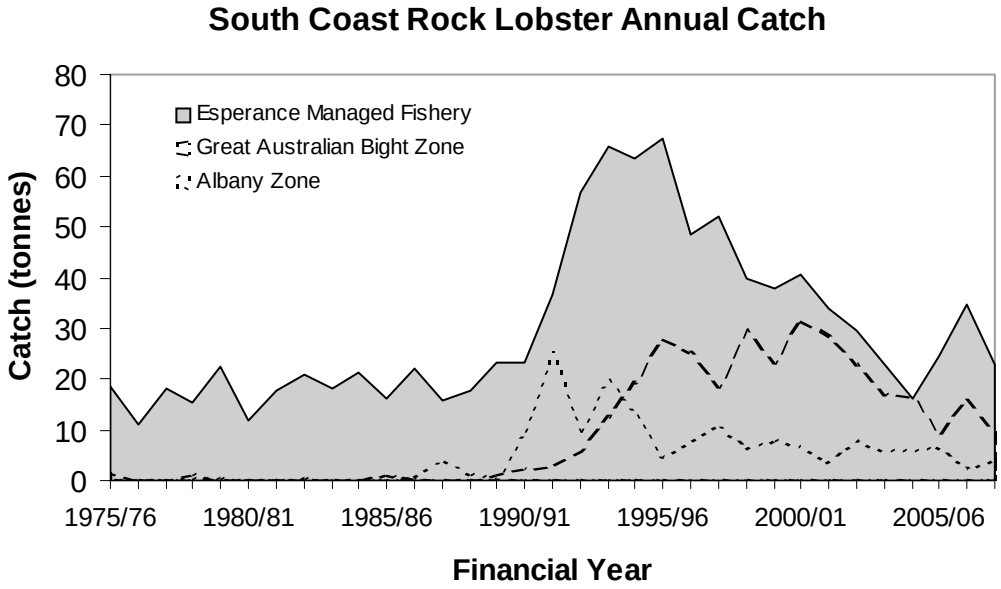
Comparisons of fishing effort and southern rock lobster and crab catch in 2006/07 and 2007/08 in the south coast crustacean fisheries.

Management zone	Season	Pot lifts	Southern rock lobster catch (tonnes)	Deep-sea crabs catch (tonnes)
ERLF	2006/07	56,000	35	6
	2007/08	35,000	23	3
	difference	-37.5%	-34.0%	-50%
Albany	2006/07	10,000	2	15
	2007/08	13,000	4	22
	difference	+30%	+100 %	+47%
Great Australian Bight	2006/07	27,000	16	0
	2007/08	26,000	10	0
	difference	-4%	-37.5%	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

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings

Commercial Greenlip / Brownlip Catch - Total (All Zones) - 197 t

Recreational Greenlip/Brownlip catch 3-4% of total catch (last estimate 2007)

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 species of abalone: greenlip abalone (*Haliotis laevigata*), and brownlip abalone (*H. conicopora*), both of which can grow to approximately 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

Fish Resources Management Act 1994

Fish Resources Management Regulations 1995

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

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 2008 was 205 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 and south-west coasts. 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, 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, sub-area 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 2008, 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 2008): 197 tonnes

In 2008 the overall greenlip/brownlip catch was 197 t whole weight (Greenlip Brownlip Abalone Table 1), which was 4% lower than the 2007 catch of 205 t. The Area 1 (Nullarbor fishery) exploratory quota remained at 1.2 t.

Greenlip catch at 157.2 t whole weight, from a total quota of 163.2 t, was 6% lower than the catch in 2007. The brownlip catch of 39.5 t whole weight for the 2008 season was similar to last year's catch of 38.8 t. and 94% of the quota of 41.9 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 2008 was 1,144 days. This was very similar to 2007 (1,1139 days), but catch was slightly lower.

Recreational

For the 2008 season, around 25,000 licences were issued. This was an 8% increase over the 2007 figure of 22,500 licenses (Greenlip Brownlip Abalone Figure 2). Overall license numbers were stable for 6 years between 2001 and 2006, but have increased by 15% in the last 2 years, primarily due to an increase in abalone specific licenses (Greenlip Brownlip Abalone Figure 2). It is likely however that the vast majority of these new licenses have been issued to fishers targeting the Perth metropolitan roe's abalone fishery.

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

Assessment method: Catch rates / Fishing mortality

Breeding stock levels: Adequate

A stock assessment of the greenlip/brownlip abalone fishery was undertaken for the 2008 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 2008, the catch rate for the combined greenlip stocks was 135 kg whole weight (51 kg meat weight) per diver day. This was very similar to 2007, 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 provided a more robust estimate of abalone abundance compared to the use of raw CPUE data. A report that reviews performance indicators for the abalone fishery was completed in 2008 and from 2009 onwards, the standardised CPUE information will be the principal indicator of the abundance of legal-sized abalone.

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. Fishing mortality of greenlip abalone declined between 2007 and 2008 for all areas (Greenlip Brownlip Abalone Figure 3a). The largest decline was in the south coast stocks of Area 3, where it declined from 0.53 to 0.32. There was only a small decline in Area 2 (0.48 to 0.45). The main cause for the decline was that the catch was composed of a larger proportion of larger animals, suggesting enhanced growth and/or a pulse of

recruitment moving through the fishery.

Fishing mortality of brownlip abalone in Area 3 also declined between 2007 and 2008, but remained stable in Area 2 (Greenlip Brownlip Abalone Figure 3b).

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 before reaching legal size.

Industry-imposed length limits that are larger than 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 2008, the average sizes of greenlip and brownlip caught were 200 g and 264 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 (1,144 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 24,500 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 2008: $9.2 million

The estimated average price received by commercial fishers was $130/kg meat weight (approximately $49/kg whole weight) for greenlip and $99/kg meat weight (approximately $39/kg whole weight) for brownlip abalone, resulting in a fishery valued at $9.2 million, compared to $8.8 million in 2007, and $9.0 million in 2006.

Greenlip prices in 2008 are higher than 2007 ($119/kg), but 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 (205 t in 2008) 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 2008 was 1,144 days (main stocks), which is within the governance range and indicates that the fishery as a whole is performing satisfactorily.

Based upon the improved status of the greenlip stock, the overall greenlip/brownlip quota for 2009 was increased to 213

t, up from 205 t (Greenlip Brownlip Abalone Table 1).

Current effort level: Acceptable

New management initiatives (2008/09)

The main new management initiative in 2008/09 was the development of performance indicators and TACC decision rules for the abalone fishery. A report has been published, and TACC setting for 2009/10 was undertaken with the new decision rules. These will be included in the 2009/10 state of fisheries review.

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 has been high, the decreasing value of the Australian dollar against the $US in 2008/09 enabled higher gains to the sector, compared to 2007/08. However the outlook for 2009/10 is uncertain, as the GFC (Global Financial Crisis) has depressed the price of seafood products on a global basis.

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 TABLE 1

Greenlip and brownlip abalone catch and effort1 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	157,224	7,830	41,900	39,515	196,739	1,144	135 (51)
2009	**171,301**			**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

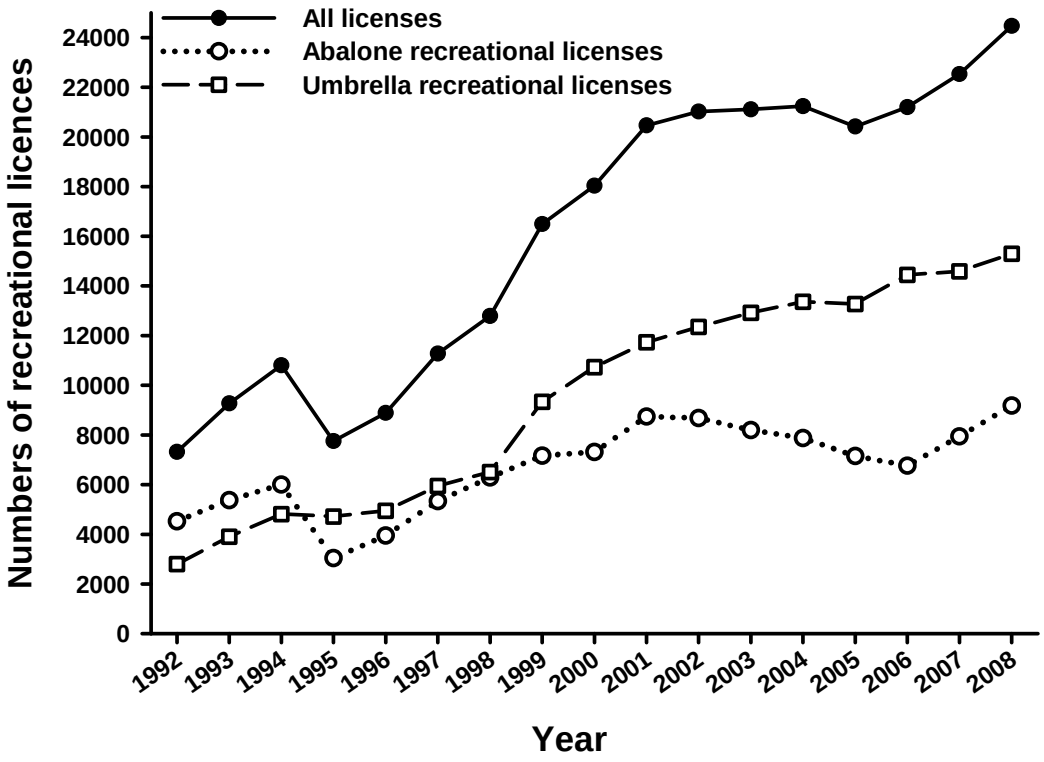
Summary of telephone diary surveys of recreational effort (fisher days), catch rate (abalone per fisher day) and catch (tonnes whole weight) for the greenlip and brownlip abalone fisheries in 2004, 2006, and 2007.

			Greenlip		Brownlip	
Location	Year	Effort	Catch Rate	Catch (tonnes)	Catch Rate	Catch
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).

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).

South Coast Estuarine Finfish Fisheries Status Report

K. Smith and J. Brown

Management input from N. Chambers

Main Features

Status	Current Landings
Stock level - Acceptable	Commercial - 207 tonnes
Fishing level - Acceptable	Recreational - 30 - 40% of total catch of key recreational species

Fishery Description

Commercial

Approximately 25 major estuaries exist in the South Coast bioregion, extending from Black Point in the west, to the WA/SA border to the east. Of which, thirteen 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 gill net and haul net.

Recreational

Estuarine fishing is dominated by recreational fishers who target finfish using line fishing methods.

Governing legislation/fishing authority

Commercial

South Coast Estuarine Fishery Management Plan 2005

South Coast Estuarine Managed Fishery Licence

Fish Resources Management Act 1994 and subsidiary legislation

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council).

Recreational

Recreational Fishing Advisory Committees

Boundaries

Commercial

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.

Recreational

Recreational fishing is permitted in all south coast estuaries.

Management arrangements

Commercial

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.

Recreational

Recreational fishers in south coast estuaries take a number of different finfish and invertebrate species. The various size and bag limits for the south coast bioregion applies to these species.

A small number of south coast estuaries are conditionally open to recreational netting. Recreational netting is subject to gear restrictions and spatial and temporal closures specific to each estuary.

As some of these estuaries are also utilised by the commercial sector, resource-sharing issues are a major consideration for this fishery.

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. Voluntary recreational fisher log books and annual fishery-independent surveys of juvenile fish recruitment (including cobbler, herring, whiting and mullet) 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.

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 2008): 207 tonnes

The 2008 SCEF catch contained approximately 35 different species, including finfish, rays, molluscs and crustaceans. The majority of landings were finfish, with cobbler, black bream and sea mullet *(Mugil cephalus)* comprising nearly 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 in line with a decline in effort, 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. In 2007, the catch increased to 251 t primarily due to large catches of sea mullet, black bream and Western Australian salmon *(Arripis truttaceus)*.

The 2008 catch of 207 t was a decrease of 44 t from the previous year and was also 44 t below the 10-year (1998-2007) average annual catch. The decrease in catch in 2008 from 2007 levels can be attributed to declines in catches of numerous species, including sea mullet, Western Australian salmon, black bream and leather jackets (Monocanthidae). Only landings of cobbler, sea garfish *(Hyporhamphus melanochir)* and silver bream *(Rhabdosargus sarba)* were substantially above 2007 levels.

Catches of many species were below their 10-year (1998-

2007) average including leatherjackets (9.7 t lower), King George whiting (8.9 t), blue swimmer crabs *(Portunus pelagicus)* (7.9 t), sea mullet (6.3 t), Australian herring *(Arripis georgianus)* (6.0 t) and yellow eye mullet *(Aldrichetta forsteri)* (4.3 t). However, King George whiting and blue swimmer crabs have inflated 10-year averages due to unusually large spikes in recruitment during this period. Catches of cobbler (7.8 t higher), black bream (2.7 t), garfish (2.6 t) and skates/rays (1.4 t) were significantly above their 10-year average.

For the second consecutive year, all 13 individual estuaries were fished. Wilson Inlet again recorded the highest catch, with 50.6% of total SCEF landings. Combined landings from Oyster Harbour, Irwin Inlet, Princess Royal Harbour and Beaufort Inlet contributed a further 38.7% of total landings in 2008. The remaining 10.7% of total SCEF landings were recorded in the remaining eight estuaries; Stokes Inlet, Broke Inlet, Gordon Inlet, Oldfield Inlet, Jerdacuttup Lakes, Hamersley Inlet, Waychinicup Inlet and Culham Inlet.

The 2008 catch in Wilson Inlet was 104.8 t, which was 6.0 t below the 2007 level and also slightly below the 10-year (1998-2007) average annual catch of 118.1 t for this estuary. The catch in Princess Royal Harbour continued its declining trend, 6.7 t below the 2007 level and 16.5 t below the 10-year average. Oyster Harbour, increased by 9.4 t on 2007 levels but was still 12.6 t below the 10-year average. Stokes Inlet was 2.1 t above 2007 levels but 4.1 t below the average.

Following very high catches in 2007, Gordon Inlet and Beaufort Inlet recorded large declines in 2008, 26.5 t and 24.8 t respectively. However, both estuaries were only just below their 10-year average.

Irwin Inlet was the only estuary to record significantly higher catches, 9.2 t above the 10-year average. In 2008, catches in Broke Inlet and Irwin Inlet were 5.1 t and 4.0 t higher than 2007 levels.

Cobbler: Cobbler is the most dominant species in the SCEF catch, comprising 27.1% of the total catch over the past 10 years (1998-2007). In 2008, the total SCEF cobbler catch was 75.3 t, which was slightly higher than the 10-year (1998-2007) average annual catch of 67.5 t.

The 2008 catch, as in previous years, was primarily taken in Wilson Inlet (76.8%), with smaller catches in Irwin Inlet (16.4%), Oyster Harbour (5.8%) and Princess Royal Harbour (1%). In 2008, 92% 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). In 2007, the catch increased to 60.0 t, and in 2008 was 57.9 t. The 10-year (1998-2007) average is 54.2 t. The 2008 catch in Irwin Inlet was 12.4 t, an increase of 7.8 t from 2007 levels and is 9.1 t above the 10-year (1998-2007) average.

Black bream: The catch of black bream averages 35.2 t per year (or 14.0% of the total SCEF catch). This species is important because it has a widespread distribution and comprises 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 2008, the total SCEF black bream catch was 37.7 t, which was 8.4 t less than in 2007, but 2.5 t more than the average catch (South Coast Estuarine Figure 3). In 2008, black bream catches were reported in all 13 of the SCEF estuaries and comprise 98.5% of the total state catch. Consistent with the last 10 years, Beaufort Inlet, Wilson Inlet, Stokes Inlet and Oyster Harbour contributed the majority (87.9%) of black bream landings. Oyster Harbour recorded the greatest increase in catch in 2008, up 7.9 t from 2007 and 9.6 t above the 10-year (1998-2007) average).

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 favourable 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 2008, the total SCEF King George whiting catch was 7.2 t, most of which (72.2%) was taken in Wilson Inlet, with Princess Royal Harbour, Irwin Inlet, Oyster Harbour, Broke Inlet and Waychinicup Inlet contributing the remainder. The 2008 catch from Wilson Inlet was 5.2 t, which was 2.1 t more than 2007 but 7.5 t less than the 10-year (1998-2007) average catch in this estuary (South Coast Estuarine Figure 4). However, the 10-year average of 12.7 t is inflated by very high catches from 1997 to 2000, which resulted from high juvenile recruitment into Wilson Inlet by the 1995 year-class.

Approximately 44% of the total WA commercial catch of King George whiting in 2008 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 27.6 t per year (or 11.1% of the total SCEF catch). Sea mullet is also a significant component of commercial landings within many individual estuaries, although over half (51.3%) of the catch in the past 10 years has been caught in Wilson Inlet and Oyster Harbour. The 2008 catch of sea mullet was 21.3 t, which was well below the 2007 catch of 54.5 t, and slightly below the 10-year (1998-2007) average catch of 28.1. This continues the overall declining

trend in sea mullet landings seen over the past 10 years with the exclusion of the large spike in catch seen in 2007, which was due to high catches in the Gordon and Beaufort Inlets.

In 2008, yellow-eye mullet catches were reported in 8 of the 13 SCEF estuaries, with Wilson Inlet, Broke Inlet and Beaufort Inlet contributing the majority (94.8%) of the catch. The majority of yellow-eye mullet catches (76.8%) over the past 10 years were caught in Wilson Inlet and Broke Inlet. While, the catches in these two estuaries increased in 2008, their combined catch in 2008 was still below the 10-year average. The low catches are likely to reflect low abundance due to low recruitment by this species over the past five years.

Recreational catch: 30-40 % 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 *(Pagrus auratus)*, skipjack trevally *(Pseudocarnanx georgianus)*, prawns, Western Australian salmon, mullet, Australian herring, mulloway *(Argyrosomus hololepidotus)*, tailor *(Pomatomus saltatrix)*, squid and silver bream. 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 (Platycephalidae) 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.

The percentage of total catch by recreational fishers for all south coast estuaries is likely to have remained in the 30-40% range.

Fishing effort/access level

Access level

Since July 2002, the level of commercial 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 previously 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 licensees in the fishery through the implementation of the Voluntary Fisheries Adjustment Scheme. This buy-back system resulted in the number of licensees being reduced from 66 in 1987 to 25 in 2002. In 2008, the average number of boats fishing per month was at a record low of 15.3, slightly less than the 16.6 boats per month in 2007.

The total annual reported fishing days also peaked at 6,747 days in 1992 and then progressively declined, reaching a record low of 3,259 days in 2008 (South Coast Estuarine Figure 1). Accordingly, most estuaries recorded a decrease in effort levels in comparison to the 10-year average (1998-2007), with the exception of Irwin Inlet, Beaufort Inlet, Hamersley River and Waychinicup Inlet. Also, most estuaries reported a decrease in fishing days from 2007 to 2008, except for Oyster Harbour, Broke Inlet, Stokes Inlet and Hamersley River.

Effort in Oyster Harbour increased to 339 days fished in 2008, following a period of decline from 917 days fished in 2001 to a record low of 230 days fished in 2007. Effort in Princess Royal Harbour has also declined over the past decade, from a high of 753 days fished in 1997 down to a record low of 298 days fished in 2008. The declining levels of effort expended 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 2008, SCEF fishing effort was primarily focused in Wilson Inlet (60.1% of fishing days), Oyster Harbour (10.4%), Princess Royal Harbour (9.1%), Irwin Inlet (8.3%) and Beaufort Inlet (5.0%).

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
Assessment method:	Catch rates
Breeding stock levels:	Acceptable

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 60.7 kg/day fished from 1980 to 2008 (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. In 2008, total CPUE was 63.5 kg/day fished.

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.

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 increasing in 2007 and 2008. In 2008, the CPUE was 29.6 kg/day fished, which was above the 10-year average (1983-2007) of 24.7 kg/day fished.

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 undertook a fishery-independent survey of cobbler in Wilson Inlet in 2006. High numbers of juveniles were observed throughout the estuary during this survey, suggesting strong recruitment which is expected to have a positive effect on catch rates 3-4 years later.

Fishery-independent surveys of cobbler using catch-and-release methods are now being repeated annually by the Department in this estuary. A recruitment index derived from these data is under development and will be published in a later report.

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 the main estuaries of Beaufort Inlet, Oyster Harbour and Wilson Inlet simultaneously increased from the mid-1990s to 2005, recording a peak CPUE for the SCEF of 18.2 kg/day fished. From 2006 to 2008, the catch and CPUE of black bream in these estuaries were lower than 2005 levels but still high compared to historic levels.

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 (1998 – 2007), nearly 80% 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. In 2008, the estuary bar was open for a number of months, allowing for the recruitment of this species into the estuarine system.

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 2008, 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, pers. comm.).

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

Commercial

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 2008 fishing season, the SCEF employed an average of 18.9 fishers per month and generated additional regional employment in associated industries such as fish processing.

Recreational

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. Consequently, fishing in south coast estuaries ha s a great benefit to local tourism.

Economic Effects

Estimated annual value (to fishers)

for year 2008: $1,208,000

The top five most valuable species to the fishery were cobbler, black bream, King George whiting, sea mullet and Australian herring. King George whiting recorded the 3rd highest overall value even though it was only the 6th 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 and black bream.

Fishery Governance

Commercial

Current fishing level (2008): Acceptable

Target commercial catch range: 200 – 500 tonnes

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, however as environmental pressures increase in these sensitive areas, and the recreational fishing pressure increases, stock levels will need to be closely monitored.

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 2008 of 207 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. Declining effort is mainly due to buy-backs funded through a Voluntary Fisheries Adjustment Scheme. The target catch range will need to be recalculated when effort stabilises.

Recreational

Current fishing level (2008): Acceptable

Target catch range: Not developed

New management initiatives (20008/09)

No management changes will be implemented in 2009

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.

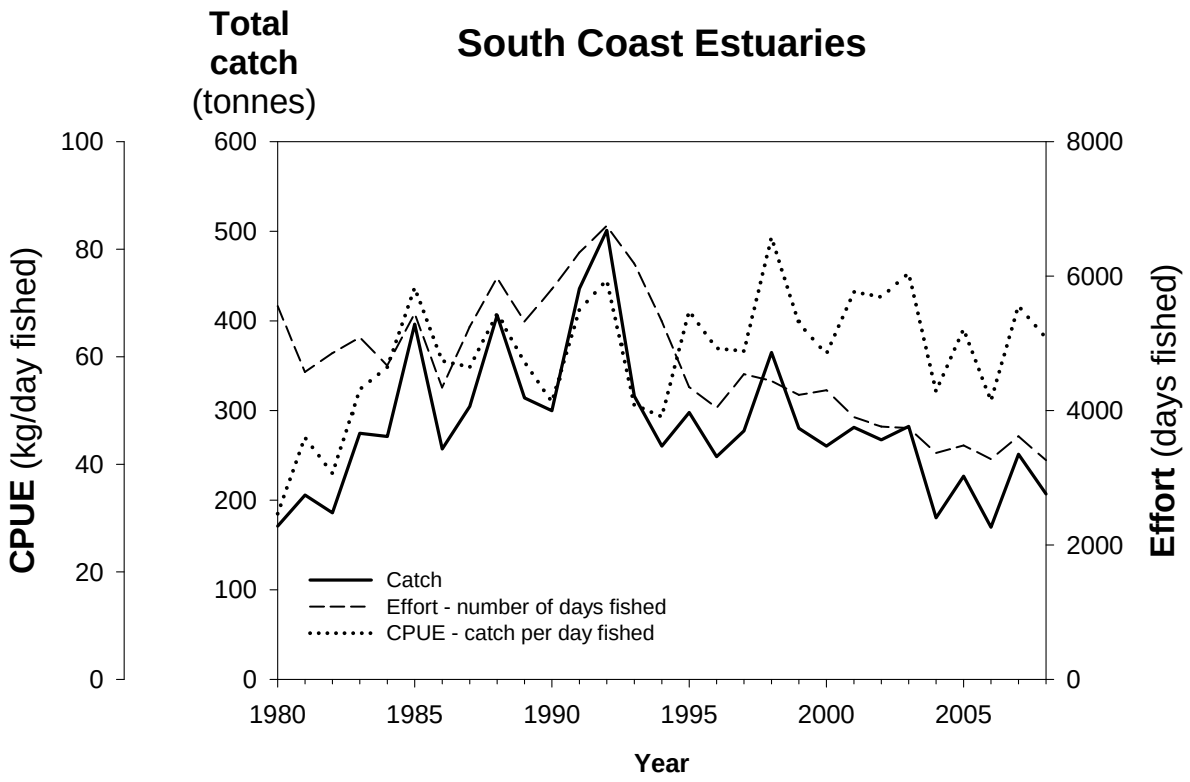
The influence of environmental factors on recruitment to estuaries is further complicated by the practice of human intervention to breach estuarine sandbars, mostly for reasons related to estuarine amenity coupled with ecosystem ‘health’.

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 2008.

Species	Scientific name	Catch (tonnes)
Cobbler	*Cnidoglanis macrocephalus*	75.3
Black bream	*Acanthopagrus butcheri*	37.7
Sea mullet	*Mugil cephalus*	21.3
Australian herring	*Arripis georgianus*	14.6
Flathead	*Platycephalidae*	8.2
King George whiting	*Sillaginodes punctata*	7.2
Sea Garfish	*Hyporhamphus melanochir*	6.6
Leatherjacket	*Monocanthidae*	6.5
Silver bream	*Rhabdosargus sarba*	5.1
Yellow-eye mullet	*Aldrichetta forsteri*	4.5
Other species		20.0
Total		207.0

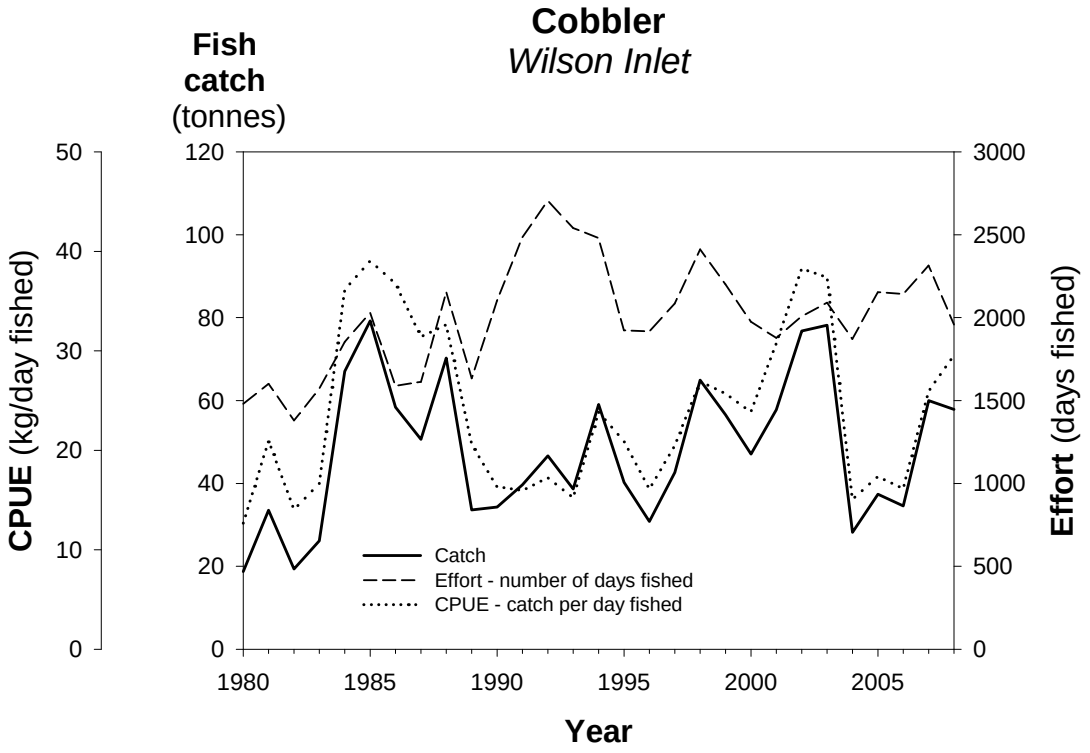


SOUTH COAST ESTUARINE FIGURE 1

The annual catch, effort and catch per unit effort (CPUE) for the South Coast Estuarine Fishery over the period 1980 – 2008.

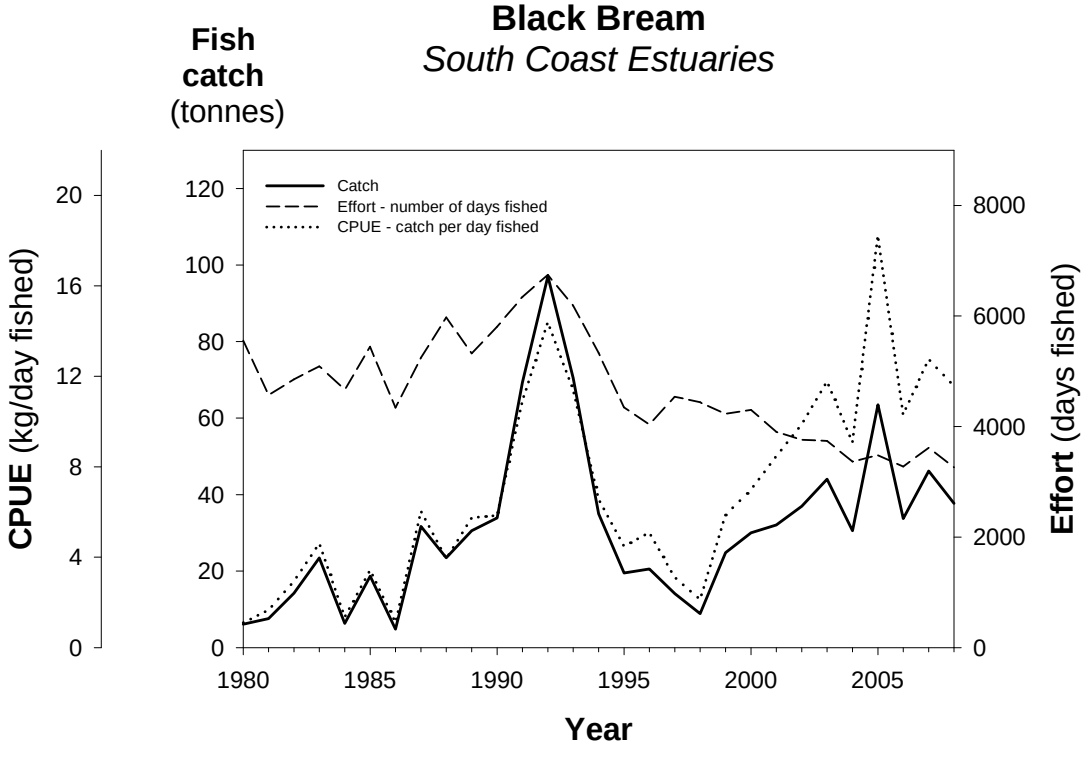
Note 1: Prior to 1993, the South Coast estuarine catch figures included King George Sound, which was not part of the SCEF. From 1993, when a separate fishing block was created for Princess Royal Harbour, the catch figures include Princess Royal Harbour but not King George Sound.

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.



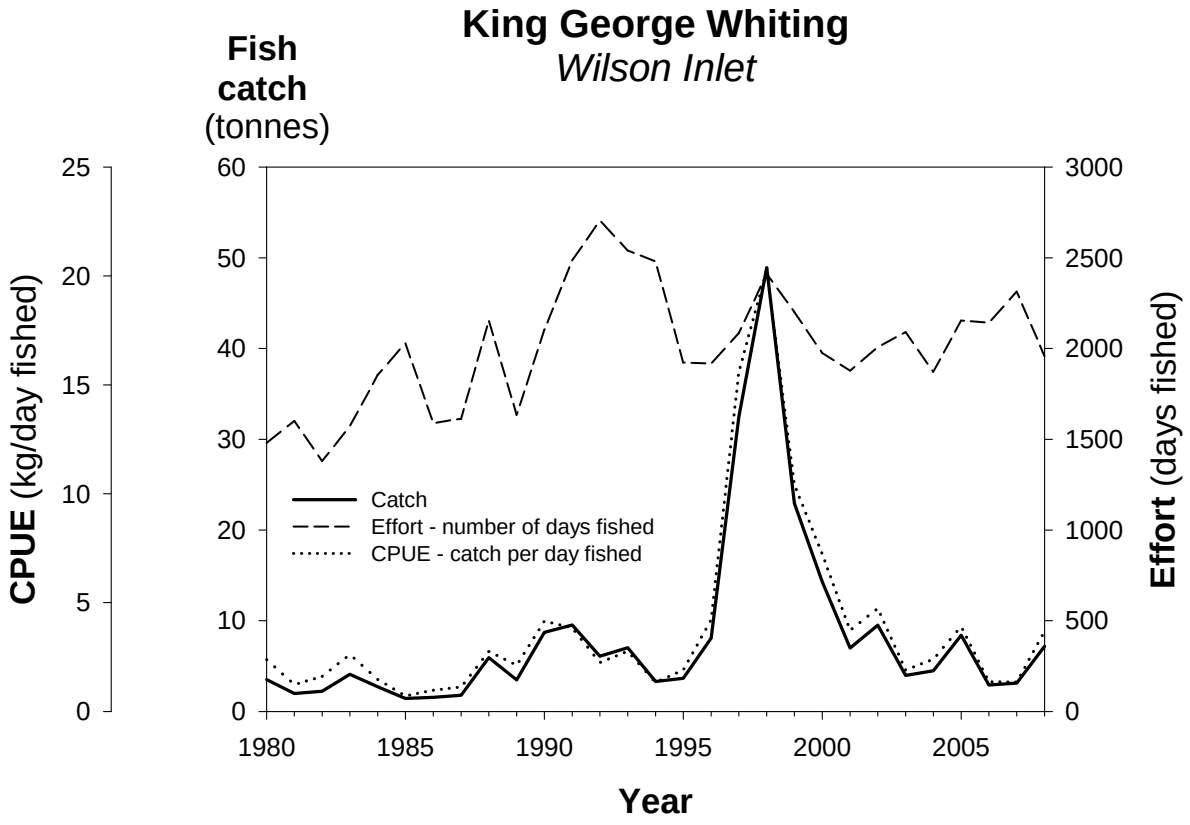
SOUTH COAST ESTUARINE FIGURE 2

The annual catch, effort and catch per unit effort (CPUE) for the cobbler (*Cnidoglanis macrocephalus*) fishery of Wilson Inlet over the period 1980 – 2008.



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 – 2008.



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 – 2008.

Australian Salmon Managed Fisheries Status Report

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

Main Features

Status	Current Landings
Stock level - Acceptable	Commercial - 879 t
Fishing level - Acceptable	Recreational - 6% of total catch (2000/01) of key recreational species

Fishery Description

Commercial

The western species of Australian salmon *(Arripis truttaceus)* forms large migratory schools, particularly during the autumn spawning season, that move along the coast in near-shore waters between South Australia to the east and Kalbarri in the west. The species 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 Australian 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

Recreational fishers also target this species on the south coast and lower west coast, mainly during the annual spawning migration.

Governing legislation/fishing authority

Commercial

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)

Fish Resources Management Act 1994 and subsidiary legislation

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. Western Australian Fishing Industry Council).

Recreational

Recreational Fishing Advisory Committees

Boundaries

Commercial

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

Recreational fishing for Australian salmon can occur in all WA waters except in areas closed to recreational fishing, i.e. sanctuary zones in marine reserves.

Management arrangements

Commercial

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 only. 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 Australian 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

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. The same minimum legal size also applies to commercial fishers. Australian salmon is listed as a Category 2 (medium risk) recreational species in both regions.

As Australian salmon is targeted by both recreational and commercial fishers, resource-sharing is an issue in the management of this fishery.

Research summary

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.

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 Australian 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 catch rates recorded in commercial returns and recreational logbooks can 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 can be a reasonable indicator of breeding stock level.

Annual fishery-independent surveys of juvenile Australian 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 Australian salmon recruitment for the south-west region, which is then used to forecast adult abundance and fishery catches 3 to 4 years later.

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 2008): 879 tonnes

The total state commercial catch of Australian salmon for the 2008 season was 879 t, which was slightly more than in 2007 (8.4 t higher), but was still the third lowest catch on record (Salmon Figure 1). The 2008 catch was well below the average catch of 2,082 t for the past 10 years (1998 – 2007) and outside the long-term catch range for this fishery (1,200 – 2,800 t).

On the south coast, the commercial catch of Australian salmon was 546 t in 2008, which was 298 t more than in 2007, but 949 t less than the 10-year (1998 – 2007) average. The 2008 catch was primarily taken from the central (Albany to Cape Riche) and western (Windy Harbour to Albany) regions of the fishery (66.5% and 26.1% of total catch, respectively). A small proportion (7.3%) was taken from the eastern sector of the fishery (from Cape Riche eastwards).

Historically, almost the entire south coast catch (approximately 90%) was taken between February and May each year, which coincides with the time of the spawning run along the south coast. In 2008, however, only 47% of the total annual catch was taken during this period, with the remaining 53% being taken during the 'back run' (June to December).

The west coast catch for 2008 was 333 t, which was 290 t less than in 2007 and 254 t less than the 10-year average (1997-2006) of 587 t. The Geographe Bay and Capes regions contributed nearly all (99.9%) of the south-west coast catch in 2008.

Recreational catch:

6% of total State catch (approximately)

The most comprehensive recent recreational fishing survey to include Australian 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 Australian 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 Australian salmon (Sumner and Williamson 1999, Sumner et al. 2007). In 1996/97, an estimated 2,740 Australian salmon were retained and a further 1,095 released by boat-based fishers. In 2005/06, an estimated 3,891 Australian 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 Australian 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 Australian salmon are not available.

Fishing effort/access level

Commercial

In 2008, 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 total number of licenced teams is an approximate measure of the annual commercial fishing effort applied to the stock effort. The number of 'active' teams per year is another measure of effort. In 2008, 13 of the 18 south coast licensees reported catching Australian salmon, up from the 5 in 2007, while 10 of the 12 licensees on the west coast reported catches.

The commercial Australian 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.

Recreational

Recreational catches of Australian 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 Australian salmon.

Stock Assessment

Assessment complete: Yes

Assessment method: Catch rates

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) could 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 Australian 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 Australian salmon during the spawning run, provide relative indices of breeding stock abundance.

On the south coast, the commercial catch rate from 1995 to 2002 displayed an overall stable trend, fluctuating between 80

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 2008, 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 just below the historical level in 2008. Collectively, all available information suggests that the total breeding stock level was adequate in 2008.

and 129.9 t per licensed team (Salmon Figure 2). After 2002, the catch rate declined from 117.2 t per licensed team in 2002 to 13.8 t per licensed team in 2007 and remained relatively low in 2008 at 30.3 t licensed team. Commercial fishers on the south coast report that their relatively low recent catch rates are partly the result of a lack of targeting due to limited market demand and also partly due to environmental factors (e.g. the Leeuwin Current) on the south coast reducing catchability, and not a result of a decline in total stock level.

On the west coast, the commercial catch rate has displayed an approximately inverse relationship to the south coast catch rate, particularly since 2000. On the west coast, the commercial catch rate increased from virtually zero in 2000 to a peak of 99.5 t per licensed team in 2006. In 2007, the catch rate dropped to 51.9 t per licensed team, which was still above the 10-year (1998-2007) average of 41.2 t. In 2008, catch rate declined to 27.8 t per licensed team.

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 Australian salmon. The number of Australian salmon retained by boat-based fishers increased by 42%, whereas the total boat-based effort in the zones where Australian salmon was caught increased by only 15% between these surveys (Sumner et al. 2007). This suggests an increase in the abundance of Australian salmon on the west coast between these two surveys.

Juvenile Australian 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 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 and fishery catch rates 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.

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 Australian salmon. Boxed text in this status report provides the annual assessment of performance for this issue.

Non-Retained Species

Bycatch species impact: Negligible

The fishery uses beach seine nets to specifically target schooling Australian 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 Australian 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

Australian 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 Australian 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

Commercial

During the 2008 fishing season there were approximately 46 commercial fishers involved in the south coast fishery and 22 in the south-west fishery.

Recreational

The number of recreational fishers targeting Australian 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 Australian 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 2008, anecdotal reports suggested that Australian salmon abundance along the west coast was low and, as a consequence, recreational targeting on the west coast may also have been low.

Economic Effects

Estimated annual value (to commercial fishers) for year 2008 $413,000

The price paid to south coast commercial fishers for Australian salmon in 2008 was at an average of $470/t. 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

Commercial

Current fishing level: Acceptable

Target commercial catch range: 1,200 – 2,800 tonnes

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.

The target catch range for the commercial fishery is 1,200 – 2,800 t. In 2008, the total commercial catch (879 t) was below the target range. Licencees in the South Coast Salmon Managed Fishery report that their relatively low recent catches are a result of a lack of targeting due to limited market demand and also partly due to environmental factors reducing catchability on the south coast.

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.

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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*.

Recreational

Current fishing level: Acceptable

Target recreational catch range: Not developed

New management initiatives (2008/09)

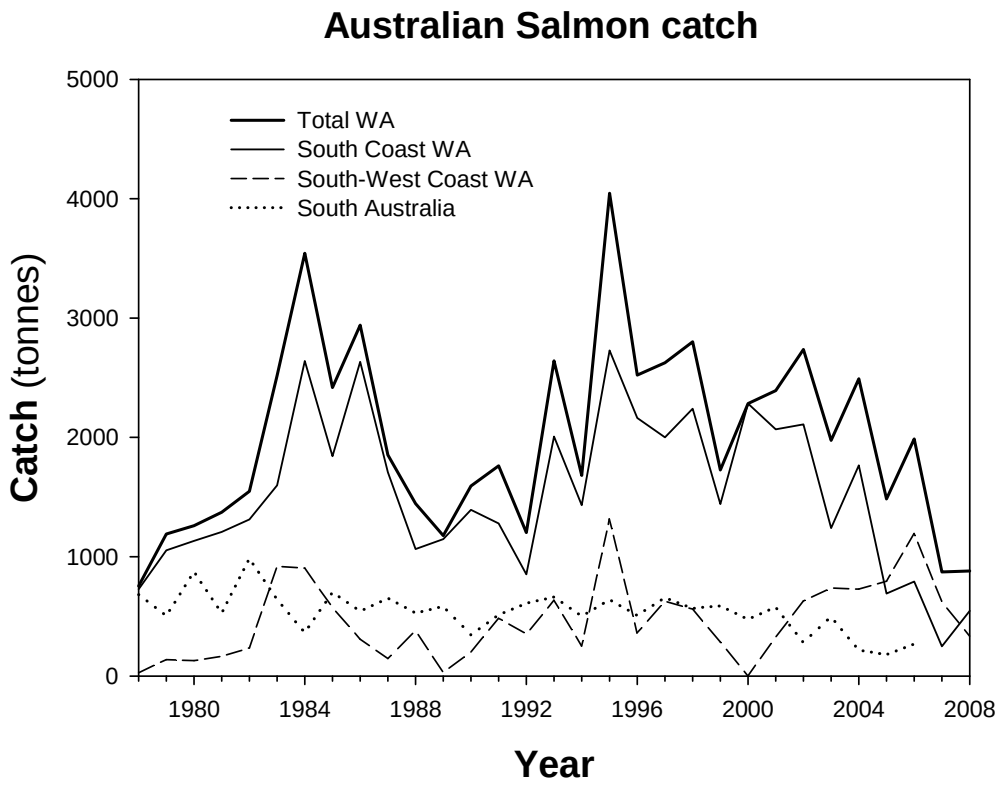
A voluntary Fisheries Adjustment Scheme remains in progress for the South-West Coast Salmon Managed Fishery. The period to make offers to the scheme closed on 30 June 2009.

A permanent closure to commercial salmon fishing in a section of Geographe Bay seawards to 800 metres came into effect on 1 July 2009.

External Factors

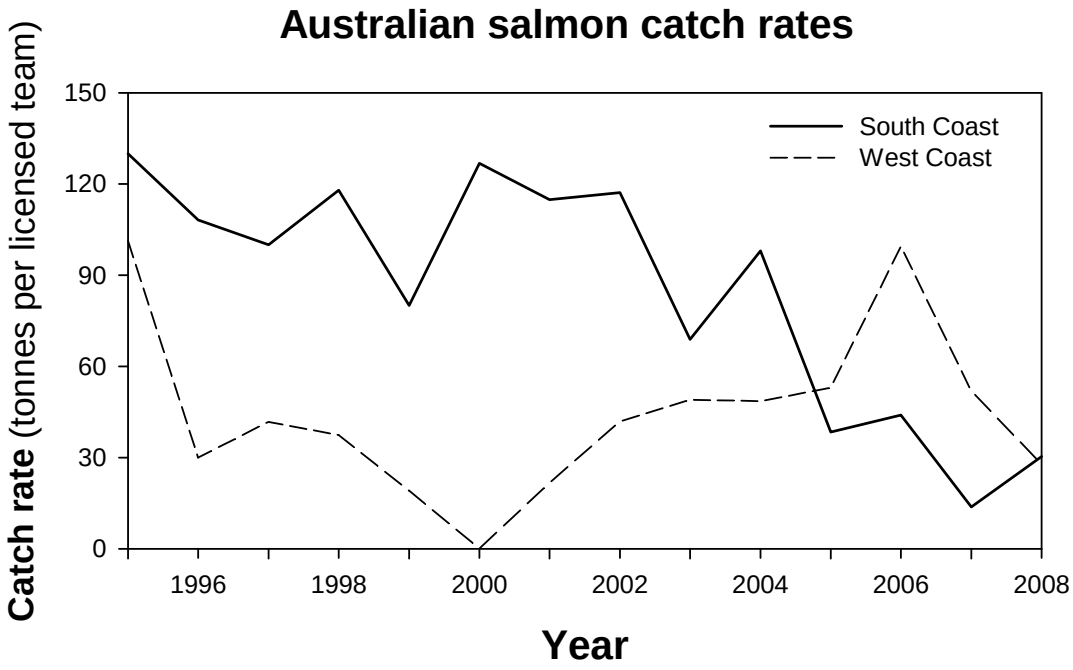
The cyclic nature of Australian salmon catches, with peaks at intervals of about a decade, is likely to reflect changes in abundance that are related to variations in recruitment success linked to large-scale environmental influences, such as the flow of the Leeuwin Current.

Fluctuations in Australian salmon catches can also occur due to the influence of environmental factors, without a change in stock level. For example, beach 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 2008.



SALMON FIGURE 2

Australian salmon catch rates in south coast and west coast regions for the period 1995 to 2008.

Australian Herring Fishery Status Report

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

Main Features

Status		Current Landings
Stock level -	Uncertain	Commercial - 271 t
		Recreational - 40% of total State Catch (based on 2000/01)
Fishing level –		
Commercial -	Acceptable	
Recreational -	Uncertain	

Fishery Description

Commercial

Most of the commercial catch of Australian herring *(Arripis georgianus)* in Western Australia (WA) 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, gill nets 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 are responsible for most of the commercial landings of Australian herring.

Recreational

A large number of recreational anglers in WA target Australian herring on the west and south coasts.

Governing legislation/fishing authority

Commercial

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

Recreational

Fish Resources Management Act 1994 and subsidiary legislation

Consultation process

Commercial

Meetings between the Department of Fisheries, industry and peak body members (e.g. the Western Australian Fishing Industry Council)

Recreational

Recreational Fishing Advisory Committees

Boundaries

Commercial

Australian herring can be taken commercially by holders of an unrestricted fishing boat licence along the lower west and south coasts, 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

Recreational fishing for Australian herring can occur in all WA waters except in areas closed to recreational fishing.

Management arrangements

Commercial

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.

Recreational

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 for this fishery, particularly on the west coast.

Research summary

The catch rates of commercial and recreational fishers, who mainly target mature Australian herring during the autumn spawning migration, have been used as relative indices of breeding stock abundance. Catch and effort data for commercial fisheries are obtained annually from compulsory monthly commercial fishing returns and recreational fisheries by voluntary recreational angler daily logbooks and intermittently for recreational fishing surveys (phone and creel). Recent surveys relevant to Australian herring include a national phone survey in 2000/01 and a boat-based creel survey on the west coast in 2005/06.

Fishery-independent surveys of juvenile fish are used to monitor annual Australian herring recruitment. Annual recruitment levels provide an indicator of future adult stock abundance and catch rates. Annual fishery-independent surveys of juvenile Australian 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 Australian herring caught per haul are used to generate a relative index of annual Australian herring recruitment for the south-west region, which is then used to forecast adult abundance and fishery catches 2 to 3 years later. Recruitment indices are being developed and will be presented in next year's report.

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 supplied by volunteer anglers at sites along the lower west coast. Fish are donated to researchers who age the fish using validated methods. Sampling to determine the age structure of the commercial catch will recommence in mid-2009, as part of a new research project designed to provide more rigorous monitoring and assessment of the status of Australian herring and other inshore species.

Retained Species

Commercial landings (season 2008):Total 271 tonnes
South coast 236 tonnes

The total commercial catch of Australian herring reported in 2008 was 271.2 t. While this was an increase of 36.8 t on the previous year, it is still the second lowest on record and well below the 10-year (1998-2007) average of 563.0 t. The majority (87.7%) of the south coast catch was caught using trap nets, with gill nets, beach seine nets and haul nets comprising most of the remainder of the catch. Approximately 93% of the south coast landings were from ocean waters, with the remainder from estuaries and embayments.

The low catch in 2008 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. Between 2000 and 2005, the total annual catch steadily declined each year in line with reduced effort in the trap net fishery. Since 2005, total landings have remained relatively stable, albeit, at historically low levels (Herring Figure 1).

The south coast catch in 2008 was 236.2 t which for the fifth consecutive year was below the target catch range (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.

The west coast catch of Australian herring in 2008 was 35.0 t, a decrease of 6.8 t from 2007 and over 50 t below the 10-year (1998-2007) average. For the third consecutive year, the lowest catch on record was recorded for this region. The majority (57%) of these landings were from embayments (Geographe Bay and Cockburn Sound), with the remainder from ocean waters (25%) and from estuaries (18%). The 2008 catch was below the target catch range of 70 – 185 t for this region. The decline in catch can be attributed to a large reduction in the Geographe Bay region (32.5 t below the 10-year average), the south-west (Bunbury) region (13.8 t below the 10-year average) and Cockburn Sound (10.7 t below the 10-year average).

The vast majority of commercial herring landings are taken between January and May each year. May is traditionally the end of the trap net fishing season and marks the end of the main pre-spawning migration for this species. In 2008, 91.8% of the total WA catch occurred in this period.

Recreational catch: 70% of West Coast Catch
11% South Coast Catch

An estimate of the total state recreational Australian herring catch is not available for the current year (2008). 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 Australian 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 Australian 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). This compares to an estimated 364,932 fish (46 t) retained by boat-based recreational fishers during a similar survey in 1996/97 (Sumner et al. 2008). Boat-based surveys miss the significant catches made by shore-based anglers and thus these boat-based figures are likely to substantially under-estimate the total west coast recreational catches.

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. Using the estimated 32% take by boat fishers from the 2000/01 national survey extrapolated against the 2005/06 boat-based creel survey generates an estimated 125 t of

Australian herring potentially being taken in the west coast region in 2005/06 by both shore-based and boat-based recreational fishers. This equates to approximately 70% of the total west coast catch (commercial and recreational) for the same 12-month period.

Fishing effort/access level

Commercial

The majority of the commercial catch of Australian herring is caught by trap netting along the south coast. 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 2008, only 5 teams recorded effort during the season. This was an increase from the 3 active teams in 2007 but continues the low participation level in this fishery in recent times. These historically-low effort levels were in response to the lack of markets and low wholesale prices paid for Australian herring.

On the west coast, a total of 21 commercial fishers in ocean waters and a further 9 commercial fishers in the Peel-Harvey estuary reported landings of Australian herring in 2008. However, 90% of ocean landings were taken by only 6 fishers. The level of commercial fishing effort expended in the capture of Australian herring in ocean waters of the west coast has declined since 2000. For example, in 2000 a total of 43 commercial fishers reported landings of Australian herring in ocean waters and 15 fishers caught 90% of these landings.

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 Australian herring, but the proportion that actually catch Australian 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 Australian 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
Assessment method:	Catch rates
Breeding stock levels:	Uncertain

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, the status of the stock is now uncertain. Historically, the stock has been assessed primarily using data from the commercial south coast trap net fishery but a significant reduction in effort and targeting by commercial fishers since 1990 has made the commercial catch rate an increasingly unreliable an index of herring abundance. Therefore, the decline in the annual catch rate of the trap net fishery after 2001 does not necessarily reflect a decline in stock level. However, several other data sources suggest that the breeding stock level has declined.

Recreational catch rates from periodic surveys and from voluntary logbooks may provide a more reliable index of abundance than current commercial catch rates. The estimated number of Australian 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 Australian herring in west coast waters between surveys.

The average catch rate of Australian 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. In 2008, the average catch rate declined slightly. However, since logbook data have only been available since mid-2005, it is difficult to interpret these initial data in the absence of comparable historical data.

The maximum 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.

Relatively high juvenile recruitment was observed in 1998. In 2000 and 2001, localised peaks were evident in catch rates by commercial trap netting and also by some other commercial methods. 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 the late 1990s. Compared to annual recruitment levels observed during fishery-independent sampling in the late 1990s, recruitment in 2006 and 2007 was very low in both west and south coast regions, suggesting a low abundance of adults would occur in 2008 and 2009. The recruitment index increased to a moderate level in 2008, but was still well below that observed in the late 1990s.

The available information strongly suggests that the abundance of Australian 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. In a prolonged 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.

A more recent estimate of the total catch and effort by shore-based recreational fishers, who catch the majority of Australian herring on the west coast, would provide information about the current stock level. More intensive monitoring of the age structure of the catches by each sector would also assist in determining stock status.

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

Commercial

Approximately 17 fishers participated in commercial trap net fishing in 2008. Numerous other commercial fishers take part in the capture of Australian herring using other fishing methods, such as estuarine haul and gill nets, 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.

Recreational

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 Australian herring was the second most common finfish retained by recreational fishers in WA (after whiting, a category which includes a few species), and comprised 22% (by number) of finfish in the retained recreational catch (marine/estuary waters only). In 2000/01, Australian 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 2008: $301,000

The estimated value to fishers of the total state commercial catch for the year 2008 is based on values paid to both trap net fishers (primarily sold as bait at a lower price) and to other fishers (primarily sold for human consumption at a higher price).

Fishery Governance

Commercial:

Current fishing (or effort) level: Acceptable

Target commercial catch range:

South coast 475 – 1,200 tonnes

West coast 70 – 185 tonnes

Target catch ranges for the south coast Australian 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 2008, the south coast catch was 236 t, which was below the target catch range (475 – 1,200 t) for this region. However 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 5 of the 11 licensed trap net teams fished for Australian herring in 2008 and only 3 out of the 11 teams the year before.

In 2008, the west coast commercial fishery catch was 35 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, Cockburn Sound and Bunbury areas. Some effort previously spent targeting herring may have been redirected towards other species like Australian salmon.

The total commercial fishing level is very low and is considered acceptable at this time.

Recreational:

Current fishing (or effort) level: Not available

Target recreational catch range: Not developed

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.

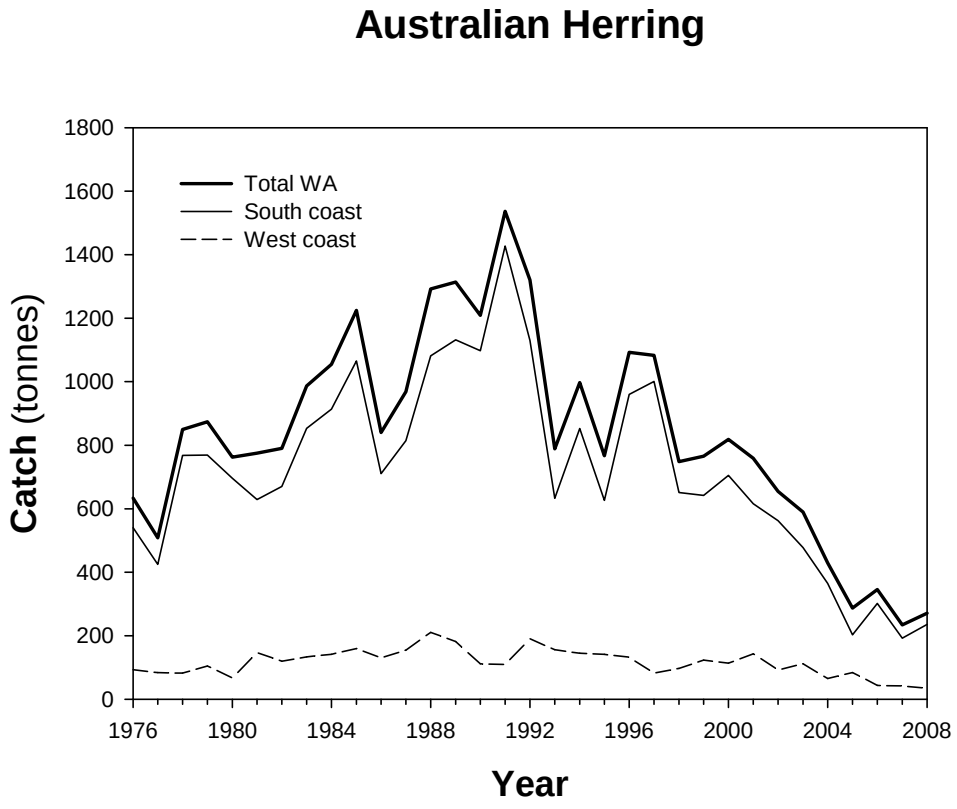
New management initiatives (2008/09)

With the Ministers approval, a new Order to regulate the herring 'G' nets is being drafted. The new Order will list those operators in the fishery that are excepted to the Order in a schedule.

External Factors

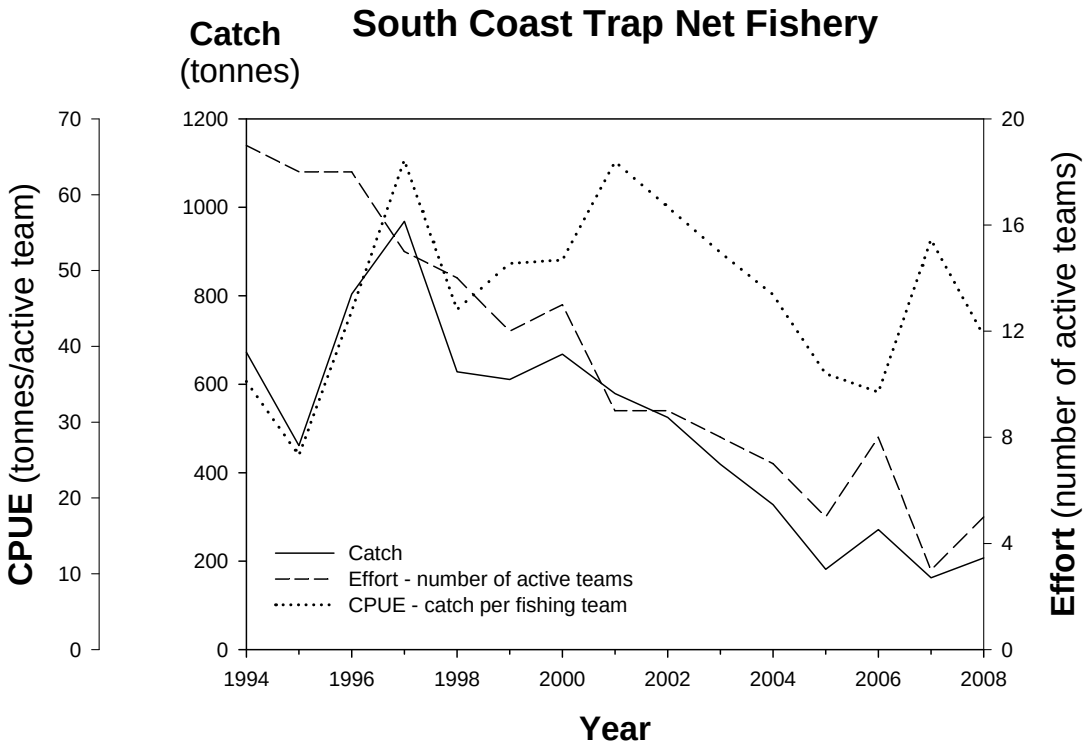
It is likely that factors other than fishing (e.g. the strength of the Leeuwin Current) significantly influence the migration patterns of pre-spawning adults, the distribution of spawning and the dispersal of larvae. These factors will then affect juvenile recruitment success and the catchability and 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 (R. Campbell, personal communication) and Australian salmon, both of which consume Australian 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 2008.



HERRING FIGURE 2

Catch, effort and CPUE for Australian herring from the south coast trap net fishery for the period 1994 to 2008.

South Coast Purse Seine Fishery Report: Statistics only

B. Molony and E. Lai
Management input from D Pupazzoni

Fishery Description

This fishery is based on the capture of pilchards *(Sardinops sagax)* by purse seine nets in the waters between Cape Leeuwin and the Western Australia/South Australia border. The management plan also covers the take of yellowtail scad *(Trachurus novaezelandiae)*, Australian *anchovy (Engraulis australis)* and maray *(Etrumeus teres)*.

Boundaries

The Fishery consists of three major management zones. The Albany Zone (including the King George Sound zone) extends from Point D'Entrecasteaux to Cape Knob. The Bremer Bay Zone extends from Cape Knob to longitude 120ºE. The Esperance Zone from 120ºE to the WA/SA border. An additional 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. The Albany zone has an annual TAC of 2683 tonnes, while both the Bremer Bay and Esperance zones have an annual TAC of 1500 tonnes each.

Landings and Effort

Commercial catches during the 2007/08 season were 1,735.3t, up from 1,622.9 t in 2006/07 (South Coast Purse Seine Figure 1). Most of the commercial catches (1,457.7 t) were reported from the Albany Zone, with much lower catches reported in the Bremer Bay and Esperance Zones (192 t and 82 t, respectively). Overall effort increased by approximately 16%. However, overall effort and catches remain below those recorded during the late 1980s and 1990s.

Fishery Governance

Target commercial catch range: not available

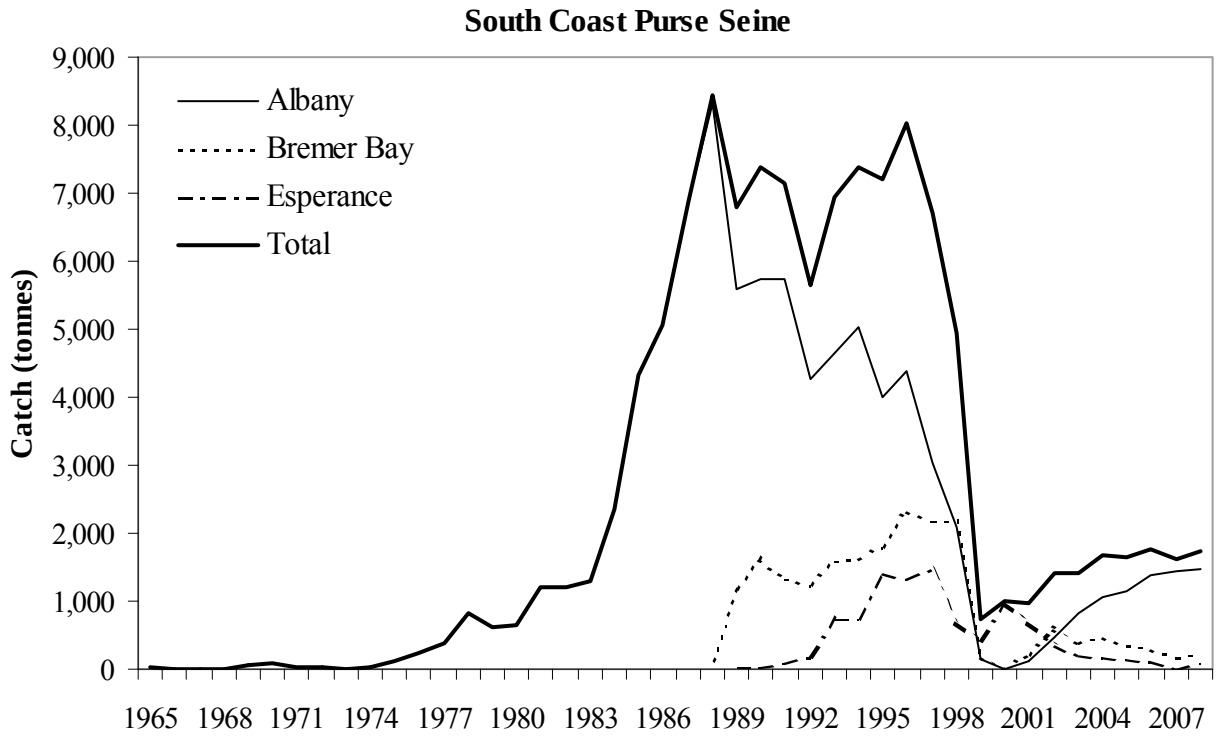
For the 2007/08 season, the catch was well below the total TAC for the entire fishery (5,683 t). The fleet and infrastructure for this fishery is rebuilding, but irregular availability of market-sized fish, particularly in Bremer Bay and Esperance, influence how much of the TAC is caught. Furthermore, 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

Based on the most recent assessment (completed in 2006) the level of spawning biomass in each major management zone is appropriate therefore the current level of fishing is acceptable.

New management initiatives (2009/10)

In 2006 the Department of Fisheries instigated a working group to examine the issue of seabird and dolphin interactions with purse seine fishing operations. A joint research project with Murdoch University, the Western Australian Fishing Industry Council and the Conservation Council of Australia developed strategies for the mitigation of seabird bycatch. A code of practice, which is supported by industry and reviewed annually helped reduce seabird mortalities by 90% and secure another three-year Wildlife trade export approval from the Department of Environment, Water, Heritage and the Arts.



SOUTH COAST PURSE SEINE FIGURE 1

Annual catches of pilchards along the south coast, by fishing zone

Demersal Gillnet and Longline Fisheries Status Report

Rory McAuley
Management input from Nikki Sarginson

Main Features

Status

Stock level -	Gummy shark	Acceptable
	Dusky shark	Depleted
	Sandbar shark	Depleted
	Whiskery shark	Recovering
Fishing Level –	JASDGDLF Zone 1	Not assessed
	JASDGDLF Zone 2	Not assessed
	WCDGDLF	Not assessed

Current Landings (2005/06)

Demersal Gillnet and Demersal Longline Fishery

- Total sharks and rays	1357 t
- Scalefish	236 t

Indicator species

- Gummy shark	463 t
- Dusky shark	274 t
- Sandbar shark	198 t
- Whiskery shark	187 t

Catch of sharks and rays by other commercial fisheries (2007/08) 7.2 t

Recreational catch (2005/06) <5% of commercial catch

Fishery Description

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed 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 to 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 gummy shark (*Mustelus antarcticus*) and dusky shark (*Carcharhinus obscurus*), while on the west coast fishers primarily target dusky shark and sandbar shark (*Carcharhinus plumbeus*). 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 Licences

West Coast

West Coast Demersal Gillnet and Demersal Longline (Interim) Management Plan 1997

West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery Permits

Consultation processes

Meetings between the Department of Fisheries and the WA Demersal Net and Hook Fisheries Management Advisory Committee (WADNHFMAC; although inactive since 2006); the WA Demersal Gillnet and Longline Association; direct correspondence and port visits with authorisation holders.

Boundaries

The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery spans the waters from 33°S latitude to the WA/SA border and comprises two separate management zones. Zone 1 extends southwards from 33°S to 116°30'E longitude off the south coast. Zone 2 extends from 116°30'E to the WA/SA border (129°E).

The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery technically extends northwards from 33°S latitude to North West Cape (114°06'E longitude). However, the use of shark fishing gear has been prohibited north of 26°30'S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has also been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since 15 November 2007.

The management boundaries of both fisheries are illustrated in Demersal Gillnet and Longline Figure 1.

Management arrangements

The southern and west coast fisheries are regulated through two complementary management plans. The JASDGDLF management plan was introduced in 1988 and is managed by the Western Australian Government on behalf of a Joint Authority comprising the Western Australian and

Commonwealth Governments. The WCDGDLF is administered by the Western Australian Government under a management plan introduced in 1997.

Both fisheries are managed via input controls in the form of transferable time/gear effort units, with additional restrictions on mesh and hook sizes, net height ('drop') and maximum net length. Historically, each unit has permitted the use of one length of net or an equivalent number of hooks for one month. However, since 2006/07, the Department has been working with operators to transition the fishery to a more explicit hourly effort management system, with the objectives of removing latent effort capacity and restricting effort within each management zone to 2001/02 levels. Once formally implemented, through amendments to the management plans, all units will permit the use of 27 m of gillnet or 9 hooks on a longline for either 288 hours (in the WCDGDLF), 264 hours (in Zones 1 and 3 of the JASDGDLF) or 380 hours (in Zone 2 of the JASDGDLF.

Additional measures to address remaining sustainability concerns for key stocks were introduced during the 2006/07 season. These included:

- a two month closure of the fisheries (16 August to 15 October), including the inshore waters to 200m depth throughout all of the WCDGDLF and the waters of the South Coast west of 118° E (in the JASDGDLF) to assist in the recovery of the over-exploited whiskery shark stock;
- a maximum size limit for dusky sharks to protect their breeding stock and
- a prohibition of metal trace wire and large hooks, which had previously been used to target large whaler sharks.

These new (and pending) shark management arrangements are supported by more precautionary regulations in non-target fisheries, including the State-wide commercial protection of all sharks and rays, which is intended to restrict their landings to a handful of fisheries.

The metropolitan zone has now been closed to many commercial finfish fisheries including the WCDGDLF.

Research summary

Current research monitoring involves analysis of the CAES and logbook data and limited biological sampling of commercial catches. However, to support the new and pending fishery management arrangements, improve assessments of key stocks and to facilitate the more detailed reporting requirements of the fisheries' export accreditation under the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act, a new daily/trip catch and effort reporting system was introduced in 2006/07. 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 and 2007/08. New data validation procedures are therefore being developed but catch and effort statistics for the 2006/07 and 2007/08 seasons cannot yet be reported with sufficient levels of confidence.

Retained Species

Commercial landings (season 2007/08):

All sharks (and rays): Not available

Key species: Not available

Shark catches in other fisheries: Sharks are also caught off the south and west coasts in a variety of other commercial fisheries. However, due to the very poorly reported species identification of shark catches in non-target fisheries and their contribution to sustainability risks to some stocks (eg. dusky shark), the retention of sharks and ray catches in most non-target fisheries was prohibited in November 2006 by commercially protecting all sharks and rays. Reported shark and ray catches by vessels operating in other managed fisheries between North West Cape and the South Australian border consequently declined to 5 t in 2006/07 and 3.4 t in 2007/08. Despite the commercial protection, 47 tonnes of sharks were taken by vessels using 'wetline' methods in the region during 2006/07, although this declined to 3.8 t in 2007/08.

Other finfish (i.e. non shark) catch: The WCDGDLF and the JASDGDLF also capture a number of scalefish species in addition to their main catch of sharks. In 2005/06 this totalled 236 t of scalefish. Since this time, as their effort has been reduced and the areas where they can operate have also been reduced it is likely that their level of catch of scalefish has declined.

Recreational catch estimate (season 2005/06):

< 5% of total catch

The recreational catch of sharks by fishers operating from trailer-boats between Augusta and Kalbarri was estimated from two Department of Fisheries surveys conducted in 1996/97 and 2005/06. The total recreational shark catch was estimated to have declined from ca. 7,000 sharks per year in 1996/97 to ca. 5,500 sharks per year in 2005/06, although only about half of these were reported to have been retained. The reported species composition of the retained catch in 2005/06 was similar to that of the Demersal Gillnet and Demersal Longline fisheries, Whaler shark species were the most commonly retained group (31%), followed by hound sharks (gummy, whiskery, etc.; 28%), wobbegongs (14%) and hammerheads (10%). Assuming 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 13.5 t, or approximately 3% of the west coast commercial shark catch in that year.

Fishing effort/access level

There were 57 licences in the JASDGDLF in 2007/08, 24 in Zone 1 and 33 in Zone 2. However, based on preliminary information, only 8 Zone 1 vessels and 17 Zone 2 vessels reported active fishing returns during the year. There were 26 licences in the WCDGDLF in 2007/08, although only 7 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.

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. 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 or CPUE) referred to below are the 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 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 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 developed during the recently completed FRDC-funded project and analyses of CPUE 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 1–2% 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 (very similar to the estimate for 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 - 10 year-old sharks, this declining trend is consistent with a decline in recruitment beginning in the late 1990s. Thus 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 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.

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, a new effort management system will be introduced in coming seasons, which is aimed at constraining catches to their 2001/02 levels (9% less than in 2005/06) and a seasonal closure was implemented in 2006/07 to further reduce catches and improve recruitment (see management arrangements above).

Assessment method:	
Gummy shark	Age Structured Model
Dusky shark	Direct Survey
Sandbar shark	Direct Survey
Whiskery shark	Age Structured Model
Breeding stock levels:	Gummy shark acceptable
	Dusky shark unacceptable
	Sandbar shark unacceptable
	Whiskery shark 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 yet to result in 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 (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 ESD 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.

Small numbers of white sharks (*Carcharodon carcharias*) and grey nurse sharks (*Carcharias taurus*) were caught (*< 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 (and still is) assessed as very low.

Ecosystem Effects

Food chain effects: Not assessed

This is either the risk assessment outcome if it is low or negligible – it should only change annually if the risk is Moderate or higher and there is a monitoring program.

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.

This is either the risk assessment outcome if it is low or negligible – it should only change annually if the risk is Moderate or higher and there is a monitoring program.

Social Effects

Direct: Estimated employment during 2005/06 was 60 skippers and crew in the JASDGDLF and 25 in the WCDGDLF. Unlike other regions, sharks are generally not targeted by recreational fishers in Western Australia, thus their direct social importance to this group is negligible.

Indirect: Sharks are viewed as a menace by some members of the community due to their perceived danger to bathers and their predation of prized recreationally caught fish. However, others consider them to be important components of marine ecosystems that deserve to be conserved.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2006/07: Not assessed

Fishery Governance

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 New management initiatives below).

Target commercial catch range:

Key shark and ray species 725–1,095 tonnes

Individual target catch ranges for the key species in 2007/08 were as follows:

Gummy shark	350–450 tonnes
Dusky shark	200–300 tonnes
Sandbar shark	< 120 tonnes
Whiskery shark	175–225 tonnes

New management initiatives (for the next year)

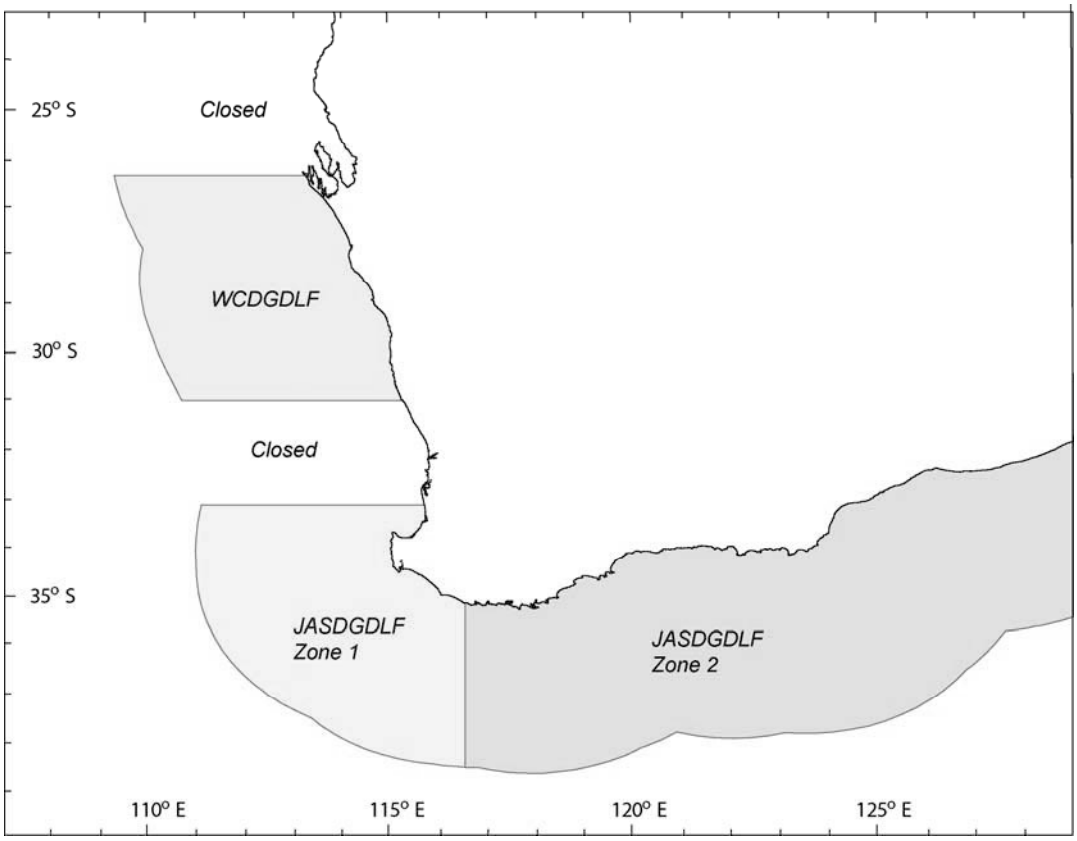
The remaining components of the new JASDGDLF and WCDGDLF management arrangements foreshadowed in previous status reports are expected to be in place by the commencement of the 2008/2009 season (for the WCDGDLF) and by the end of 2009 (for the JASDGDLF). Currently, the outstanding elements of this package are:

- formal conversion of existing monthly gear units to hourly units;
- explicitly capping effort within each zone at their 2001/02 levels; and
- formal implementation of the vessel monitoring system.

To support and assess the success of these management changes, there will need to be increased monitoring of these fisheries, with a focus on size composition of catches and tagging to update harvest rates, particularly for dusky shark and sandbar sharks. A complimentary maximum size limit for recreationally-caught whaler shark species will be introduced for the southern and west coast bioregions during the 2008/09 season.

External Factors

There are a number of factors outside of the control of the fishery which 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, continued high catches of the breeding stock in the northern shark fisheries is a cause for increasing concern. 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, it is unlikely to be currently causing any detrimental effect to the WA fisheries. All of these outside influences however need to be taken into account in the stock assessment process for these species and accommodated in the management strategy.



DEMERSAL GILLNET AND LONGLINE FIGURE 1

Management boundaries of the WA temperate Demersal Gillnet and Demersal Longline Fisheries

AQUACULTURE

Regional Research and Development Overview

Abalone is considered a key species for aquaculture development on the south coast.

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 approved an application for an offshore abalone farm near Augusta, which is linked to an existing, land-based hatchery. It is also reviewing licensing and 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

COMPLIANCE AND COMMUNITY EDUCATION OVERVIEW

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Commercial and recreational fisheries compliance in the South Coast bioregion is undertaken by Fisheries and Marine Officers (FMO's) 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. South Coast Natural Resource Management Inc. provided funding for a Marine Education Officer position for the South Coast.

Activities during 2007/08

Due to the variety of commercial and recreational fisheries, expanse of coastline and variable and seasonal weather conditions, Fisheries and Marine Officers employ a risk management driven approach to prioritise and plan compliance activities.

Overall, Fisheries and Marine Officers delivered a total of 2663 hours of "in-field" compliance activity during 2007/08 (South Coast Compliance Table 1) representing a decrease from the previous year. (South Coast Compliance Figure 1).

Officers made contact with a total of 198 commercial fishers in the field, with the majority of the commercial compliance effort directed towards the Managed Abalone 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 fishery to undertake spot checks of net lengths and catch inspections, inspections of deep-sea crab and rock lobster catches and quota checks and monitoring in the Purse Seine Fishery.

During the year, 8 infringement warnings and 3 infringement notices were issued and a further 3 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. Fisheries and Marine Officers (FMOs) made contact with a total of 2542 recreational fishers. During 2007/08, 41 infringement warnings and 21 infringement notices were issued and 4 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 Fisheries Volunteers who conduct education programs throughout the region.

In 2007/08 the Volunteer program involved 6 volunteers in the Albany and Denmark areas and 6 in Esperance. Community education activities conducted in the bioregion included attendance and presentations by the Marine Education Officer and Volunteers at primary and secondary schools, regional shows and festivals, community group meetings and fishing competitions.

Initiatives in 2008/09

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 (JADGDLF), which include effort restrictions and the whiskery pupping closure. Abalone compliance activities will continue to focus on targeted inspections of landings based on analysis of the existing intelligence.

FMO's will structure recreational fishing compliance programs to address a growing concern of increased catches of demersal scalefish by recreational fishers due the potential additional effort from fishers relocating from the West Coast as a result of the new West Coast rules and license fees. The program will include operations aimed at ensuring compliance with possession limits as well as investigations into suspected illegal fish sales.

The recent development of the Walpole – Nornalup Inlets Marine Park will see the personnel in the southern bioregion engaged in a range of tasks including delivery of marine park compliance services and education programs. Operational plans are being developed with the Department of Environment and Conservation with a focus on joint operations to maximize the management presence in the marine park.

The Volunteer 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.

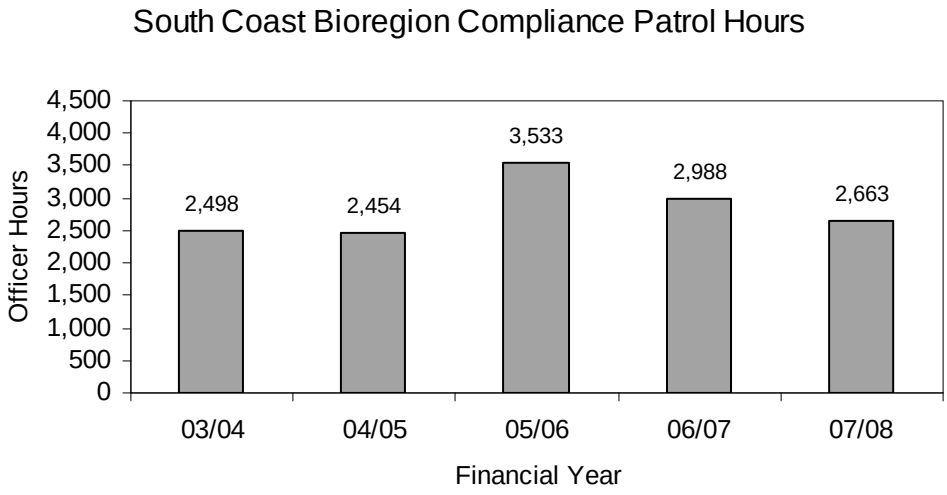
SOUTH COAST COMPLIANCE TABLE 1

Summary of compliance and educative contacts and detected offences within the South Coast bioregion during the 2007/08 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,663 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	198
District Office contacts	408
Infringement warnings	8
Infringement notices	3
Prosecutions	3
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field Contacts by Fisheries & Marine Officers	2,542
District Office contacts	730
Infringement warnings	41
Infringement notices	21
Prosecutions	4
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field Contacts by Fisheries & Marine Officers	125
District Office contacts	503
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.



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 07/08 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.)

NORTHERN INLAND BIOREGION

NORTHERN INLAND BIOREGION

ABOUT THE BIOREGION

The Northern Inland bioregion, encompassing the northern half of Western Australia, is predominantly a desert area, with few permanent water bodies. As a result of occasional summer cyclones, the various river systems flow at flood levels for short periods before drying-out to residual waterholes. The only exceptions to this are man-made dams, which trap rainfall for water supply purposes and irrigation.

The only significant fishable water body in the region is Lake Argyle, created by damming the Ord River. The continuous release of water from the dam has resulted in the Ord River maintaining its freshwater fish populations year-round, as does the lake, where some freshwater native fish populations have expanded. Populations of reptiles, such as the protected freshwater crocodile, are supported by the expanded food chain of native fish, and are thought to have increased significantly from their original billabong-based populations.

SUMMARY OF FISHING ACTIVITY

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.

ECOSYSTEM MANAGEMENT

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.

In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has an initiated Ecosystem Based Fisheries Management (EBFM) framework.

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 to ensure the sustainable management of fish stocks in the future. The EBFM risk assessment process for the West Coast Bioregion has been completed (see Table 1 for the West Coast Bioregion) and serves as an example of what will be undertaken for the Northern Inland Bioregion. 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.

FISHERIES

Lake Argyle Silver Cobbler Fishery: Statistics Only Report

S.J. Newman and C. Skepper
Management input from R. Green

Fishery Description

Commercial

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 (*Arius midgleyi*).

Recreational

A small recreational and charter boat fishery for this species exists in Lake Argyle with fishing activities peaking during the dry season (winter months).

Boundaries

Commercial

The waters of the Lake Argyle Silver Cobbler Fishery (LAFCF) include all waters of Lake Argyle.

Recreational

Recreational anglers can fish in all creeks and tributaries that feed into the Ord River and Lake Argyle.

Management arrangements

Commercial

The LASCF is a limited entry fishery, with six current (licence condition) endorsement holders permitted to operate in the Fishery. A licence condition restricts the net type permitted, with fishers only permitted to use set nets that have a minimum mesh size of 159mm and maximum net drop of 30 meshes.

Under the *Lake Argyle Fishery Notice 1994*, endorsement holders are allowed to use no more than 1500 metres of net at any one time, and all nets must be suitably marked with licence identification. 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 is aimed at protecting fish during the spawning season. Also, at this time of the year water temperatures in the lake are high resulting in spoilage of fish in the nets. Fishers in the LAFCF are not permitted to take barramundi (Lates calcarifer) at any time.

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 licence holders, charter operators, the general public and conservation groups of interactions between commercial fishing operations 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.

Governing legislation: Fisheries Notice no. 665 '*the Lake Argyle Fishery Notice 1994*' (Section 43 order); Condition 55, 56, 292 on a Fishing Boat Licence.

Consultation: Department–industry meeting. Meetings with the Department of Environment and Conservation.

Recreational

There are currently no size limits in place for silver cobbler. There is a bag limit of 8 fish that applies to any species in the Family Ariidae.

Legislation: *Fish Resources Management Act 1994*, *Fish Resources Management Regulations 1995* and subsidiary legislation.

Consultation: Recreational Fishing Advisory Committee, East Kimberley Regional Recreational Fishing Advisory Committee (Kununurra).

Landings and Effort

Commercial (season 2008):

Total (all species) 126 tonnes

Silver cobbler 117 tonnes

Argyle bream (sooty grunty) 8.8 tonnes

The fishery first developed in 1979 with increasing catches reported until 1988 (138 t). Catch levels then fluctuated between 90 t and 145 t until 1997 (Lake Argyle Silver Cobbler Figure 1), after which they increased to a peak of 231 t in 2000. Owing to voluntary reductions in effort, catches declined in both 2001 and 2002. From 2003 to 2005, the level of catch has ranged from 131 to 165 t. In 2006, the catch dropped to 78 tonnes. The catch in 2007 (119 t) is similar to that reported in 2008 (117) and is within the target catch range for this fishery (Lake Argyle Silver Cobbler Figure 1).

In 2008, Argyle bream (sooty grunter, *Hephaestus jenkinsi*) were reported in the landed catch for the first time with a total of 8.8 tonnes landed.

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 2008, three vessels were active in the fishery, and generated an effort of 6,787 units (100 m net days), this level of effort is higher than the 5,823 units reported in 2007 (Lake Argyle Silver Cobbler Figure 1).

Recreational: Charter <1 tonne

Limited data are currently available on recreational fishing in this region. The reported charter boat catch for Lake Argyle from 2002 to 2008 was less than 1 t of silver cobbler per annum. There are no data available on general angling catches.

Fishery Governance

Commercial

Target commercial 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 derived the range. 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 catch in 2007 and 2008 has been within the target catch range (Lake Argyle Silver Cobbler Figure 1).

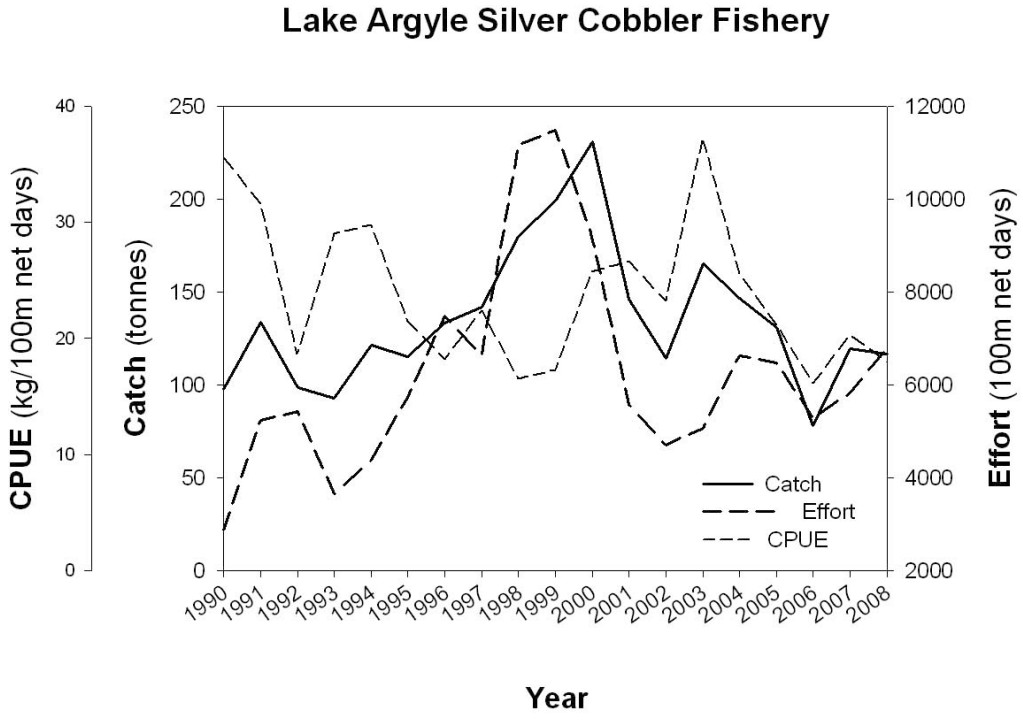
Current Fishing (or Effort) Level Acceptable

The levels of catch in the fishery in 2008 was similar to that reported in 2007 despite increased levels of fishing effort within the fishery. The 2008 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 (for the next year)

LASCF licence holders, and representatives from the Western Australian Fishing Industry Council (WAFIC) and Seanet are working with representatives from the Department of Fisheries and the Department of Environment and Conservation to review the current LASCF Bycatch Action Plan.

Future management measures for the LASCF include: i) a review of the legislative management arrangements of the Fishery, including consideration of amendments to the *Lake Argyle Fishery Notice 1994*; ii) consideration of incorporating key elements of the LASCF code of practice into the formal management arrangements for the Fishery in the future, iii) review of the latent effort present within the fishery, and iv) a possible shift in the seasonal closures to better accommodate the wet-season breeding period for the target species.



LAKE ARGYLE SILVER COBBLER FIGURE 1

The annual catch, effort and catch per unit effort (CPUE, kg/100 m net day) for silver cobbler in the Lake Argyle Silver Cobbler Fishery over the period from 1990 to 2008.

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 was expected to be issued by the end of June 2008; however, the group has recently expressed its wish to consider an alternate site. The Department has also issued an Aquaculture Licence to allow the production of 500 tonnes per annum of barramundi in Lake Argyle.

COMPLIANCE & COMMUNITY EDUCATION

The Northern Inland bioregion includes the freshwater rivers, lakes, billabongs and wetlands primarily located in the Kimberley. Commercial fishing is permitted in Lake Argyle (man-made lake) and in the tidal area of the mouth of the lower Ord River.

Compliance and education for the freshwater systems in the North Inland bioregion focuses on:

- 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
- commercial Silver Cobbler 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 2007/08

During 2007/08, Fisheries and Marine Officers (FMOs) recorded 443 hours of active compliance patrol time in the Northern Inland bioregion – a decrease compared to the previous year but aligned with historic levels of patrol activity (Northern Inland Compliance Patrol Hours Figure 1).

Across the Northern Inland bioregion, personal contact was made with 2,386 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 2008/09

Compliance service delivery will continue to target any areas of complaint and high levels of recreational fishing pressure. These locations are reviewed during annual risk-assessment processes.

Compliance activities relating to the only freshwater commercial fishery, which targets the Lake Argyle silver cobbler, will continue. The 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.

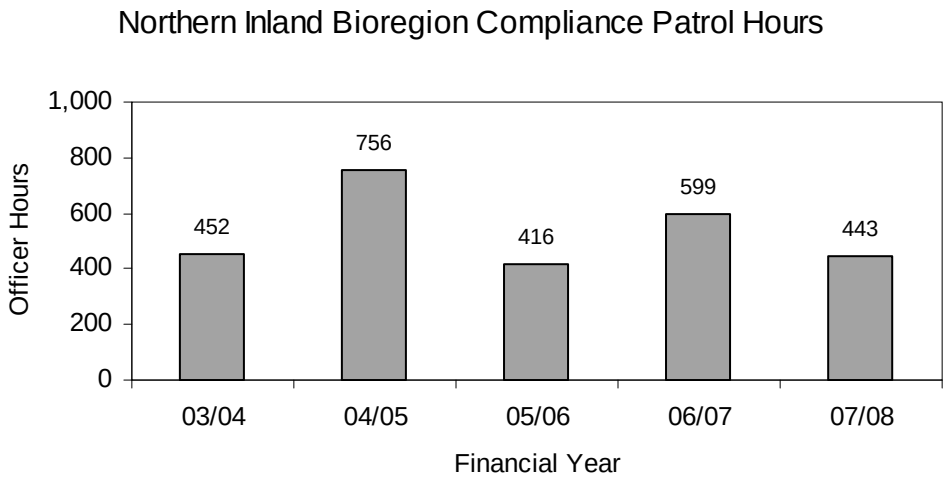
NORTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Northern Inland bioregion during the 2007/08 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	443 Officer Hours
*CONTACT WITH THE COMMERCIAL FISHING COMMUNITY**	
Field contacts by Fisheries & Marine Officers	15
District Office contacts	20
Infringement warnings	0
Infringement notices	0
Prosecutions	1
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	637
District Office contacts	25
Infringement warnings	6
Infringement notices	7
Prosecutions	1
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	2,386
District Office contacts	0
Fishwatch reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The "other fishing-related contacts with the community" category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine parks), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

** Fishwatch calls relating to the Northern Inland bioregion are not recorded, as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Northern Inland bioregion will be included in both the North Coast and Gascoyne Coast bioregion totals.



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 2007/08 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 BIOREGION

SOUTHERN INLAND BIOREGION

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. Most large fresh water bodies are man-made irrigation, water supply or stock-feeding dams. There is a diverse variety of natural water bodies in this region ranging from numerous small springs and billabongs, up to Lake Jasper, the largest permanent freshwater Lake in the south west region, with 440 ha of open water up to 10 m deep. In combination these diverse natural and man-made permanent waterbodies provide valuable habitat for fish and crayfish during the summer months. 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.

SUMMARY OF FISHING ACTIVITY

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 60 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. Silver perch are also grown in purpose-built ponds to supply local markets.

ECOSYSTEM MANAGEMENT

The conservation of the 13 species of freshwater native fish in freshwater ecosystems in the south-west of WA is a growing issue for the Department of Fisheries. Many of these species are endemic to WA, and under pressure through increasing salinity, feral fish populations, infrastructure (bridges and dams) and adjacent land-use development.

The Department works 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.

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.

In 2005 The Department of Fisheries was successful in obtaining a grant from the SWCC (South West Catchments Council) to collect "hairy" marron from the wild and establish a breeding program to save this rare species from extinction.

DNA fingerprinting was developed in collaboration with UWA to distinguish between pure "hairy" marron and hybrids. The DNA testing identified 230 pure "hairy" marron that were transferred to the Department of Fisheries Pemberton Freshwater Research Centre (PFRC) to establish a genetic repository of this critically endangered species. The breeding program has been very successful and has now progressed to the stage where sufficient "hairy" marron have been produced to permit restocking of the Margaret River with this critically endangered species. This will

re-establish this species in its natural environment and prevent its extinction.

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.

Most freshwater fish species are no longer present in large areas of their original range and some have been listed as critically endangered (e.g. Western trout minnow *Galaxias truttaceus hesperius*, and Margaret River marron *Cherax cainii*). While others have been listed as vulnerable to extinction (e.g. Balston's pygmy perch *Nannatherina balstoni*). This has resulted in a reduced abundance and distribution of many species in lakes, rivers and streams in the southwest bioregion.

The Department has therefore established a captive breeding program for the most critically endangered and vulnerable species at its Pemberton Freshwater Research Centre and Aquaculture and Native Fish Breeding Laboratory at the UWA Field Station Shenton Park (See Appendix 4). The project aims to: i) prevent extinction of endangered species by establishing living gene banks at research facilities; ii) develop techniques to breed endangered native fish and crustaceans; iii) produce endemic species suitable for restocking natural water bodies; iv) address human health concerns (e.g. Ross River virus) by restocking wetlands with native fish species that control mosquito populations.

In recognition of the need to manage the State's fish resources on an ecosystem-wide basis, the Department of Fisheries has an initiated Ecosystem Based Fisheries Management (EBFM) framework.

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 to ensure the sustainable management of fish stocks in the future. The EBFM risk assessment process for the West Coast Bioregion has been completed (see Table 1 for the West Coast Bioregion) and serves as an example of what will be undertaken for the Southern Inland Bioregion. 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.

FISHERIES
Licensed Recreational Marron Fishery Status Report

Prepared by M. de Graaf and T. Baharthah

Management input by Nathan Harrison

Main Features

Status	Current Landings
Stock level – Acceptable	Marron 14.1 t
Fishing Level – Acceptable	

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 southwest 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 (see http://www.fish.wa.gov.au/).

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 25th January to 17th February 2008. Three types of legal gear exist; scoop nets, drop nets and snares. 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 and biological characteristics (growth, size-at-maturity, fecundity etc) of key marron populations in different catchments. 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.

Retained Species

Commercial component: Nil

Recreational catch estimate (season 2008) 47,400 marron

The total catch for the 2008 season was estimated at approximately 47,400 ± 4,360 standard error (SE) marron or 14.1 ± 1.3 tonnes of marron (average weight marron 297g, based on logbook data). This is a decrease (~30%) compared to the previous season (2007: 69,900 ± 6,900 marron or 20.8 ± 2.1 tonnes; Fig. 1). The decrease in catch in numbers is due to a decrease in effort.

The overall CPUE (dams and rivers combined) recorded by fishers, based on phone surveys, was the same in 2008 at ~3.4 marron per fisher per day as was recorded in the previous season (Marron Fig. 1).

Note that the change in minimum legal size from 76 to 80 mm RCL 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 2008 season was estimated from phone surveys at around 14,000 days. Fishing effort significantly decreased (~30%) compared to the previous season of 20,300 days (Marron Fig. 1). This decrease was due to a large

decrease (~30%) in the number of participating licensed fishers which were down from 7,400 in 2007 to 5,200 in 2008. The number of fishing days per fishermen in 2008 was the same as in the 2007 season. The season length was 23 days in both 2007 and 2008.

The proportion of effort allocated to dams (~30%) and rivers (~70%) has remained stable between 2000 and 2008 (Fig. 2a). Among dams (Fig. 2b) Wellington Dam and Harvey receive by far the most fishing effort, with Harvey Dam being the most popular dam since 2005. Effort is more widely spread among the rivers in the South-West (Fig. 2c). The Blackwood River is the most popular site (~30% effort) followed by the Murray River (~14%) and Collie, Preston, Donnelly and Warren River all with receiving similar amount of effort of around 5-10%.

Stock Assessment

Assessment complete: Yes

Assessment Method:

Fishery Independent Direct Survey

Breeding stock levels: Acceptable

Fishery-dependent catch and effort data (e.g. CPUE as determined by logbook or phone survey) can be poor indicators of true stock abundance especially in heavily managed fisheries like the Recreational Marron Fishery. In 2006 a new stock assessment program using traps was initiated providing fishery-independent data on relative abundance and average size (mm Orbital Carapace Length [OCL]) of marron in three dams (Waroona Dam, Wellington Dam, Harvey Dam) and eight rivers (Shannon, Warren, Donnelly, Blackwood, Preston, Collie, Murray and Moore River). These three dams and eight rivers account for more than 75% of the total fishing effort of the Recreational Marron Fishery (see Fig. 1).

The annual fishery-independent survey provides vital data for monitoring trends in stocks, evaluating the performance of changes in management on stocks and will allow for recommendations to be made for adjustments to fishery management when necessary.

Relative abundance and size of marron varies greatly spatially among the surveyed rivers and dams (Fig. 3), however, within each water body little temporal variation in abundance or size was observed between 2006 and 2008.

In addition to data on abundance and size, the annual fishery independent survey also provides information on size-at-maturity and fecundity for each of the rivers and dams.

From the 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 80 mm Rostrum Carapace Length (RCL) for the majority of marron stocks in the south-west (e.g. Warren River ±56 mm RCL, Murray River ±54 mm RCL, Collie River ±42 mm RCL, Preston River ±60 mm RCL, Waroona Dam ±63 mm RCL, Drakesbrook Dam ±31mm RCL, Wellington Dam ±54 mm RCL). Present size restrictions seem to adequately protect the majority of the female breeding stocks. The exception with regards to size-at-maturity, are the stocks in Harvey Dam and Hutt River, where a larger female size-at-maturity of about 85 mm and 95 mm, respectively, occurs. A larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stocks and these water bodies are managed as 'Trophy' waters.

A tagging program may be incorporated in the annual fishery-independent stock assessment, to obtain information on growth and mortality of marron in the different rivers and dams.

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

For the 2008 season, a total of 18,458 licences were sold,

including umbrella licences (14,326). This represents a (-14%) decrease from the 21,542 licences in 2007. The marron fishery in the 2008 season involved approximately 5,200 licence holders undertaking about 14,000 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 $337,000 (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 $281,000 which is used to support recreational fishery management, research and compliance. In addition, the estimated 14,000 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: 96,000-136,000 marron

In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available research data and the knowledge of the marron fishery, the fishery be managed to a maximum target catch of between 96,000-136,000 marron. It should be noted that under current management arrangements (short 16 day season since 2003) the average estimated recreational catch has been around 55,000 marron. The most likely explanation for the current low annual catch is not limited marron stocks but the sharp reduction in effort since 2003 (Recreational Marron Figure 1). In 2007 the marron season was increased from 16 to 23 days. Assuming relative stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Developments in marron abundance (fishery independent surveys) and marron catches (phone survey and logbook) will be closely monitored after the 2008 season to determine the impact of the changes in season length and increase in legal minimum size. Existing management arrangements will be reviewed and if necessary adjusted prior to the 2009 season.

Current fishing (or effort) level — Acceptable

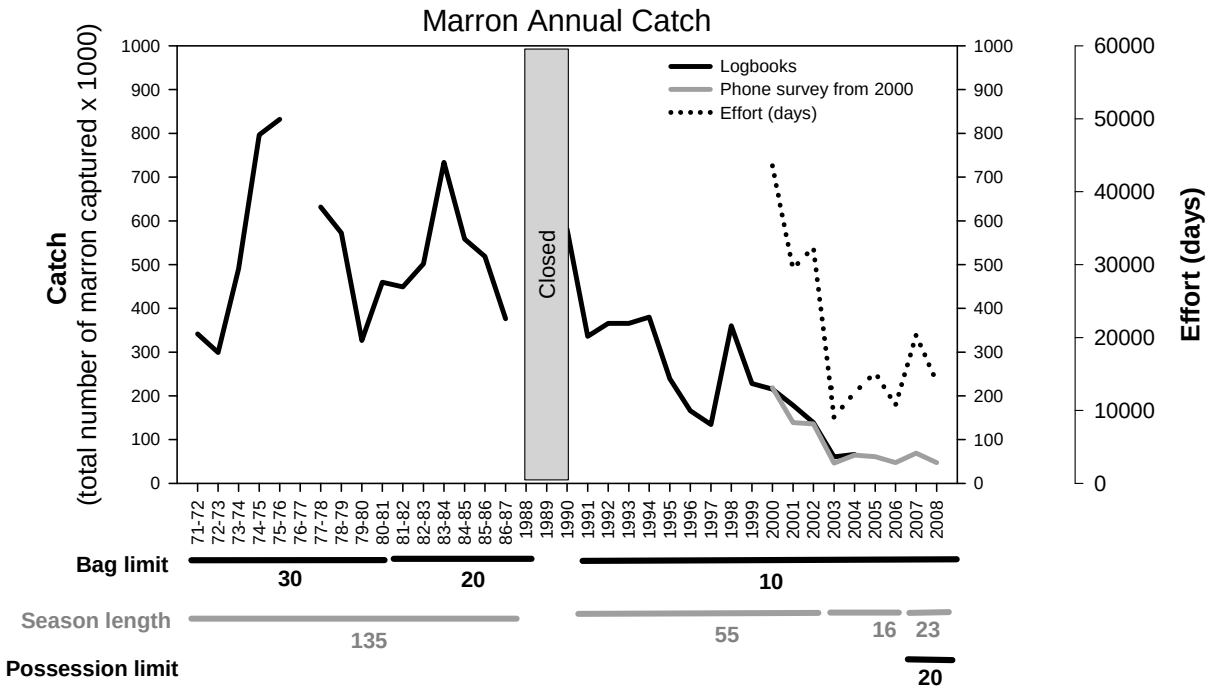
Fishing effort has been low under current management arrangements. Since 2003 when the reduced 16 day season was introduced effort (fishing days) dropped considerably from ~40,000 fishing days (2000-2002) to ~11,000 fishing days (2003-2006). The season length was extended from 16 to 23 days in 2007 and a significant increase in effort from ~11,000 (2003-2006) to ~17,000 fishing days (2007-2008) was observed.

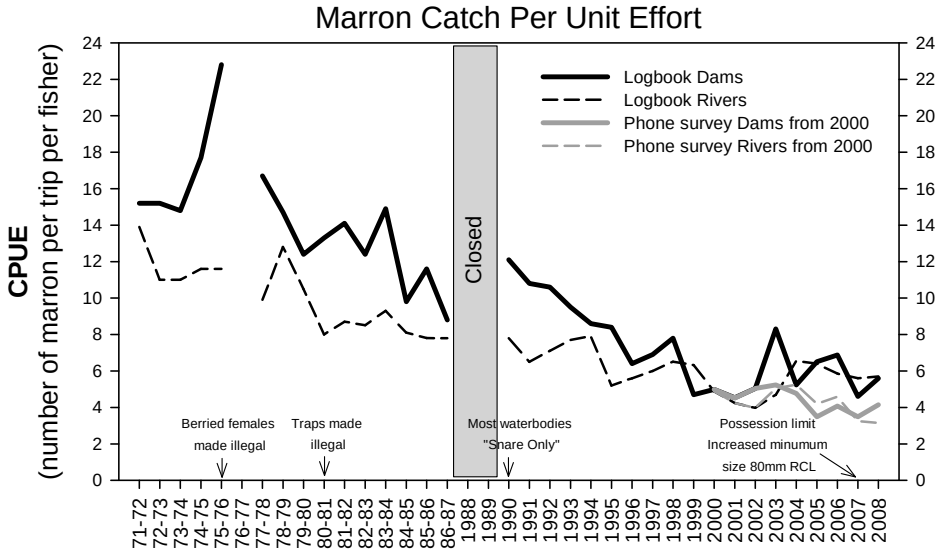
New management initiatives (2008/09)

No new managements initiatives will be introduced for the 2009 marron season. The marron season length will last again for 23 days, from 12 noon, Friday 16 January 2008 to 12 noon, Sunday 8 February 2009.

External Factors

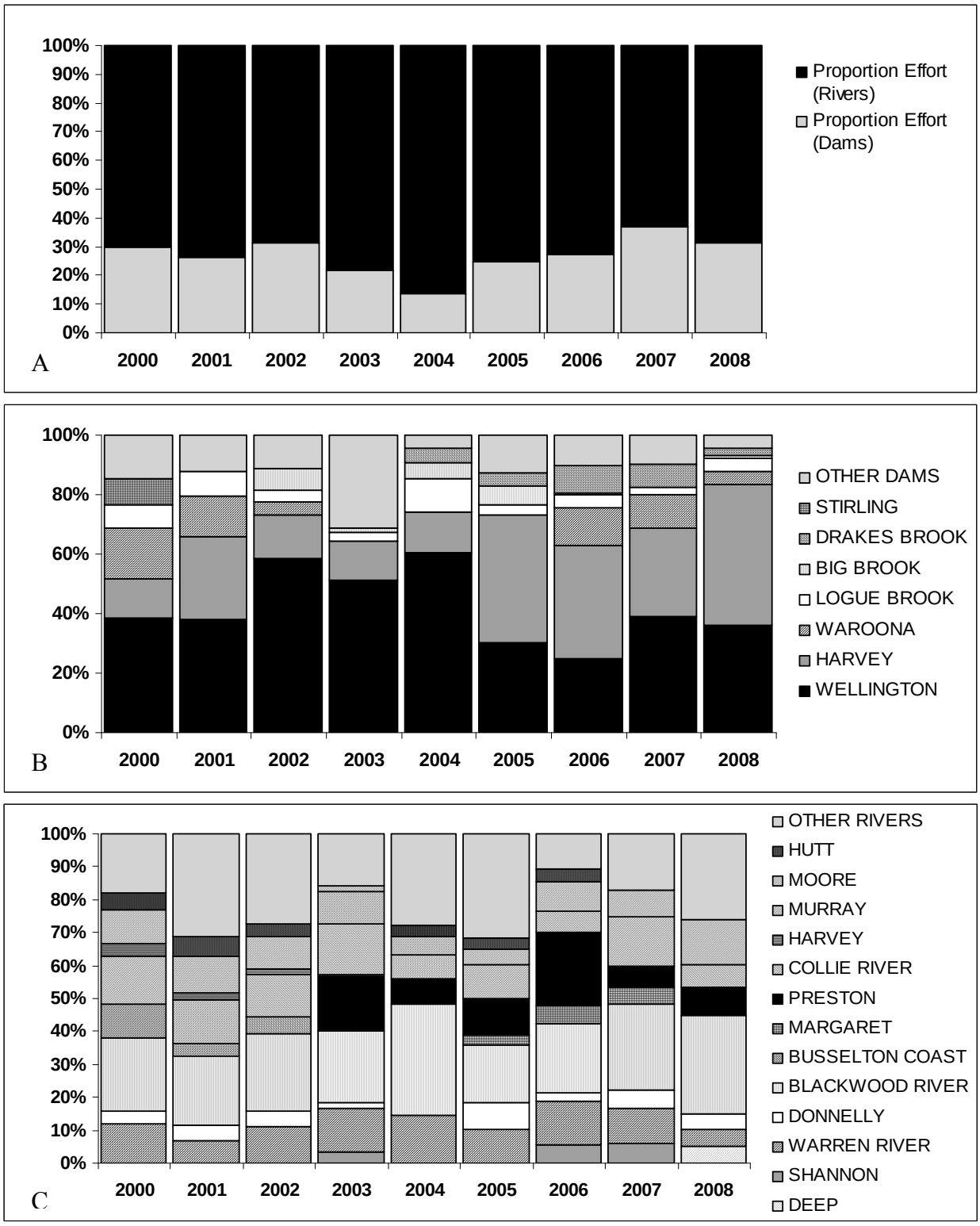
Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. A second major issue in 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 metropolitan water supply, and there is a strong possibility of limitations to fishing in Wellington Dam in the near future. Drakesbrook Dam, the next in line for maintenance work, is expected to be unavailable for recreational marron fishing in 2010 to possibly 2013. 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.





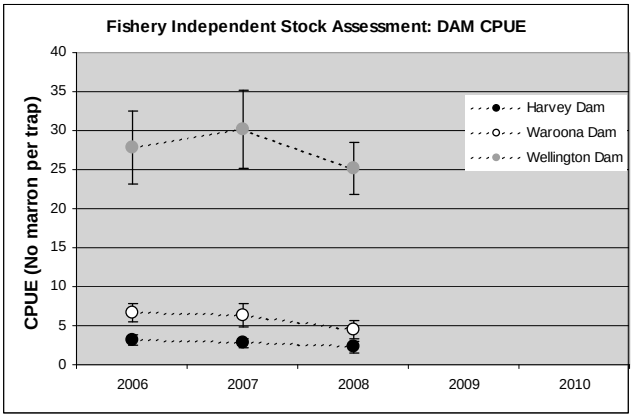
RECREATIONAL MARRON FIGURE 1

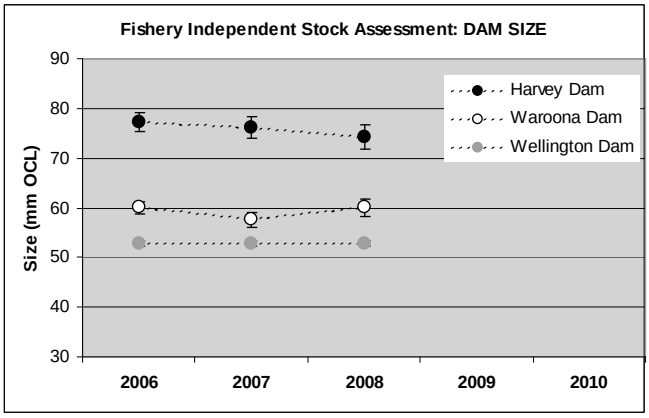
The estimated total catch (a) and catch per unit effort (b) of the recreational marron fishery between 1971 and 2008.

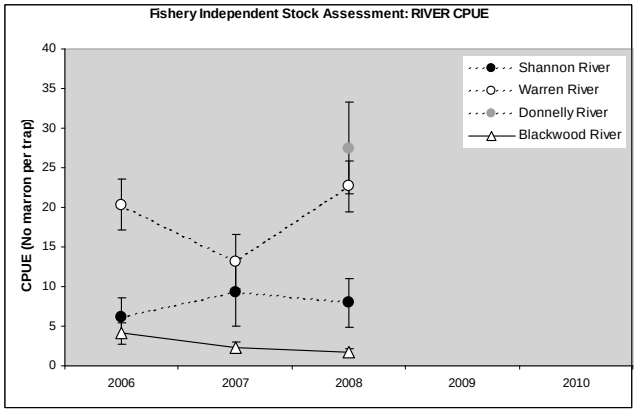


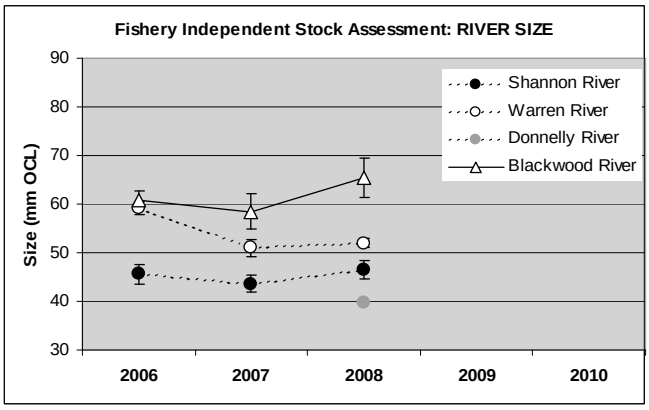
RECREATIONAL MARRON FIGURE 2

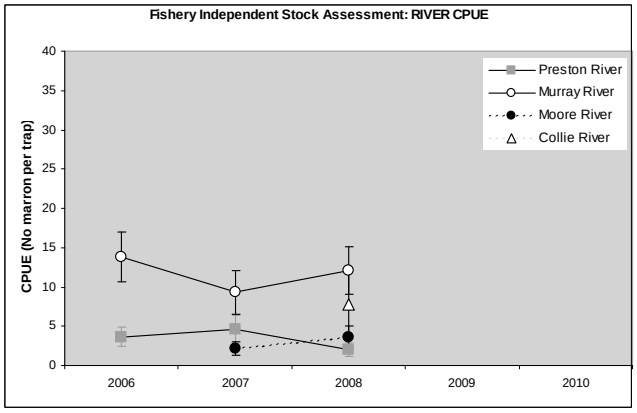
The distribution of effort over (a) rivers and dams, (b) among dams and ((c) among rivers of the recreational marron fishery between 2000 and 2008.

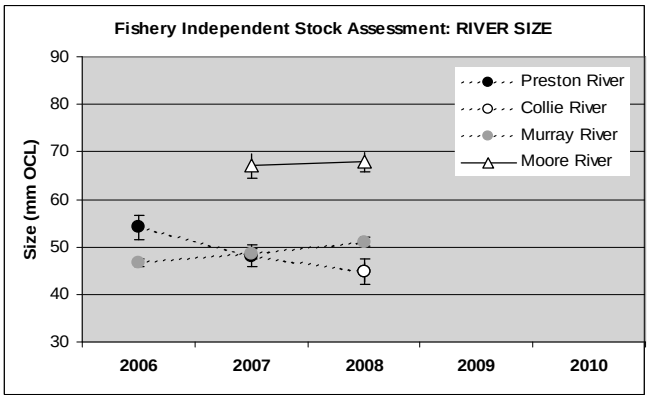












RECREATIONAL MARRON FIGURE 3

The relative abundance (CPUE) and size (mm OCL) of marron in three dams and eight rivers as determined by the fishery-indpendent stock assessment.

Licensed South-West Recreational Freshwater Angling Managed Fishery Status Report

Prepared by M. de Graaf and T. Baharthah

Management input by Nathan Harrison

Fishery Description

The south-west recreational freshwater fishery is primarily an angling fishery for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) which are the subject of an annual controlled stocking program by the Department of Fisheries. In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*) and an exotic species redfin perch (*Perca fluviatilis*). Redfin perch was previously released in the south-west and now occurs as self-breeding populations in most water bodies.

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^{o} 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. Licensed anglers may only use a single rod, reel and line or single handline when targeting these species.

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 RFAC Recreational Freshwater Fisheries Stakeholder Sub-Committee (RFFSS), focuses on public waters where trout have been stocked or been present since the 1930s. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

Landings and Effort

Commercial catch estimate (season 2007/08)

Not applicable

Recreational catch estimate (season 2007/08)

20.1 tonnes

An estimated 20.1 ± 3.4 t of fish were landed in this fishery by recreational anglers in the 2007/08 season, including 15.5 t of retained fish (43,800 fish) and 4.6 t of captured and released fish (23,000 fish). The estimated catch was composed of 12,300 rainbow trout (3.2 t), 1,600 brown trout (0.4 t), 48,200 redfin perch (15.4 t), 1,800 native freshwater cobbler (0.5 t) and 2,900 black bream (0.5 t) (Freshwater Angling Figure 1).

The overall reported catch is similar to the previous season, which was 26.8t. Landings of redfin perch (4%; 1,850 fish) remained similar while landings of rainbow trout (–23%: 3,600 fish), brown trout (-43%; 1,250 fish) and black bream (-91%: 29,800 fish) decreased significantly. Landings of native catfish (177%: 1,100 fish) increased compared to the previous season (Freshwater Angling Figure 1).

Estimates of fishing effort are based on telephone surveys of license holders. Total effort was estimated to be 24,900 days, similar to the previous season (23,800 days).

A catch rate of 2.7 fish of all species per day was estimated for the 2007/08 season. This included 1.8 retained fish and 0.9 released fish per angler per day. This is lower (~35%) than for the 2006/07 season but within the range of catch rates reported in the last eight years.

The stock levels of both rainbow and brown trout as indicated by catch rates and catches, have remained reasonably stable over the past seven years (Freshwater Angling Figure 1. Both species of trout display little or no breeding in local waters and the fishery is supported through the stocking of fry, yearling and ex-broodstock trout by the Department of Fisheries. Redfin perch breed in all waters, and dominate all freshwaters. The management arrangements (e.g. minimum legal size, bag limit) for native freshwater cobbler are currently under review based on historical and recent scientific data.

Fishery Governance

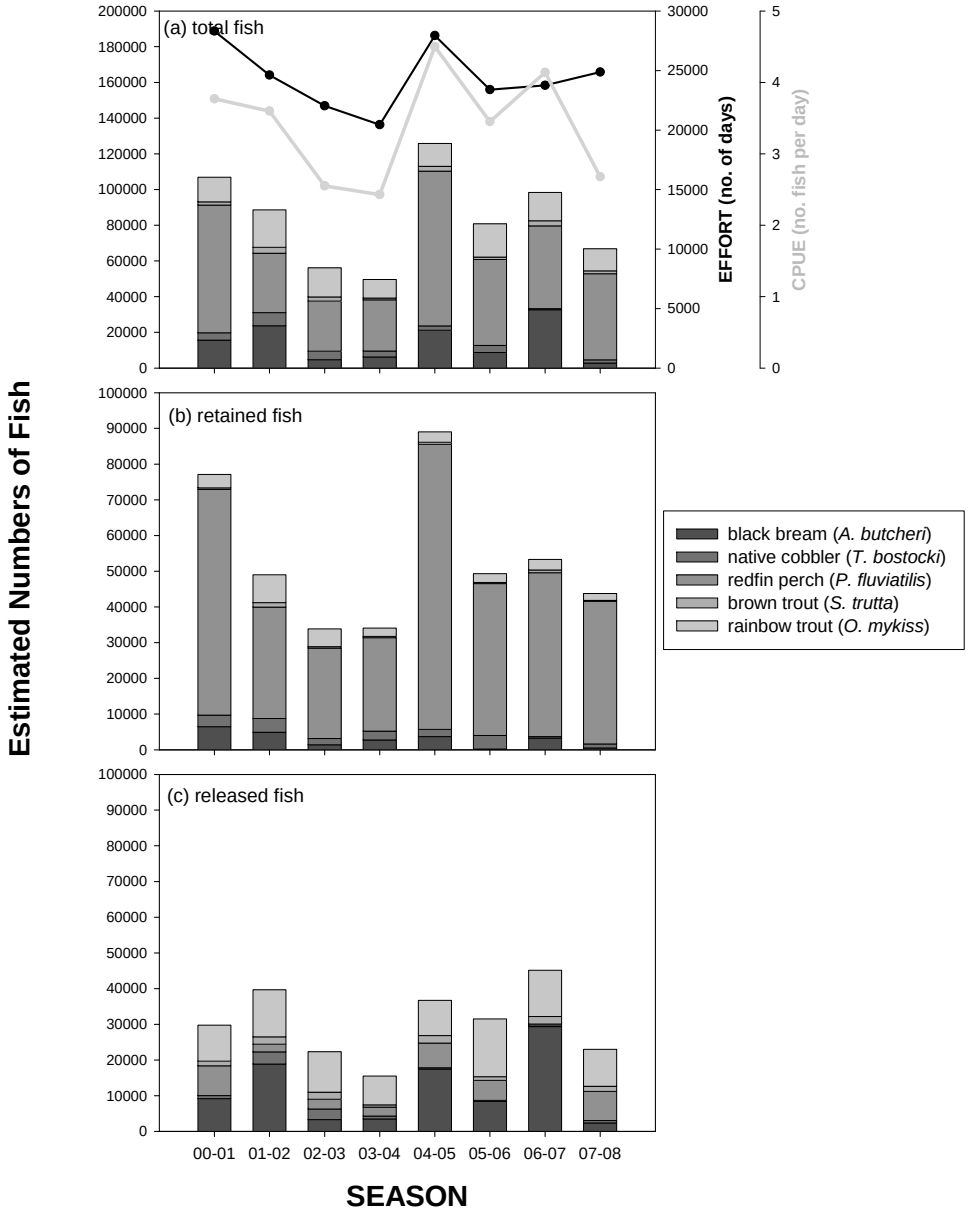
Target catch (or effort) range — Not applicable

Current fishing (or effort) level — Not applicable

New management initiatives (2008/09)

The Recreational Freshwater Fisheries Stakeholder Sub-committee (RFFSS) is currently reviewing the management arrangements for freshwater fisheries in the State's southwest. 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.

Baltson's Pygmy Perch (*Nannatherina balstoni*) and Western Trout Minnow (*Galaxias truttaceus hesperius*) are native freshwater fish species found in waters of the South West of WA that are both listed under the EPBC Act (1999) as Critically Endangered. In response to the threatened status of these native fish species, the Department of Fisheries is currently developing a strategy to minimise the impacts of trout stocking on threatened native fish species.



FRESH WATER ANGLING FIGURE 1

Estimates of the development of total catch, effort and CPUE (a) and total numbers of fishes reatined (a) and released (b) by species in the south-west freshwater angling fishery.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken 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 are applying the results of the 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 grain value-adding industry developed in Western Australia. Interstate and international exports, currently less than 10,000 tonnes per annum, vary according to production. Inconsistent grain supplies are reportedly impeding the growth of the industry and its ability to compete in larger markets that use other agricultural products as protein substitutes. One WA grain company is exploring options to increase the reliability of supply and, consequently, production volume and value.

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 second year. It is being undertaken with the co-operation of local compliance officers in the south west.

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 Fisheries Volunteer program is a vital education mechanism in the Southern Inland bioregion. Although the Volunteer 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 (28 days as of 2010), the risk of illegal fishing during the closed season (February-December) is extremely high.

Increasingly, dams and catchment areas once open to marroning are being closed by Water Corporation, which presents further challenges to ensure compliance in these areas. A number of Water Corporation Rangers have been authorized as honorary FMO's to assist with the compliance of illegal fishing on Water Corporation dams. Some DEC officers have also been authorized as honorary FMO's and play an important role in the marron compliance through out the South West. 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, particularly 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 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. The compliance effort in this fishery focuses mainly on closed waters, setting times, net lengths and licensing.

Activities during 2007/08

During 2007/08, FMOs delivered 1990 hours of compliance patrol hours to the Southern Inland bioregion (Southern Inland Compliance Table 1) – which is an increase from the compliance hours delivered in the previous year.

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 3207 field contacts with recreational fishers and 47 contacts with commercial fishers. During the year, 44 infringement warnings and 19 infringement notices were issued with 38 prosecutions instigated, of which all were for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The 2008 marron season was the third 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 2007 the compliance activities for the 2008 marron season were developed from a risk assessment process, and targeted areas of high risk identified through that process. The marron season start date has been reviewed to permit better long term planning for recreational fishers and the Department of Fisheries. As of 2010 the start date will be the 8th January each year and end on the 5th February.

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 inspection of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMO's also carry out joint patrols with police to investigate theft from farm dams.

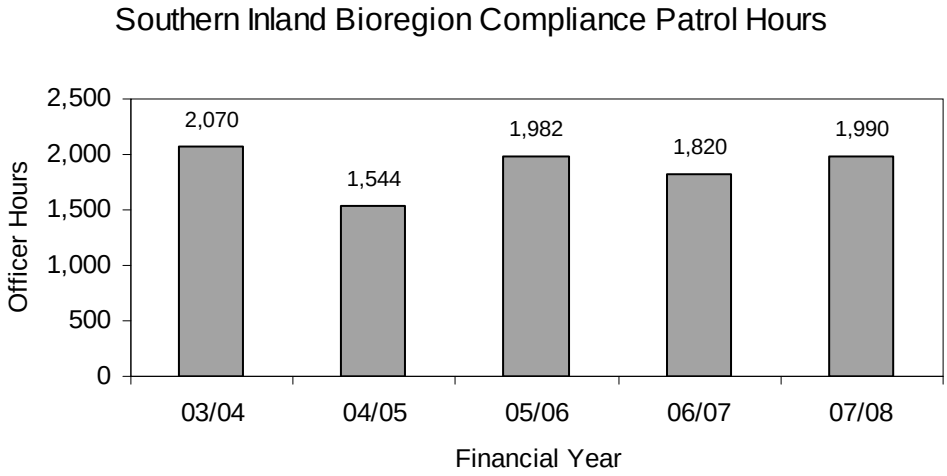
Initiatives for 2007/08

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 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 Volunteer program will be instrumental in delivering information to marron fishers and campers during the opening of the marron season at the Collie River, Harvey Dam 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 2007/08 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 2007/08 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	1,990 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	47
District Office contacts	0
Infringement warnings	0
Infringement notices	0
Prosecutions	0
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	3,207
District Office contacts	3,120
Infringement warnings	44
Infringement notices	19
Prosecutions	38
*OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY**	
Field contacts by Fisheries & Marine Officers	314
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

Marine Aquarium Fish Managed Fishery Report

S.J. Newman and M. Cliff
Management input from S. Brand-Gardner

Fishery Description

Commercial:
The Marine Aquarium Fish Managed Fishery (MAF) targets more than 250 species of fish under the management plan. By way of a Section 43 Order and Ministerial Exemption, fishermen also take coral, live rock, algae, seagrass and invertebrates. It is primarily a dive-based fishery that uses hand-held nets to capture the desired target species from boats up to 8 m in length. While the MAF operates throughout all Western Australian waters, catches are relatively low in volume due to the special handling requirements of live fish. Fishing operations are heavily weather-dependent due to the small vessels used and the potentially hazardous conditions (e.g. waves, 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 where collections can occur.

Recreational:
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.

Boundaries

Commercial:
The MAF operates in Western Australia's state waters spanning the coastline from the Northern Territory border in the north to the South Australian border in the south. The effort is spread over a total gazetted area of 20,781 km. During the past three years the fishery has been active in waters from Esperance to Broome with popular areas being around Dampier, Exmouth, Carnarvon and Perth

.

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 most are active. In 2008, 9 licences operated in the fishery.

Licencees are not permitted to operate within any waters closed to fishing (e.g. Rowley Shoals, Reef Protected Areas, sanctuary zones). The fishery is permitted to operate in general-purpose zones of marine parks for the collection of fish and some invertebrates (usually excluding coral and live rock). Fishing is also prohibited on Cleaverville Reef to exclude the take of coral and associated organisms.

Fish caught in this fishery may not be used for food purposes, and operators are not permitted to take species covered by other specific commercial management arrangements or management plans.

The MAF is permitted to take most species from the Syngnathid family (seahorses and pipefish), which is listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, there is a total ban on the take of leafy seadragons (*Phycodurus eques*). If the current ESD trigger value of 2000 individual syngnathids is reached, a review will be initiated, and the results used to determine whether further management action is required.

Landings and Effort

A total of over 22,167 fish were landed in 2008. 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 2008 levels of catch is provided in Marine Aquarium Fish Table 1. The reported landings of aquarium fish and syngnathids for 2008 are less than those reported in 2007.

Effort in the fishery has been relatively stable over the past three years at an average of 816 days fished, with nearly all licencees 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 the remote northern locations of WA) restricts the levels of effort that can be expended in the fishery at any given time.

Fishery Governance

Target commercial catch range: Not assessed

Current Fishing (or Effort) Level: Acceptable

The current effort level in the fishery is constant from year to year and the operating extent of the fishery is low relative to the widespread distribution of the plethora of species targeted. No other fisheries exploit these species and therefore there is limited potential for impact on breeding stocks. Therefore the current level of fishing activity is considered acceptable.

New management initiatives (2010)

New subsidiary legislation regulating the take of coral and live rock has provided access to live rock for all licencees and prohibited the take of the coral species *Catalaphyllia jardinei* in the Dampier Archipelago region. In addition, all categories of invertebrates, seagrass and algae are subject to annual and/or daily limits. The introduction of daily logbooks and a requirement to notify the Department prior to fishing is imminent for the MAF.

The Australian Government Department of Environment and Water Resources 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 2008.

COMMON NAME	QUANTITY (NUMBERS)	WEIGHT (KG)
Fish	20,949	
Syngnathidae (not included in Fish)	1,218	
Hermit crabs (land hermit crabs only -*Coenobita variabilis*)[1]	118,403	
Invertebrates	105,254	
Live-feed (mainly shrimps)		61
Algae/Seagrasses (litres)		789
Hard coral		5,014
Soft coral[2]		5,676
Live rock		4,527

1 Other fishers holding a separate exemption authorisation also collect hermit crabs.

2 The soft coral category includes 4,175 kg of coral like anemone groups such as corallimorphs and zooanthids in the Class Anthozoa. These are harvested under an invertebrate Ministerial Exemption and are not part of the annual coral TAC.

Specimen Shell Managed Fishery Status Report

A. Hart and M. Cliff
Management input from S. Brand-Gardner

Main Features

Status

Stock level - Acceptable

Fishing level - Acceptable

Current Landings

Specimen Shell Catch Total - Shell numbers - 13,355 shells

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.

This is a limited entry fishery with 32 licences in the fishery (but many are not active). Furthermore, 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. This includes 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.

The SSF is not permitted to take any mollusc species for which separate management arrangements exist – such as abalone, mussels, scallops and pearl oysters.

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 activity 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 2008): 13,355 shells

Recreational catch estimate (season 2008): Unknown

Commercial Landings

In 2008, the total number of specimen shells collected was 13,355, 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 2007 and 18% of those collected in 2008. 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 2008, 1,037 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 2008 season the catch rate was approximately 13 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% in 2006 64% in 2007 and 77% in 2008 of the shells sighted were not harvested. The measure of the number of shells sighted is reported correctly in only about 10% of the cases where one of the vulnerable species is reported.

The figures for 'sighted' versus 'taken' vulnerable shells continue to be poorly recorded by the majority of licensees, it is anticipated that current averages are an overestimate of harvest rates.

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, not all licensees are reporting correctly with many continuing 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 for logistical and safety reasons 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 having an unacceptable impact 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 2008, the catch level of approximately 13,355 shells and catch rate of 13 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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APPENDIX 1

Stock Status and Catch Ranges for Major Commercial Fisheries

(Appendix 5 from Annual Report 2008/09[1])

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
WEST COAST BIOREGION							
West coast rock lobster	Yes	Adequate	8,166 - 14,523	8,926 (Includes Windy Harbour and Augusta)	2007/08	Yes	The below average catch is due to relatively low puerulus settlement three to four years previously. The run of low settlements has resulted in significant effort reductions being introduced in 2008/09.
Roe's abalone	Yes	Adequate	106.7 (Q) (620 – 750 days)	93.2 (580 days)	2008	Yes	Full quota was not taken, therefore a lower level of fishing effort was used.
Abrolhos Islands and mid west trawl	Yes	Adequate	95 – 1,830	1216	2008	Yes	The annual recruitment (and therefore catch) of scallops is highly variable and dependent upon favourable environmental conditions. Good catches for this season were predicted from recruit surveys.
South-west trawl	No	NA	Not available	Prawns 8t Scallops 7t	2008	NA	
Cockburn Sound crab	Yes	Recovering	Not Applicable	0	2007/08	NA	The fishery continued to be closed for the 2007/08 season due to low breeding stock. The level of recovery of the stock is being monitored.
Deep sea crab	Yes	Adequate	140 t (Q)	139	2008	Yes	The introduction of a 140 t Total Allowable Commercial Catch (TACC) for this fishery began in 2008. The acceptable effort range to take the TACC will be determined over coming years.
Estuarine fin fisheries (west coast)	No	NA	75 – 220 (Peel-Harvey only)	174	2008	Yes	Catches have been stable since 2000.
West coast beach bait	Yes	Adequate	60 – 275 (whitebait only)	57	2008	Yes	Yearly fluctuations in whitebait stocks are due to environmental conditions.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
WEST COAST BIOREGION (CONTINUED)							
West coast purse seine	Yes	Adequate	3,000 (Q)	45	2008	NA	Continued low catches are due to a combination of market competition, irregular availability of market-sized fish and low activity levels by the fishing fleet.
West coast demersal scalefish	Yes	Inadequate	< 480 t	413	2007/08	Yes	Commercial catch was reduced through limited access management in January 2008. A TACC introduced in January 2009 is designed to maintain this catch in the desired range. Note that recreational catch still requires reductions.
GASCOYNE COAST BIOREGION							
Shark Bay prawn	Yes	Adequate	1,501 – 2,330	1,232	2008	Yes	King and tiger prawns were below the target range, due to targeting of larger-sized prawns for economic reasons. In addition, less effort was spent on prawns, due to increased targeting of scallops.
Exmouth Gulf prawn	Yes	Adequate	771 – 1,276	1,170	2008	Yes	The total catch was in the target range but catches of both tiger and endeavour prawns were above their individual target levels. This was related to good recruitment of these species. King prawns were below target range, due to targeting of tiger prawns.
Shark Bay scallop	Yes	Adequate	1,250 – 3,000	3,674	2008	Yes	The scallop catch was predicted to be above the acceptable levels, due to good recruitment.
Shark Bay beach seine and mesh net	Yes	Adequate	235 – 335	269	2008	Yes	Total catch and effort were higher than 2007 but the catch rates of all species were maintained.
Shark Bay snapper	Yes	Recovering	276.8 t (Q) (380-540 days)	229 t (382 days)	2008	Yes	At current TACC levels, the spawning biomass is projected to recover to the targeted level by 2014.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
NORTH COAST BIOREGION							
Onslow prawn	Yes	Adequate	60 – 180	33	2008	Yes	The low catch was associated with low fishing effort.
Nickol Bay prawn	Yes	Adequate	90 – 300	86	2008	Yes	The catches of banana prawns were below the predicted catch range. King prawn catches were low throughout the northern bioregion in 2008.
Broome prawn	Yes	Adequate	55 – 260	Negligible	2008	NA	Extremely low level of effort this year.
Kimberley prawn	Yes	Adequate	240 – 500	168	2008	Yes	Banana prawn catch is below range, due to lower effort and change to management strategy.
Kimberley gillnet and barramundi	Yes	Adequate	25 – 40 (barramundi)	50	2008	Yes	The catch of barramundi has increased substantially, due to increased effort. This will be monitored closely.
Northern demersal scalefish	Yes	Adequate	Total 600 – 1,000 (goldband <433) (red emperor <204)	Total 1010 (goldband 450) (red emperor 167)	2008	No	The outcomes of an independent science review will be incorporated into future assessments and management settings.
Pilbara fish trawl	Yes	Adequate	2,000 – 2,800	1,210	2008	Yes	Reduced catch levels were due to unused effort and the natural cycles in catch rates of some shorter-lived species. The acceptable catch range is currently being reviewed.
Pilbara demersal trap and line	Yes	Adequate	400 – 600 (trap) 50 – 115 (line)	508 (trap) 86 (line)	2008	Yes	Catches have increased due to higher retention of some species and higher abundance of target species (goldband and red emperor).
Mackerel	Yes	Adequate	410 (Q) 246-410 t (all except grey mackerel)	323	2008	Yes	Catch rates are increasing in the Kimberley and Pilbara. As the quota is accumulated over four zones, a catch range will continue to be used to assess acceptability.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
NORTH COAST BIOREGION (CONTINUED)							
Northern shark	Yes	Depleted	< 20 (key species)	NA	2007/08	N/A	Protocols for validating new trip logbooks are still being finalised. Therefore estimates of catch remain uncertain. Status of stocks remains the same.
Pearl oyster	Yes	Adequate	877,600 oysters (Q) (14,071 – 20,551 dive hours)	820,207 oysters (15,786 dive hours)	2008	Yes	Despite record high catches, effort was relatively low, due to the predicted entry of record year classes. The high abundance levels have resulted in an increased Total Allowable Catch of 1,060,400 for 2009.
Beche-de-mer	Yes	Adequate	50 – 150	196	2008	Yes	Total catch was above targeted range but two species are now being exploited. Species-specific indicators are currently under development for this fishery.
SOUTH COAST BIOREGION							
South coast crustacean	No	Uncertain	50 – 80 (southern rock lobster)	37	2007/08	Yes	The management arrangements, including the acceptable catch range, are currently being reviewed.
Abalone (greenlip/ brownlip)	Yes	Adequate	205 (Q) (907 – 1,339 days)	197 (1,144 days)	2008	Yes	
Estuarine fisheries (south coast)	Yes	Adequate	200 – 500	207	2008	Yes	The total catch is below 10-year average but the stock levels of key species are still considered adequate.
WA salmon	Yes	Adequate	1,200 – 2,800	879	2008	Yes	The total catch was similar to the previous year. Recent catches continue to be low relative to historic levels, due to low effort owing to limited market demand.
Australian herring	Yes	Uncertain	475 – 1,200 (south coast only)	192	2008	Yes	Stock levels appear to have declined from poor recruitment. The commercial catches have also been low as a result of the low effort levels owing to poor markets.

Fishery	Stock assessment complete	Breeding stock assessment	Target catch (and effort) range in tonnes (days)	Catch (tonnes) for season reported[2]	Season reported[2]	Catch (or effort) level acceptable	Comments on performance in reported season
SOUTH COAST BIOREGION (CONTINUED)							
Albany/King George Sound purse seine	Yes	Adequate	2,722 (Q)	1,448	2007/08	NA	Similar catch level to last few years.
Bremer Bay purse seine	Yes	Adequate	1,500 (Q)	192	2007/08	NA	Similar catch level to last few years
Esperance purse seine	Yes	Adequate	1,500 (Q)	82	2007/08	NA	Some increase has occurred this year but the catch levels remain low.
Southern and west coast demersal gillnet and longline	Yes	Gummy and whiskery recovering. Dusky and sandbar depleted.	725 – 1,095	NA	2007/08	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 previous assessment.
NORTHERN INLAND BIOREGION							
Lake Argyle catfish	Yes	Adequate	95 - 155	126	2008	Yes	Catch level similar to last year

NOTES:

1 The information in this table is also used in Appendix 5 of the Department of Fisheries' Annual Report 2008/09, where it underpins some of the Department's Performance Indicators. Appendix 5 in the Annual Report utilised an earlier draft of this table and may vary slightly from this version. The Performance Indicators calculated from the information have not changed.

2 Catch figures supplied for latest year/season available.

NA Not assessed.

Q Quota management.

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*	12,259	12,259
Anchovy	*Engraulis australis*	1,468	1,468
Australian sardine (Pilchard)	*Sardinops sagax ocellatus*	1,834,579	1,834,579
Barramundi (giant perch)	*Lates calcarifer*	30,495	44,811
Bass grouper	*Polyprion americanus*	2,276	2,276
Bigeye (not tuna)	Priacanthidae	18,663	18,663
Boarfish	Pentacerotidae	4,579	5,321
Bonito	*Sarda australis*	2,799	2,799
Bream, black	*Acanthopagrus butcheri*	40,209	40,209
Bream, monocle	*Scolopsis spp.*	13,288	13,288
Bream, Robinson's	*Gymnocranius grandoculis*	31,642	31,646
Bream, silver (tarwhine)	*Rhabdosargus sarba*	5,101	5,101
Bream, western yellowfin	*Acanthopagrus latus*	13,915	13,915
Catfish, sea (golden cobbler)	Ariidae	18,142	18,165
Chinaman fish (not cod)	*Symphorus nematophorus*	10,660	10,660
Cobbler	*Cnidoglanis macrocephalus*	48,556	69,285
Cobbler, silver	*Arius midgleyi*	95,300	139,775
Cod	Serranidae	72,743	72,866
Cod, bar (grey-banded, eight-bar)	*Epinephelus octofasciatus*	18,373	18,373
Cod, breaksea	*Epinephelides armatus*	5,267	5,370
Cod, chinaman	*Epinephelus rivulatus*	1,493	1,493
Cod, radiant/comet	*Epinephelus radiatus/morrhua*	642	642
Cod, Rankin	*Epinephelus multinotatus*	143,513	143,513
Cod, spotted	*Epinephelus microdon, E.areolatus, E. bilobatus*	46,753	46,754
Dhufish, West Australian (jewfish)	*Glaucosoma hebraicum*	113,457	118,531
Emperor, blue-lined (grass; black snapper)	*Lethrinus laticaudis*	2,338	2,338
Emperor, blue-spot	*Lethrinus hutchinsi*	279,115	279,115
Emperor, red	*Lutjanus sebae*	370,573	370,579
Emperor, red-spot (snapper)	*Lethrinus lentjan*	48,057	48,057
Emperor, spangled	*Lethrinus nebulosus*	70,257	70,277
Emperor, sweetlip	*Lethrinus miniatus*	116,410	116,419
Emperor, yellow-tailed	*Lethrinus atkinsoni*	770	770
Flagfish (Spanish flag)	*Lutjanus vitta, L.quinquelineatus, L.carponotatus, L.lutjanus*	104,987	104,987

Common Name	***Scientific Name***	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Flathead	Platycephalidae	8,936	9,107
Flounder	Bothidae	1,847	1,929
Garfish, sea	*Hyporhamphus melanochir*	33,627	33,627
Groper (wrasses)	Labridae	1,027	1,070
Groper, baldchin	*Choerodon rubescens*	15,744	16,092
Groper, blue	*Achoerodus gouldii*	31,358	38,593
Halibut	*Psettodes erumei*	1,059	1,059
Hapuku	*Polyprion oxygeneios*	12,567	12,580
Herring, Australian	*Arripis georgianus*	285,576	285,608
Herring, Perth	*Nematalosa vlaminghi*	4,348	4,348
Javelin fish	*Pomadasys spp.*	46,864	46,864
Jobfish (goldband snapper) –see Snapper, goldband			
Jobfish, rosy –see Snapper, rosy			
Jobfish (sharptooth snapper) –see Snapper, sharptooth			
Kingfish, black (cobia)	*Rachycentron canadum*	12,541	12,657
Kingfish, yellowtail	*Seriola lalandi*	627	631
Knifejaw	*Oplegnathus woodwardi*	862	886
Leather jacket	Monacanthidae	13,213	19,589
Mackerel, grey (broad-barred)	*Scomberomorus semifasciatus*	12,846	12,870
Mackerel, scaly	*Sardinella lemuru*	151,833	151,833
Mackerel, Spanish	*Scomberomorus commerson*	223,138	320,824
Mangrove jack	*Lutjanus argentimaculatus*	16,217	16,217
Morwong	Cheilodactylidae	642	642
Mullet, red	Mullidae	21,494	21,494
Mullet, sea	*Mugil cephalus*	259,769	259,818
Mullet, yellow-eye	*Aldrichetta forsteri*	33,729	33,729
Mulloway	*Argyrosomus hololepidotus*	21,371	22,364
Mulloway, northern (black jew)	*Protonibea diacanthus*	2,421	2,700
Parrot fish	Scaridae	5,785	5,869
Perch, darktail sea (maroon sea) -see Snapper, marron			
Perch, Moses –see Snapper, Moses			
Perch, pearl	*Glaucosoma buergeri*	47,427	47,427
Perch, red, maroon sea perch	*Lutjanus spp (large)*	20,450	20,450
Perch, yellowtail	*Amniataba caudavittatus*	2,581	2,581
Perches, other	Lutjanidae	4,192	4,192
Pike, sea	*Sphyraena novaehollandiae*	2,713	2,713
Pomfret, black	*Parastromateus niger*	2,377	2,402
Queenfish	*Scomberoides commersonnianus*	246	649
Redfish	*Centroberyx spp*	2,603	2,641
Redfish, bight	*Centroberyx gerrardi*	45,050	47,751
Redfish, yelloweye	*Centroberyx australis*	33,547	36,746
Rockcod, blackspotted	*Epinephelus malabaricus*	19,848	19,848
Rockcod, goldspotted	*Epinephelus coioides*	8,181	8,500
Salmon, Western Australian	*Arripis truttaceus*	681,222	684,142
Samson fish (sea kingfish)	*Seriola hippos*	40,604	42,357
Scad, yellowtail	*Trachurus novaezelandiae*	6,281	6,281
Shark, blacktip	*Carcharhinus spp.*	40,758	93,715
Shark, bronze whaler (dusky whaler)	*Carcharhinus obscurus*	93,098	148,461
Shark, common saw	*Pristiphorus cirratus*	2,960	6,706
Shark, eastern school	*Galeorhinus galeus*	8,956	14,240

Common Name	***Scientific Name***	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Shark, golden (copper whaler)	*Carcharhinus brachyurus*	33,605	53,432
Shark, gummy	*Mustelus antarcticus*	453,432	720,922
Shark, hammerhead	Sphyrnidae	49,111	93,329
Shark, lemon	*Negaprion acutidens*	6,782	18,283
Shark, mako (shortfin)	*Isurus oxyrinchus*	2,468	3,914
Shark, pencil	*Hypogaleus hyugaensis*	685	1,089
Shark, pigeye	*Carcharhinus amboinensis*	12,162	33,397
Shark, saw	*Pristiphorus spp.*	1,694	3,948
Shark, spinner (long-nose grey)	*Carcharhinus brevipinna*	18,312	29,116
Shark, thickskin (sandbar)	*Carcharhinus plumbeus*	128,787	249,288
Shark, tiger	*Galeocerdo cuvier*	12,657	31,765
Shark, whiskery	*Furgaleus macki*	111,243	166,856
Shark, wobbegong	Orectolobidae	33,357	52,891
Shark, other		6,236	8,631
Shovelnose (fiddler rays)	Rhinobatidae *&* Rhynchobatidae	1,853	6,170
Skates and rays, other		5,973	15,886
Snapper, bullnose (variegated emperor)	*Lethrinus ravus*	3,531	3,531
Snapper, crimson (formerly red snapper)	*Lutjanus erythropterus*	238,860	238,860
Snapper, fingermark (golden)	*Lutjanus johnii*	179	502
Snapper, frypan	*Argyrops spinifer*	64,757	64,757
Snapper, goldband	*Pristipomoides multidens*	618,991	618,991
Snapper, long nose	*Lethrinus olivaceus*	14,575	14,575
Snapper, maroon (formerly maroon sea perch)	*Lutjanus lemniscatus*	12,191	12,191
Snapper, Moses (formerly Moses Perch)	*Lutjanus russelli*	39,631	39,631
Snapper, nor-west	Lethrinidae	11,552	11,552
Snapper, pink	*Pagrus auratus*	465,024	470,705
Snapper, queen	*Nemadactylus valenciennesi*	47,760	54,582
Snapper, red (swallowtail) –see Snapper, crimson			
Snapper, rosy (formerly Rosy jobfish)	*Pristipomoides filamentosus*	33,194	33,194
Snapper, ruby	*Etelis spp.*	39,672	39,672
Snapper, saddletail sea (formerly scarlet sea perch)	*Lutjanus malabaricus*	193,442	193,442
Snapper, sharptooth	*Pristipomoides typus*	1,152	1,152
Sprat, blue	*Spratelloides robustus*	36,157	36,157
Sweep	*Scorpis aequipinnis*	2,221	2,341
Sweetlip	Haemulidae	72,056	72,891
Tailor	*Pomatomus saltatrix*	31,614	31,614
Threadfin	Polynemidae	6,448	6,904
Threadfin bream (butterfish)	Nemipteridae	168,706	168,754
Threadfin, giant (king salmon)	*Eleutheronema tetradactylum*	109,562	112,726
Trevalla, deepsea	*Hyperoglyphe antarctica*	7,865	8,150
Trevally, golden	*Gnathanodon speciosus*	5,332	5,332
Trevally, other (skippy)	Carangidae	169,204	169,255
Trevally, skipjack	*Pseudocaranx dentex*	9,975	10,094
Tripletail	*Lobotes surinamensis*	5,850	6,055
Trout, coral	*Plectropomus maculatus*	16,296	16,370
Trout, spotted (duskytail grouper)	*Epinephelus bleekeri*	2,737	2,737
Trumpeters	Terapontidae	761	761
Tuna, northern bluefin	*Thunnus tonggol*	504	510
Tuna, yellowfin	*Thunnus albacares*	650	699
Tuna, other	Scombridae	29,560	29,602
Tuskfish, bluebone	*Choerodon spp.*	7,900	7,900
Whitebait	*Hyperlophus vittatus*	76,144	76,144

Common Name	***Scientific Name***	Landed weight (kg)	Live weight (kg)
FISH (continued)			
Whiting, King George	*Sillaginodes punctata*	12,122	12,122
Whiting, western sand	*Sillago schomburgkii*	123,597	123,872
Whiting, other	Sillaginidae	560	569
Other fish		69,586	70,384
TOTAL FISH		**9,489,489**	**10,447,303**
CRABS			
Crab, blue swimmer (blue manna, sand)	*Portunus pelagicus*	902,148	902,148
Crab, champagne (spiny)	*Hypothalassia acerba*	11,076	11,076
Crab, crystal (snow)	*Chaceon bicolor*	203,431	203,431
Crab, giant (king)	*Pseudocarcinus gigas*	6,351	6,351
Crabs, other		6,477	6,477
TOTAL CRABS		**1,129,483**	**1,129,483**
PRAWNS			
Prawn, banana	*Fenneropenaeus merguiensis*	253,499	253,499
Prawn, brown tiger	*Penaeus esculentus*	844,412	844,412
Prawn, western king	*Melicertus latisulcatus*	1,255,053	1,255,053
Prawns, other	Penaeidae	398,508	398,508
TOTAL PRAWNS		**2,725,188**	**2,725,188**
LOBSTERS			
Bugs	Scyllaridae	9,935	9,944
Rock lobster, southern	*Jasus edwardsii*	36,885	36,885
Rock lobster, western	*Panulirus cygnus*	8,952,281	8,952,281
TOTAL LOBSTERS		**8,999,101**	**8,999,110**
MOLLUSCS			
Abalone, brownlip	*Haliotis conicopora*	14,376	35,679
Abalone, greenlip	*Haliotis laevigata*	55,612	148,310
Abalone, Roe's	*Haliotis roei*	78,808	98,400
Cuttlefish	Sepiidae	38,079	38,136
Octopus	*Octopus spp. (mainly O. tetricus)*	95,629	122,853
Scallop, saucer	*Amusium balloti*	992,725	4,958,245
Squid	*Sepioteuthis spp., Loligo spp.*	40,501	40,574
TOTAL MOLLUSCS		**1,220,101**	**5,442,197**
OTHER CLASSES			
Beche de Mer	Holothuridae	58,895	176,685
TOTAL OTHER CLASSES		**58,895**	**176,685**
GRAND TOTAL		**23,694,418**	**29,083,881**

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/fishery/cwp/handbook/B/en

APPENDIX 4
Research Division – Other Activities

PEMBERTON FRESHWATER RESEARCH CENTRE ACTIVITIES 2008/09

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, 48 tank trout nutrition facility, and a training centre. The nearby Dr Noel Morrissy Research Ponds feature 25 earthen ponds, ranging in size from 150m2 breeding ponds to 1000m2 commercial grow-scale ponds, 28 tanks and a post-harvest handling facility. This site on Thomsons Flat also includes an area that is leased to the Pemberton Aquaculture Producers (PAP) for marron processing and marketing.

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 PFRC requires a high level of expertise. As a result PFRC staff provide a key regional extension service to aquaculture, recreational fishing and conservation client groups.

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 2008/09 are briefly discussed below:

Trout production for recreational fishing, aquaculture and research

Trout production at 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 2008/09 the PFRC produced 625,000 fry. These consisted of 619,000 Rainbow trout fry and 6,000 Brown trout fry, representing a decrease in production of 3.3% and 85% respectively, compared with 2007/08. The majority of production (83%) consisting of 513,000 Rainbow trout fry and 6,000 Brown trout fry were stocked into public waterways to support recreational fishing. A further 61,000 Rainbow trout (9.75%) were sold to individuals and clubs for stocking private farm dams for recreational fishing and tourism, included in the 61,000 trout fry sold to the recreational groups were 22,000 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 our present heat shock method.

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 2008/09 commercial farmers purchased 15,000 fry from PFRC representing 2.4% of PRFC trout production.

The remaining 4.8% of trout produced 30,000 were retained for future brood stock for PFRC, yearling stocking, research and sales for private waters.

In 2008/09 during the Winter-Spring months some 18,000 Rainbow yearlings as well as 2,700 Rainbow and 200 Brown trout ex brood stock, were released to public waters for recreational fishing.

Also during 2008/09, 2,300 Rainbow yearlings were sold to individuals for private recreational fishing.

Trout research for recreational fishing and aquaculture

In late 2006 the Department 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, however prior to disposing of this valuable line, that is highly regarded by recreational fishers, Research Division staff commenced a study to confirm the extent of this problem and determine the contributing factors. 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 the department into brown trout sperm motility 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 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 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 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. In 2008/09 staff completed a series of temperature tolerance experiments that demonstrated that the PFRC rainbow trout genetic line can withstand water temperatures of up to 28oC without any mortalities. This temperature tolerance is superior to most domesticated lines elsewhere and is significant in regards to adapting to global warming.

Furthermore, the experiment showed that 50 % of PFRC trout could survive 29oC, while 100% losses occurred at 30oC. This indicated that there was genetic variation for temperature tolerance in the PFRC stock that could be exploited by selective breeding to produce a genetic line that could withstand higher temperatures. A genetic line of yearling trout that could tolerate 29oC was created, but the experiment was discontinued before the stock could be transferred to PFRC breeding ponds.

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 PFRC obtained the first hydrostatic pressure chamber for manipulating chromosome numbers to produce triploids and tetraploids in Western Australia.

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 2008/09. 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 1) Juveniles were produced and 2) 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 were individually tagged and placed into ponds with diploid siblings. They were reared at PFRC to sexual maturity, but DNA analysis to identify tetraploid female broodstock could not be completed prior to the breeding season in 2008/09. This research project will recommence when resources permit.

Native fish and crayfish conservation and biodiversity research

In response to a declining prevalence of native fish in the southwest PFRC established brood stock populations of two endemic species Pygmy Perch (*Edelia vittata*) and Western Minnows (*Galaxias occidentalis*). The aim of this research project is to develop large-scale pond production techniques for these 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 populations of Pygmy Perch (*Edelia vittata*) and Western Minnows (*Galaxias occidentalis*) established at PFRC were weaned onto a commercially available formulated pellet. The Pygmy perch broodstock subsequently spawned in concrete tanks, eggs hatched and larvae were reared. Modifications are being implemented to the hatchery protocols for these 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 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 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 (RAPID's) to identify "pure" marron from hybrids in collaboration with UWA. This resulted in the establishment of

the only "pure" brood stock population of the rare Margaret River marron at PFRC. These broodstock produced over 1200 juveniles in the first year of this project. These juveniles have been reared to sexual maturity at PFRC, and their progeny will be used to restock the Margaret River catchment in July 2009.

In addition, captive breeding populations from three other river systems were established at PFRC. These broodstock 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 PFRC. Their progeny will be available for 1) marron farmers wishing to increase the genetic diversity of their stocks based upon the results of the recently completed FRDC marron project, 2) wild fisheries research involving the release and recapture of tagged juveniles in the recreational marron fishery, and 3) 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 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 PFRC produced around 25,000 juveniles for sale to industry. A repository population of the better performing genetic lines was retained at PFRC for future selective breeding and sale of progeny to industry. Increased demand for these juveniles has necessitated re-establishing the breeding program at PFRC to supply industry.

ACTIVITIES OF THE FISH HEALTH UNIT DURING 2008/09

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. One full-time, two part-time fish pathologists, one research scientist, one laboratory manager and one technical officer permanently staff the unit. Two additional technical officers are funded on research contracts

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 2008/09 were as follows:

The fish health laboratory received a total of 148 diagnostic cases during the 2008/09 – a decrease on the previous period.

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, the same as last year. This decline is due to the continuing drought and to changes within the industry.

The provision of pearling translocation certificates also showed a slight decline to 22 cases, reflecting the downturn in the economy.

There were no notifiable diseases reported in 2008/09.

Staff spent time assisting a number of sea-cage culture farms in WA coastal waters. This is a growing area of activity in Western Australia.

Investigation of a continuing mortality of pearl oyster (*Pinctada maxima*), that began in 2006, has resulted in extra workload for the Fish Health staff. 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. Work is continuing through two Fisheries Research and Development Corporation (FRDC) funded projects; FRDC 2008/30 to develop methods to detect stress in oysters and FRDC 2008/31 to investigate novel *Chlamydia*-like bodies in pearl oysters.

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 about the same number investigated as 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 a range of national committees including the national Aquatic Animal Health Committee, the National Animal Health Strategy Advisory Group and Biosecurity Australia. This reflects the greater emphasis on national coordination and consultation on aquatic animal health issues under the national AQUAPLAN 2005-2010 biosecurity strategy.

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 identify putative virus particles in lobster (*Panulirus ornatus*) pueruli from Vietnam.

INDIAN OCEAN TERRITORIES FISHERY STATUS REPORT

S.J. Newman, M. Pember, C. Skepper and L. Bellchambers
Management input from R. Green

Main Features

Status	Current Landings
Stock level – Some species at risk	Total - Not assessed
Fishing Level – Not Assessed	Main Commercial Fishery – Not reportable

Fishery Description

Commercial:

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 nm, under a Service Delivery Arrangement with the Commonwealth Attorney General's Department (AGD), and AFMA continues to manage the waters from 12nm to 40 nm. 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 (CILF) 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 Aquarium Fish Fishery (CKIMAFF) primarily targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*).

Recreational:

Large amounts of recreational/artisanal fishing are undertaken around the Cocos (Keeling) Islands and Christmas Island targeting both finfish and invertebrate species. The Cocos (Keeling) Islands consist of a diverse range of fishable habitats that include a sheltered lagoon, fringing reefs and offshore 'blue water' environments that support a range of demersal and pelagic fish species, as well as various crustaceans (e.g. crabs) and molluscs (e.g. gong gong), which are highly sought after by fishers for both individual and community purposes. Christmas Island has a limited amount of habitat available for fishing with no lagoon present, fringing reef surrounding the island and offshore 'blue water' environments that support a limited range of demersal and pelagic fish species, as well as some invertebrates in comparison to the Cocos (Keeling) Islands.

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 Licenses 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 processes

Commercial:

Department–industry/community consultation – Christmas Island and Cocos (Keeling) Islands.

Recreational:

Community Consultation - Cocos (Keeling) Islands and Christmas Island.

Boundaries

Commercial:

The territorial seas from the shoreline out to a distance of 12 nautical miles around the Cocos (Keeling) Islands and Christmas Island (Indian Ocean Territories Figure 1).

Recreational:

All the waters surrounding the Cocos (Keeling) Islands and Christmas Island.

Management arrangements

Commercial:
The Christmas Island Line Fishery (CILF) is managed primarily through input controls in the form of limited entry to the fishery and gear restrictions. There are 3 licenses in the fishery. In 2008, only 1 license 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 licence in the fishery) and gear 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.

Recreational:
Island-specific fisheries management arrangements for the Indian Ocean Territories are currently being developed. This will include assigning species to a number of risk categories and the development of species-specific or species group specific bag and size limits.

Research summary

Risk assessment workshops were undertaken in 2006 and 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 focused 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.). Biodiversity research has also established a reef-monitoring program to detect changes in reef health due to natural and anthropogenic impacts.

Retained Species

Commercial landings (season 2008): Not reportable

Wahoo (*Acanthocybium solandri*) is the main target species of the CILF. Other pelagic species are also targeted during the trolling operations and include yellowfin tuna (*Thunnus albacares*) and to a lesser extent mahi mahi (*Coryphaena hippurus*). Some commercial fishing activities are also undertaken for demersal fish species mainly deep slope species such as ruby snapper (*Etelis* spp.). The commercial catch for Christmas Island consists of catch data from only two vessels and thus the catch data is not reportable due to confidentiality provisions. The catch in 2008 was lower than reported in 2007.

The CKIMAFF targets the endemic Cocos Angelfish or Yellowheaded Angelfish (*Centropyge joculator*), and to a lesser extent the lemonpeel angelfish (*Centropyge flavissima*). As there is only one license in the CKIMAFF the catch data is not reportable due to confidentiality provisions.

Recreational catch estimate (season 2008): 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

Commercial:
Effort in the CILF has been relatively stable over the past two years. Effort in the Fishery is weather dependent and is 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.

Effort in the CKIMAFF has been similar over the last few years providing a similar level of catch.

Recreational:
Effort by recreational anglers at both Cocos (Keeling) and Christmas Island is weather dependent. At the Cocos (Keeling) Islands the prevailing weather conditions determine what part of the Island complex is subject to fishing activities. Access to the water at Christmas Island is limited to the principal boat ramp at Flying Fish Cove, and to a lesser extent the Ethel Beach boat ramp.

Stock Assessment

Assessment complete: Yes

Assessment method: Risk Assessment

Breeding stock level: Some species at risk

Beche de Mer:
In 2006 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. Bêche-de-mer stocks are very sensitive to fishing pressure and have been have been heavily overexploited in other areas of the Indian and Pacific Oceans.

Gong Gong:
The common spider conch or gong gong (*Lambis lambis*) is 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, 2008 and 2009 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.

Giant Clams:

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, research has been expanded to assess the status of *Tridacna* clams at the islands. In addition, an on-going reef monitoring program has been 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.

Finfish:

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 (we presently know very little 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 pelagic species that are targeted by the CILF (e.g. wahoo, yellowfin tuna) are likely to be part of a wider Indian Ocean stock. However, the demersal species are likely to be localized stocks that are reliant upon self-recruitment (a key research gap).

There is anecdotal evidence of localised depletion of some deep slope species like rosy snapper (*Pristipomoides filamentosus*) and ruby snapper (*Etelis carbunculus*) around Christmas Island. An increasing number of recreational fishers are using electric-powered lines to target deep-slope demersal finfish species at the Indian Ocean Territories, thereby increasing the effective fishing effort for these species.

Aquarium Fish:

The CKIMAFF targets *Centropyge joculator* and to a lesser extent *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.

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 seabirds at Christmas Island.

No protected species interactions have been reported for the CKIMAFF.

Ecosystem Effects

Food chain effects: Not assessed

Habitat effects: Negligible

The line fishing methods used in the CILF and the hand collection method used in the CKIMAFF are likely to have minimal impact on the habitat.

Social Effects

Commercial:

At least 2 people were employed in the CILF around Christmas Island during 2008. 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 2008.

Recreational:

Due to their sport fishing and eating qualities, wahoo and other pelagic species are popular target species for recreational anglers and fishing charter operators at the Indian Ocean Territories, particularly at Christmas Island. 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 the use of a large number of small vessels. Similarly, recreational fishers at Christmas Island undertake fishing activities from a number of small vessels and also fishing from the shore and catch a large variety of

demersal finfish species including a large number of deep slope species.

Economic Effects

Estimated annual commercial value (to fishers)

for year 2008: 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

Commercial:

Current Fishing (or Effort) Level: Not assessed

Target commercial catch range: Not assessed

The potential fishing effort for both pelagic and demersal fish species at both the Cocos (Keeling) Islands and at Christmas Island is high with a capacity to operate over the entire 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 is above optimum levels.

The catch of the CKIMAFF has been small 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 (2010)

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.

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 department is developing Island-specific fisheries management arrangements for the Indian Ocean Territories.

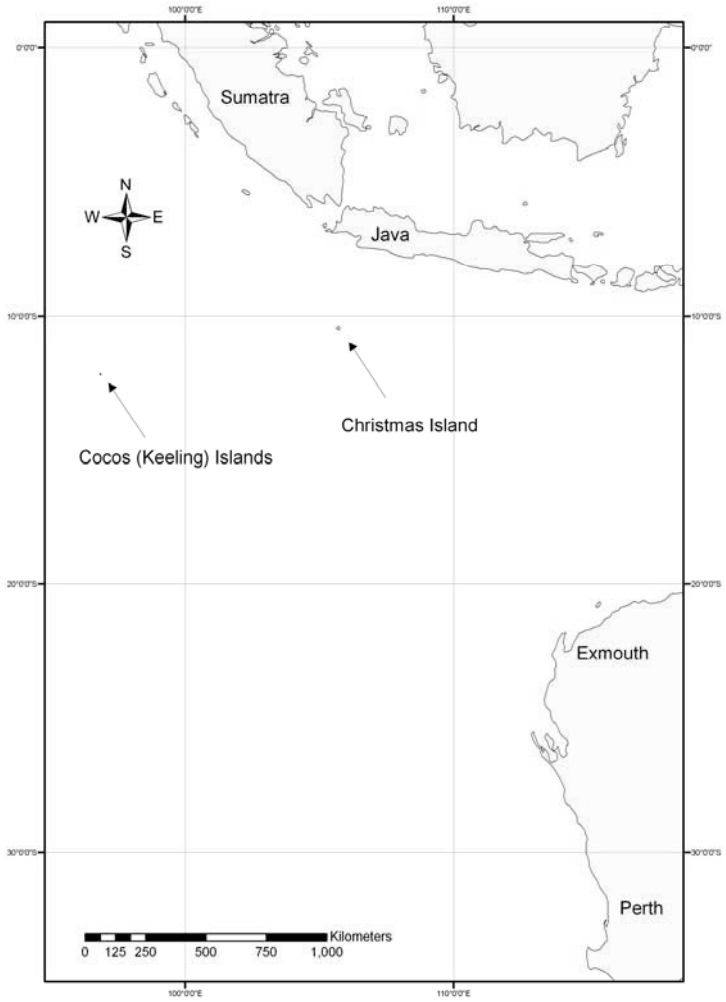
A draft paper is to be developed for the Cocos (Keeling) Islands, outlining the development of a community-based commercial fishing-licensing framework that would ensure that the commercial license would remain on the Island for the benefit of the Cocos (Keeling) Island communities.

The Department 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.

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 2007/08 season or the calendar year 2008.

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 2007/08 or 2008	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 9.9 t	Acceptable	Adverse weather conditions limited fishing A reduction to 5t recommended for 2009
	Roe's abalone Area 2 (spawning stock)	Effort range 80–106 diver days; total catch 19.8 t	Acceptable	85% 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 t	Acceptable	
	Roe's abalone Area 6 (spawning stock)	Effort range 80–127 diver days; total catch 12 t	Acceptable	
	Roe's abalone Area 7 (spawning stock)	Effort range 175–215 diver days; total catch 36 t	Acceptable	Effort was lower due to reduced TACC
	Roe's abalone Area 8 (spawning stock)	Effort range 140–200 diver days; total catch 12t	Acceptable	

Fishery details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
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	Total catch above range due to additional target species (deep water redfish. Target catch range will be revised as more Information becomes available
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	Negligible fishing occurred this season
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–90 t (7-year catch range)	Acceptable	As above
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	Below range due to greater targeting of tiger prawns
	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

Fishery details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
	Coral prawns (spawning stock)	Total catch within acceptable range of 20–100 t	Acceptable	Catch slightly below range due to low retention of species.
	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	Below due to lower effort and changes to the management strategy.
	Brown tiger prawn (spawning stock)	Total catch within acceptable range of 15–60 t	Acceptable	As above
	Endeavour prawn (spawning stock)	Total catch within acceptable range of 7–80 t	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of 0–6 tonnes (10-year catch range)	Acceptable	As above
	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 2007/08 or 2008	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	
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	Not Met	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.	Not Met	As 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	Very low effort
		Onslow: total catch within acceptable range of 2–90 t	Acceptable	
	Brown tiger prawn (spawning stock)*	Acceptable catch ranges of Nickol Bay 2–40 t and Onslow 10–120 t	Acceptable	As above
	Western king prawn (spawning stock)	Acceptable catch ranges of Nickol Bay 20–70 t and Onslow 10–55 t	Acceptable	As above

Fishery details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
	Endeavour prawn (spawning stock)	Total catch within acceptable ranges; Nickol Bay 1-10 t and Onslow 5-20 t.	Acceptable	As above
	Coral prawns (spawning stock)	Total catch within acceptable range of Nickol Bay 1–15 t (10-year catch range) and Onslow 4–20 t	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 due to very good stock levels.
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	
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	

Fishery details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
	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	
	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	

Fishery details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
	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 below historical level, 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 details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
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 and small shift of effort to scallops.
	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	
	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 details	Issue/species	Performance measure	Current performance in 2007/08 or 2008	Comment
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	
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	New management arrangements for south coast crustacean fisheries should be finalised In 2010
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 2007/08 or 2008	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	As the fishery has moved to catch quota, the performance measure needs to be updated.

APPENDIX 6
Fisheries Research Division staff adjunct positions and Supervision of students

Staff Member	Position
Brian Jones	Adjunct Professor, Murdoch University
	PhD co-supervision, Murdoch University, supervises Susan Kueh - “Diseases of Asian seabass or barramundi”
Corey Wakefield	Honours student co-supervision, Murdoch University, supervises Nick Breheny – “Larval fish assemblages in the three adjacent marine embayments of Owen Anchorage, Cockburn Sound and Warnbro Sound”.
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."
	Honours student co-supervision, Murdoch University, supervises Broderick Hosie - "Genetic relationship of blue swimmer crabs Portunus pelagicus between southwest fisheries in Western Australia"
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".
Martin de Graaf	Honours student co-supervision, Murdoch University, supervises Renea Larsen - Octopus biology
Rod Lenanton	Adjunct Associate Professor, School of Biological Sciences and Biotechnology, Faculty of Sustainability, Environmental and Life Sciences, Murdoch University.
Sagiv Kolkovski	MSc co-supervision, Edith Cowan University, supervises Justin King - ‘Artemia production’
Stephen Newman	Adjunct Associate Professor – Centre for Marine Futures, University of Western Australia.
	Adjunct Associate Professor – Centre for Fish and Fisheries Research, Murdoch University

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 escapement device
FHPA	Fish Habitat Protection Area
FMO	Fisheries and Marine Officer
FRDC	Fisheries Research and Development Corporation
FV	Fisheries Volunteer (formerly VFLO)
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
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